INTRODUCTION TO BIODYNAMICS

Learning Objectives

The learner will:

- Understand the basics of biodynamics, including the history, the approach, and the preparations.

I) Historical Overview – Justus Von Liebig (1803-73) "father of Ag. Chemistry" - NPK

a. WWI brought NO3 (saltpeter) fertilizer made from bomb making surplus
b. Tanks became tractors
c. poison nerve gas became insecticides, and herbicides
d. Sir Albert Howard (1873-1947) – soil=plant health , Indore compost process
e. Lady Eve Balfour (1898-1990) , the Living Soil (1943), founded the Soil Ass'n (UK) and Mother Earth Magazine.

II) Rudolf Steiner (1861-1925) from rural Austria, studied in Vienna

a. edited Johann Wolfgang von Goethe scientific writings – a bridge between nature and spirit
b. modern science only understands what is dead in nature, overlooks the spiritual aspect of reality
c. Introduced Anthroposophy and spiritual science
d. Led initiatives in education, health, care of mentally handicapped, architecture, theology, agriculture, economics and other fields
e. June 1924 held the Agriculture lectures in Koberwitz (then E. Germany, now Poland) to a group of farmers familiar with Anthroposophy
f. Problems that these farmers had begun to notice included: new pests (nematodes in sugar beets), decline in vigor in alfalfa (replant every 5 years, instead of 30 yrs.), decline in seed vigor in wheat, rye, oats, and increase in hoof and mouth disease in cattle.
g. From this lecture rose the "experimental circle" of farmers to implement these ideas and evaluate. By 1928 – 66 BD farms, and 148 members in Demeter
h. WWII – Anthroposophy and BD banned by Nazis\
i. Now – BD is widespread in Europe, Australia, NZ, India and to a lesser extent in US and Canada

III) The Biodyanmic Approach:

a. A holistic background necessary to understand the complexity of nature
b. Becoming a student of nature: Mind –rational/philosophical, spirit-emotional, Tactile- experience of plants, animal, minerals, weather
c. Understanding the gesture of nature – "Farm as an Organism"
d. Plant and animal health is tied to the health of the land and soil
e. Reading the book of nature – pests & disease result of imbalance in the soil
f. BD aims to enhance the biological process through stimulating microbiological activity in soil and compost
g. Organic=common sense approach -> "nature knows best" (beneficial insects, compost, garlic and pepper sprays)

h. BD Approach includes a much wider scope -> sun, moon, planets, subterranean features, looking deeper into the spirit of nature
i. Aiding nature where she is weak after centuries of abuse and destructive processes
j. Not letting things run their natural course (we harvest lettuce before it goes to seed, we interrupt many natural processes, e.g. Field to forest succession)
k. Service to Earth and its creatures, diverse plantings, hedgerows, bird & bat houses, bee pastures, closed loop systems, using natural rather than technological solutions (permaculture)
l. Fighting bugs and disease are not aims, rather support the good and health and balance will result
m. Low productivity, insect pests and disease are not problems, they are symptoms. The problem is the solution

IV) Biodynamic Preparations

a. Field Sprays: 500 –Horn Manure –supports soil humification, microbial innoculant / catalyst
b. 501 - Horn Silica – organizes photosynthesis – works with light elementals
c. Compost Preparations
d. 502 – Yarrow – Sulfur (S) and potassium (K)
e. 503 - Chamomille – Calicium (Ca), Sulfur (S), Nitrogen (N)
f. 504 – Nettles – S, K, Ca, Iron (Fe) – plant nutrition and soil health
g. 505 – Oak bark – Ca – combats plant diseases through strengthening cell wall through Calcium forces
h. 506 – Dandelion – K & Silica (Si) – Silica attracts cosmic forces to the soil
i. 507 – Valerian – Phosphorus (P) – warmth process and attracts earthworms
j. 508- Horsetail – Silica (Si) – fights fungal conditions, good in Greenhouse
k. Barrel compost – method to apply the benefits of the compost preparations to pastures and areas which don't regularly receive compost
l. Catalysts, Inoculants and homeopathy
m. Penicillin, aspirin – not necessary to understand the entire process through which the biodynamic preparations work in order to use them

V) Cosmic Rhythms-

a. humans 85% water, celery 98%, milk is 70%
b. lunar rhythms; apogee vs. perigee, ascending, & descending phases, eclipses
c. Perigee brings forces that result in poor germination, inhibited growth, fungus, disease, pests (dull, heavy rainy weather)
d. Apogee – clear and bright weather – generally not good planting time other than potatoes

NOTES

COMPOSTING

Composting on a farm is of utmost importance. It is the very definition of "renewable resource" turning by-product or waste product into vitally important soil supporting material. Compost improves tilth, biological activity; it acts as a buffer against over or under fertilization etc. in the soil. The return on investment of energy put towards the creation and maintenance of compost piles on the farm is one of the best available to farmers and gardeners. With a very basic understanding of this living mass, any individual can be successful at composting and this can play a key component in the consistent improvement of soil conditions over the years.

Learning Objectives

The learner will:

- Understand the various roles of compost on a farm
- Have a basic understanding of the processes involved in decomposition
- Learn how to make a good compost pile and proper application methods
- Understand the definition and importance of quality "tilth" in soil

Compost

- Compost is the action and end result of decomposing organic materials in their raw form turning into a vitally important soil amendment that improves the overall quality and tilth of soil
- Compost can be produced through the act of decomposing plant matter as well as decomposing animal manure

Roles of Compost on a Farm

- Recycles waste material on site
- Adds large amounts of humus to soil
- Increases soil fertility and stabilizes elements such as nitrogen
- Hugely increases biological activity in soil
- Improves soil structure and ability to retain water or create percolation of water through soil
- Creates outlet for potentially harmful excess of raw manure in animal based agriculture
- Compost is a wonderful example of alchemy, changing waste material into vitally important materials.

Decomposition

- Two types of decomposition: Aerobic decomposition is the breakdown of raw materials in which oxygen is present. This is the type of decomposition that is relevant for composting. Anaerobic decomposition is the breakdown of raw materials in the absence of oxygen and can be identified by a distinct foul smell

and a generally "slimy" feel.
- Organisms involved in aerobic decomposition

Bacteria

- Breakdown of carbonaceous material
- Heat pile by CO2 respiration
- Actinomycetes bind aggregates in pile through fungal like "gray" growth

Fungi

- Performs more complex decomposition roles such as the breakdown of cellulose
- Binds free particulates together improving overall soil structure
- Breaks down woody particulates in compost pile

Macro-organisms

- These organisms include earthworms, beneficial nematodes, fermentation mites, and springtails.
- Most macro-organisms feed on earlier inhabitants of the compost pile. They're beneficial in their support of the food chain inside the compost pile.
- They produce castings, which contribute to the overall fertility of the soil.
- They aerate the compost mix, which introduces more oxygen, which in turn helps the pile finish faster and decompose more thoroughly.

Components of a Good Compost Pile

- Carbon to nitrogen ratio is important to overall viability and health of pile. Initial ratio should be approximately 25:1 by weight.
- Moisture in pile should be equivalent to a moist sponge. A good rule of thumb should be the fist crumble test. One should be able to grab a fist full of compost and squeeze it into a ball that holds its form but crumbles under slight pressure.
- Dimensions of the pile are important. Optimal size is 6'x6'x6'. This creates conditions that are most manageable and appropriate for a hot compost pile.
- Optimal temperature should be between 130°F to 150°F. Anything over 150°F can begin to kill beneficial microbes.
- The compost pile should be covered in most conditions. This will prevent excess water from leaching out good nutrients and possibly having negative runoff. It will also retain moisture in times of no rain and excessive heat, cutting down on the need to introduce water to the pile.
- The compost pile should be turned regularly using one of many different available means. Turning the pile redistributes heat, biological activity, and moisture content. Turning a pile can finish compost up to 10 times faster than letting a pile sit unturned.

Application of Compost

- Five to seven tons of compost per acre is a generally acceptable rate of application for field dispersal.
- Intensive garden situations can use up to 10 tons per acre.
- When developing a new garden or field, compost should be integrated into the top 18 inches of soil.
- For a developed field, compost integration should be no deeper than eight inches.
- Compost should be applied in the spring prior to planting, midseason as an amendment side dress, and in fall prior to cover cropping.

Glossary of definitions:

- Tilth: the state of aggregation of soil and its condition for supporting plant growth. (this refers to the general overall suitable nature of a soil's capacity to grow and sustain cultivated plant life)
- Humus: a brown or black complex variable material resulting from partial decomposition of plant or animal matter and forming the organic portion of soil

Assessment/Review

- Name several roles of compost on the farm.
- What types of organisms help the decomposition process?
- Why is it important to turn a compost pile on a regular basis?

NOTES

COVER CROPS

Learning Objectives

The learner will:

- Be introduced to various types of cover crops and their specific applications.
- Be able to identify various benefits of cover crop application.

Why Use Cover Crops?

The role of cover crops in organic farming systems:

Cover crops are one of the primary fertility and soil management tools available to the organic farmer, and are an important strategy for preventing nutrient and soil loss from a field. They are crops grown primarily for soil or ecosystem improvement rather than cash and can provide a variety of services, from increased nitrogen (N) input, to soil protection, to weed and disease suppression. However, they can also have negative consequences if they are managed incorrectly or the wrong species are chosen.

Cover crop, green manure, and catch crop refer to different primary functions of the crops planted.

- Cover crop: Mainly used to prevent soil erosion by covering soil with living plants
- Green manure: Crop grown mainly to be turned under for soil improvement
- Catch crop: Used to "catch" nutrients left after harvest of a cash crop and prevent leaching

These are not mutually exclusive functions. For example, a fall-planted cereal + legume crop that is incorporated the following spring can serve as a cover crop, green manure, and catch crop. However, different species and mixes may perform one function better than another.

Perennial Cover Crops

- Perennial cover crops are most often planted in pastures and orchards.
- Often perennial cover crops require irrigation.
- Perennial cover crops have multiple purposes and benefits.
    - Providing forage
    - Holding soil/preventing runoff and erosion
    - Retaining moisture in soil/drought tolerance
    - Fixing nutrients through root system
    - Preventing leaching of nutrients from runoff
    - Smothering weeds
    - Cycling nutrients up from subsoil
    - Penetrating hard subsoil
    - Improving soil structure

Self-Seeding Annual Cover Crops

- Self-seeding annual cover crops are most often planted in fallow fields and in orchards.
- Often annual cover crops do not need to be irrigated.
- Annual cover crops have similar purposes and benefits as the list above. But the seed cycle makes it an ideal option for western climates with a dry summer.

Green Manure

- Green manure is a term for an annual crop sown for the purpose of incorporating the back into the soil. The green manure crop can be fall, spring, or summer sown, and irrigated or not.
- Green manure has benefits similar to those of other cover crops, but when the crop is incorporated into the soil the following additional benefits are realized:
    - Trapping nutrients (nitrogen, phosphorus) in the soil that were fixed from atmosphere via root systems
    - Adding tons of carbon (organic matter) to the soil. This builds humus, a biological soil network that is the key to unlocking nutrients in the soil. (Addition of organic matter is also beneficial to soil structure, water holding capacity, air circulation, and friability.)

How to Choose a Cover Crop

a) Identify what you want the cover crop to do:
- Provide nitrogen
- Increase soil organic matter (SOM) and improve nutrient availability by increasing soil biological activity
- Scavenge nutrients left in the soil after the cash crop and prevent loss by leaching
- Prevent soil erosion
- Improve soil structure
- Improve drainage
- Protect water quality
- Provide mulch to conserve soil moisture
- Provide habitat for beneficial insects and spiders
- Suppress weeds
- Suppress soil borne pests and diseases

b) Identify the cover crop planting niche
- Define timing of critical field operations for cash crop production
- Winter cover crops
- Summer cover crops

c) Select cover crop species or mix to meet the goals and requirements from steps 1 and 2

I. Examples - Field Activity

Tour various cover crops, identify components (nutrient fixing plants, scaffold plants, carbon source plants), and dig holes to expose soil profile.

- Perennial - alfalfa, some clovers, rye, fescue, orchard grass, birdsfoot trefoil
- Self-seeding annual - rose clovers, sub-clovers, medic, rye
- Green manure
  - Cold weather - peas, oats, fava beans, vetch (vulnerable at seedling below 20 F), rye, triticale
  - Warm weather - buckwheat, black-eyed peas, cow peas, sudan grass

Assessment/Review

- What are the three basic types of cover crops?

- What are the specific benefits of each type of cover crop application?

NOTES

CROP ROTATION

Learning Objectives

The learner will:

- Understand various benefits of a system of crop rotation.
- Examine two popular rotational designs.

Crop Rotation Overview

- Crop rotation is the practice of growing a wide variety of crops in a sequential system throughout the field with the intention of avoiding a buildup of disease and pests associated with mono-cropping.
- Crop rotation also promotes good soil health by alternating crops with different nutrient needs, therefore avoiding depletion of any one necessary element present in the soil.
- Crop rotation can also benefit overall soil structure by alternating deep and shallow rooting plants, breaking up subsoil and reducing the effects of plow pan.
- The practice of crop rotation is ancient in its use, and is widely recognized as a cornerstone of good agricultural practice.

Importance of Legumes in Crop Rotation

- Legumes are plants in the family Fabaceae and are described as nitrogen fixing" plants. Legumes collect nitrogen from the air and fix it on the root systems in the form of nodules.
- Legumes are a great crop to alternate with heavier feeding plants such as corn. The legumes return nitrogen to the soil after the plant is harvested or dies back.
- Legumes fix nitrogen through a symbiotic relationship with bacteria known as rhizobia that is naturally occurring in soil but often introduced in the form of an inoculant by the farmer planting the legume.
- Two types of legumes that are farmed are forages and grain. Common forages are: alfalfa, vetch, and clovers. Common grains are: Beans, lentils and peas.

Benefits of Crop Rotation

- Crop rotation can increase yields by15-20% when compared to monoculture.
- Increases the overall biomass of the soil
- Improves weed suppression by maintaining better soil health and providing living leguminous mulches.
- Provides valuable fodder for livestock while enriching the soil.

Popular Rotational Designs

- *The Corn Belt system on large farms:* Apply manure, grow corn, follow with soybeans, apply manure, grow corn, and follow with several plantings of alfalfa. In this rotation, legumes fix nitrogen in the soil before the heavy feeder crop (corn, in this example.) Specific plant pest cycles are interrupted. Specific plant disease is similarly suppressed. In this crop rotation, alfalfa cultivation also serves to smother weeds. Manure is applied before the heaviest feeder. Livestock feed is grown for use on farm or for sale.
- *Intensive vegetable rotational system:* This eight year rotational cycle can be adapted to many growing regions. Sweet corn followed by tubers followed by squash, followed by root crops then beans followed by tomatoes, followed by peas then Brassicas. This style has been most recently made popular by Eliot Coleman and is benefited by the following relationships.
    - ***Potatoes*** *follow sweet corn…because research has shown corn to be one of the preceding crops that most benefit the yield of potatoes.*
    - ***Sweet Corn*** *follows the cabbage family because, in contrast to many other crops, corn shows no yield decline when following a crop of brassicas. Secondly, the cabbage family can be undersown to a leguminous green manure which, when turned under the following spring, provides the most ideal growing conditions for sweet corn.*
    - ***The Cabbage Family*** *follows peas because the pea crop is finished and the ground is cleared [early] allowing a vigorous green manure crop to be established.*
    - ***Peas*** *follow tomatoes because they need an early seedbed, and tomatoes can be undersown to a non-winter-hardy green manure crop that provides soil protection over winter with no decomposition and regrowth problems in the spring.*
    - ***Tomatoes*** *follow beans in the rotation because this places them 4 years away from their close cousin, the potato.*
    - ***Beans*** *follow root crops because they are not known to be subject to the detrimental effect that certain root crops such as carrots and beets may exert in the following year.*
    - ***Root Crops*** *follow squash (and potatoes) because those two are good cleaning" crops (they can be kept weed-free relatively easily), thus there are fewer weeds to contend with in the root crops, which are among the most difficult to keep cleanly cultivated. Second, squash has been shown to be a beneficial preceding crop for roots.*
    - ***Squash*** *is grown after potatoes in order to have the two cleaning" crops back to back prior to the root crops, thus reducing weed problems in the root crops*

Assessment/Review

- Why is it important to have a solid understanding of characteristics of specific crops and the relationships between specific crops in order to design an effective crop rotation system?
- What is the importance of legumes in a rotational cycle of planting?
- Besides general soil/plant health, what are some specific benefits to rotating crops?
- What are the three basic types of cover crops?
- What are the specific benefits of each type of cover crop application?

NOTES

Community Supported Agriculture

The term "Community Supported Agriculture", hereafter referred to as "CSA", refers to various types of arrangements that enable consumers to buy a portion of a farm or its crops for a given season. Payment for a share of the crop is done in advance, and the crop yield is delivered gradually, as harvested. CSAs started in Japan in 1965. Housewives concerned with pesticides and overly processed foods, made arrangements with local farmers to have access to purchase their crops directly.

Learner Outcomes

The learner will:

- Look at various models for community supported agriculture
- Understand benefits enjoyed by the consumer and producer
- Examine special considerations for success as a CSA

Theory behind CSAs

Participation in a CSA offers consumers and producers certain personal, economic, ecological, and community benefits.

Benefits to the Consumer

- Access to high quality, fresh food – health benefits are well documented. Food from a known source is safer, assurance of good farm practices.
- Support sustainable agriculture
    - Support genetic diversity – produce sold fresh and local does not have to be bred for storage and shipping characteristics, can be bred for flavor and nutrition.
    - Assurance of no genetically modified crops
    - Assurance of organic growing methods – supports long term health of soils, farm systems, and ecosystems that sustain our lives
- Consumer is able to build a relationship with farm and farmer. Connection and access to local food supply is a basic human right.
- Food dollars stay local. This strengthens the local economy, which is beneficial for several reasons:
    - Fosters independence and self-determination
    - Promotes community cohesion and common vision
    - Makes community more immune to crises, less affected by economic swings.
- Local food is not shipped long distances – enormous savings on fuel cost and environmental impact of shipping

Benefits to the Farmer

- Crops can be pre-sold. Helps in making economic and field plans for the year
- No middle man, farmers get better than wholesale price for crops
- Connection to community
- Provides a model that enables small farms to compete in a market dominated by industrial agriculture.

CSA Models and Methods

- Member/Farmer relationships: The details of the member/farmer relationship vary according to the specific CSA program.
    - In some CSAs, members buy land collectively and hire a farmer to grow the crops. In this model, members split all costs and split the harvest.
    - In other CSAs, the farmer owns land, recruits members to buy portion of crops at a set share price for the upcoming season. In this model, the farmer is in charge of all crops, distribution and finances. This is the most common CSA model in the U.S.
    - Various hybrids of these two models for organizing a CSA are also possible.

- Distribution
    - Member harvest
    - Farm pick up
    - Farm stand/market pick up
    - In town pick up, often at member's home or business
    - Home delivery

- Growing the crops
    - Single farm – responsible for all crops. Organization and understanding of succession cropping is vital.
    - Cooperative – coordination of crops grown among several farms. Requires a farmer to act as coordinator. Advantage of crop specialization and reduced risk of crop failure.

- Setting the price and sizing the box
    - CSAs that operate on member owned land establish share price based on one investor's fraction of the total cost of land, labor, and materials.
    - CSAs that operate on farmer owned land can be "produce driven." In this model, the share price reflects amount of produce supplied to a member. Price per share remains same regardless of number of members. The size of box is largely pre-determined. The member is paying for what produce

they receive. What produce goes into the box is a function of what is being harvested, plus the total value of a box in a given week.

- CSAs that operate on farmer owned land can also be "need driven." In this model, the share price is determined by dividing income that the farm needs for the season by the number of members. The more members, the lower the share cost. Box size varies more; whatever is harvested on the farm goes into the box without much emphasis on the dollar value of any given box.

Special considerations in growing for a CSA

- **Variety**
  - Crop selection should be seasonally oriented. This assures that at least 8 crops are available on any given week, and insures variety in every box and over the course of the season.
  - Spring/early summer - broccoli, cabbage, cauliflower, kale, lettuce and salad greens, chard, green garlic or spring onions, radish, beets, carrots, spinach, Asian greens, peas, fava beans, cherries, strawberries, etc.
  - Mid-summer - above crops plus: summer squash, tomatoes, peppers, eggplant, onions, garlic, lettuce and salad greens, basil, parsley, potatoes, berries, peaches, plums, green beans, cucumber, corn, etc.
  - Late summer and fall – above crops plus: winter squash, leeks, parsnips, melons, pumpkins, dry beans, apples, pears, etc.

- **Quantity**
  - Quantity is an important consideration in order to assure that there is enough produce to go to all members.
  - Plant proven varieties that are appropriate for farm's climate and environment
  - Proper planning – plant more than enough for all members – consider planting extra to compensate for crop losses due to weather, pests, etc.
  - Succession planting – required for steady supply of several crops. For example, to have a continuous supply of an important crop like lettuce over a 20-week period, the farmer must make several successive sowings. To do this, the farmer must understand the role of light, soil temperature, ambient temperature, and all other environmental factors in raising the crop. A lettuce crop seeded on March 1 may take 75 days to reach maturity, but a crop seeded June 1 may only take 55 days.

- **Member considerations**
  - Membership goal – enough to meet financial needs of farm, but not so many as to exceed farm's productive capacity
  - Members' tastes – do they want staple items or gourmet? Standard varieties or heirlooms?

- **Impact on farm land**
  - Is the land able to support a variety of crops without sacrificing soil fertility?
  - Are crops grown appropriate for environment?

- **Adding value**
  - Aside from the fresh produce, most people join a CSA because they also desire some sort of closer connection to the farmer and the land that supplies their food.
  - Newsletters can provide regular updates on farm and CSA news. A newsletter can include interviews with producers, articles on sustainable agriculture, etc
  - Recipes can be included in produce boxes. Recipes give suggestions on storing, preparing, and eating the wealth of produce. This can include ideas about how to use unfamiliar vegetables and new ideas for old standards.
  - CSAs sometimes offer "farm days" that allow members to visit the farm, meet the farmer and crew, see fields and crops, etc.

Assessment/Review

- Describe the range of models for CSA programs.
- What benefits of a CSA program appeal to you the most as a consumer?
- What benefits of a CSA program appeal to you the most as a producer?

DIRECT SEEDING

Learning Objectives

The learner will:

- Gain a solid understanding of direct sowing, and in doing so create the best environment for seeds to thrive.

What Crops Should Be Direct Sown and Why?

- Root nature of direct sown crops: often tap rooted
- Intended density of crop: Direct-sown crops require sowing at high density and eventual thinning
- Scale of production: Many crops are direct sown on a large scale to avoid additional production costs
- Exceptions: Many, if not all crops, including tap-rooted crops, may be transplanted if sown and transplanted in clusters

Review Optimal Environmental Considerations for Seed Germination

- Soil Moisture
- Degree of secondary cultivation
- Soil temperature

Preparation of bed

- Incorporation of green manure crop (discuss)
- Subsoiling (discuss)
- Forming bed, addition and incorporation of amendments - activity/demonstration. Use tractor and rototiller. Discuss that seed size dictates fineness of soil needed to direct seed. Base amendments on needs of crop.

Seeding

- Methods
    - Seeder - choose correct plate for seed, troubleshooting, gauging success
    - Hand - slower but more accurate, inappropriate for larger scale
- Determining depth of seed - rule of thumb
- Covering seed - with soil or sand - discuss pros and cons

Subsequent

- Irrigation - frequent and sufficient enough to ensure good germination - critical at seedling stage in hot weather.
- Thinning - when plants reach appropriate size, thin to desired spacing - based on desired size at harvest. Demonstrate/practice thinning.

NOTES

ENTOMOLOGY

Learning Objectives

The learner will:

- Gain a basic understanding of the balance of insects on the farm/garden (pests and beneficial insects.)
- Be able to identify a number of common pests and suggest methods of control.
- Be able to identify several beneficial insects and discuss how they interact with crops and insect pests.

Harmful Pests

Corn Earworm

- Range: From the lower half of Canada stretching to the extreme southern latitudes of southern America
- Host plants: Mostly corn and tomatoes. Occasionally found on some bean varieties.
- Appearance/Habits: Winters in soil as pupa. Brownish green moth emerges in spring. The moth then lays several thousand eggs on hosts. Several generations are possible in a season. Larvae burrow into cob through silk leaving tunnel of excrement in path.
- Control: Planting marigold near corn is helpful. Mineral oil applied to browning silk at tip of ear is helpful. (one dropper per plant maximum)

Squash Bugs

- Range: Common throughout the US from Central America to Canada.
- Host Plants: Squash bugs attack all vining plants, congregating enthusiastically on squash and pumpkins.
- Appearance/Habits: Dark brown, sometimes light spotted brown. Hard shell. Three to four inches long. There are five nymph stages before the adults appear in eight weeks. Leaves eaten by squash bugs begin to wilt, blacken, and die. Smaller week plants may be have 40 percent die off rate.
- Control: Companion planting with radishes, nasturtiums and marigolds is beneficial.
- Striped/Spotted Cucumber Beetle
- Range: Native to United States and from Mexico to Canada.
- Host Plants: The striped cucumber beetle is a voracious pest of all the members of the cucurbit family. The spotted cucumber beetle is a much more general feeder effecting up to 250 different vegetables, flowers, weeds and grasses.
- Appearance/Habits: Striped cucumber beetle: Yellow beetle with three black stripes down back. Spotted cucumber beetle: Greenish yellow back with twelve pronounced black spots. Cucumber beetles affect the garden host plants in numerous harmful ways. They feed on all portions of the host. They can carry cucumber wilt as well as mosaic virus.
- Control: Protect transplanted starts with Remay. Straw mulch can slow spread of adults considerably. Predators of cucumber beetles include braconid wasps, nematodes, and soldier beetles.

Cabbage Worm

- Range: Imported worm/moth arrived on this continent in the late 1800's and can be found throughout the US.
- Host Plant: Specializes in members of the cabbage and mustard family but can also be found in other brassicas and some lettuce.
- Appearance/Habits: Springtime when temperature becomes warm enough pupa hatch into white butterfly with three or four black spots on their wings. Butterflies lay yellow oval shaped eggs hatching into soft green caterpillars. Caterpillars eat large uneven holes in foliage. They feed for roughly three weeks and pupate. There can be as many as five generations in a season.
- Control: Companion plant with tomatoes, onion, garlic, and other alliums. Remay can be effective if used early on in the season. Encourage Braconid wasps by planting strawberries near possible host plants or around gardens.

Aphids

- Range: There are many different species of aphids that can be found throughout the United States
- Host Plants: Aphids can be found attacking and colonizing on an incredible number of plants. The real garden danger arrives in the form of communicable diseases the aphids can bring to your garden.
- Appearance/Habits: Aphids will come in a variety of colors ranging from green, brown, red, yellow, to black. They are generally a wingless soft-bodied insect that colonizes a garden when a few winged aphids land on a suitable host and quickly deposit a number of wingless young on the tender edible part of plants. The young feed on plant sap, maturing in about 10 days, and are ready to produce the next generation. This process repeats until plants become so stressed and weak that winged aphids are reproduced, fly off in search of a new host, and the process repeats. Effected plants decline in overall health until becoming very weak and covered in sticky aphid colonies until eventually die. Large aphid colonies in your gardens will also encourage an unwanted ant population as ants show up to "farm" aphids excretion as a food source. Protecting the aphid colony from natural predators.
- Control: Ladybugs and lacewings are the natural predators of aphids but the aphids breeding is so vigorous it generally can out compete the predators. Removing and destroying effected plants is important in control of the general population in your garden.

Colorado Potato Beetle

- Range: The Colorado Potato Beetle is a native pest in the United States and began its destructive reign as the Great Plains east of the Rockies fell under heavy cultivation in the 20's. It has now spread to all parts of the USA east of the Rockies as well as some other isolated pockets.
- Host Plants: Potato plants are a favorite of these voracious larvae, but the CPB will enjoy a wide variety of plants in the nightshade family such as tomato, peppers, and eggplants.
- Appearance/Habits: Colorado Potato Beetles are large wide beetles growing to ½ " in size. Adults are yellow and black striped hard shell beetles. They will lay an egg mass of yellowish orange eggs on the underside of the host foliage. After the hatch, a large deep red larva will emerge and can very easily skeletonize a plant in little time.

- Control: Aggressive hand picking of larvae is EXTREMELY important for control of spread as well as health of infested plants. Once larvae emerge and are established on plant a dusting of wheat germ will be ingested causing bloat resulting in death.

Cutworm

- Range: There are many species of cutworms ranging throughout the majority of the USA.
- Host Plants: Cutworms will attack a wide variety of garden plants, and because of the great variety of cutworm species, each specie has a group of favorite hosts.
- Appearance/Habits: Cutworms generally appear as a plump caterpillar that can vary greatly in color. They can appear solid or variegated in color, often a greenish black with some stripes. When in moth form they generally are brownish black. They are often recognizable curled up around the base of plants laying in the soil. Cutworms can do severe damage to crops in a variety of ways: They can chew through the stalk of a plant leaving the entire plant toppled from the base. They can climb, eating the fruits and stems, they can burrow, chewing on the root structure, and with Army cutworms they will chew the growth tip of plants before moving on to the next available target.
- Control: By turning the soil over in the fall after intense cutworm pressure you can expose the larvae, or you can deeply bury any pupae. Thorough cultivation in the spring after the plants emerge and frequent cultivations through out the season will expose cutworms to predators. Dig around base of plant destroyed by cutworm to find worms responsible. Planting sunflowers as a trap crop around the garden will attract cutworms and expose them for disposal. Wood ashes around the base of plants may be strong deterrent.

Flea Beetle

- Range: Flea Beetles range throughout the United States.
- Host Plants: Flea Beetles will chose various host plants depending on what variety of beetle is present. Pressure on plants in the Brassicae family can become especially tough as spring turns to the hot summer of Oregon and weed host plants dry up and leave the irrigated garden plants extremely attractive to flea beetles.
- Appearance/Habits: Flea Beetles are generally very small shiny black hopping beetles that will jump for safety when approached by the farmer. Its this characteristic that makes Flea Beetles an extremely challenging garden pest to deal with. There plant damage is easily recognizable by the hundreds of small irregular holes chewed through the foliage of weakened plants. It often looks like tiny shotgun peppering on the leaves.
- Control: Because of the challenge in catching and killing flea beetles without the use of pesticides, the organic farmer has the best opportunity to avoid heavy infestation by applying a good regimen of diversification, crop rotation, and adequate watering. Under watered plants are more susceptible to heavy populations. There has been some effective control using bug vacuum systems. Early use of Remay may help the spread and heavy pressure.

Beneficial and Predatory Allies

Lady Beetle (Lady Bug)

- Prey/Habits: The Lady Bug feasts on many small soft-bodied insects such as aphids and spider mites. A single Lady Bug can consume up to 500 aphids a day. They often are most

valuable for the farmer or gardener when contained which is why they are often employed in a greenhouse type situation. The larvae of ladybugs are strictly predators, but the adults will sometime feed on pollens and nectars. They are not harmful to plants. Lady Beetles born in the summer time may only live a few weeks to a month however over wintering Lady Beetles can survive up to ten months. The Lady Beetles sold in stores are generally of the variety Hippodamia Convergens or the convergent Lady Bug. The problem with this variety is they have a tendency to flee the sight. Another drawback is that they are generally incapable of laying eggs.

- Appearance: The larvae are black and longer than the adults with speckled yellow or orange dots on there back. The adults are shiny and generally red with some black spotting on there back.

Lacewings

- Prey: Lacewings feed primarily on caterpillars, small beetles, soft-bodied insects such as aphids, and some larvae. Both larvae and adults are predatory, and use there modified jaws to suck the liquid inners out of their prey.
- Habits: Lacewings will mate and lay their eggs on any surface like windows, sides of homes etc. They will molt several times before spinning a silk cocoon and disappearing to pupate. They will emerge relatively quickly and can go through multiple generations in a season
- Appearance: Lacewings are generally a green-bodied long insect with two pairs of wings. Their wings are covered with a lacey veining pattern that is quite delicate. They have large compound eyes next to long antennae.

Trichogamma Wasps

- Prey: Trichogamma Wasps are amazing predators as they parasitize other insects egg masses. They are known to attack over 150 different insect species such as cabbage loopers, hornworms, cutworms, as well as many different moth larvae.
- Habits: Adult wasps seek out eggs following odor. The parent wasp then deposits her egg inside the host egg. Once the wasp hatches, it begins to consume the contents of the egg. The larva then pupates, and eventually chews out of the egg as adult and flies off to locate next host egg.
- Appearance: One of the smallest insects on the planet, they look just like larger wasps but are not much bigger than the head of a pin. Wasps have two pair of wings and the females are equipped with a stinger. This is used for probing possible host eggs.

Praying Mantis

- Prey: The Mantis will eat just about anything that suits its appetite, feasting largely on any insects that happen by. They have been known to eat birds. The mantis will either stay absolutely still and wait for its prey to walk by, or it will slowly and purposefully creep towards its prey. It will then strike out with its folded forelegs, grasping or even impaling its prey. These beneficial garden friends do not differentiate between allies and pests in the garden.
- Habits: The mantis is a strange creature with stranger habits. When the mantis mates, the female will often kill the male in the throws of passion. The male can continue to have fruitful intercourse for several minutes after he loses his head. The mantis often sways

back and forth when it moves possibly simulating the wind-influenced movements of the tree or foliage it's hiding on.
- Appearance: The mantis is a large insect, measuring from a centimeter being the smallest variety, to the largest being six inches. Most mantises are green or greenish/brown, however tropical mantis can be pink. They have swiveling heads that can turn a full 180 degrees, and their main defense against larger predators is their camouflage. Some mantises have hollow bodies that they use as an echolocation chamber to "hear" bat frequencies and therefore avoid being eaten by hurling themselves to the ground.

Tachinid Fly

- Prey: The tachinid fly will parasitize grasshoppers, beetles, larvae, caterpillars etc. They will often take on large hosts such as the tomato hornworm. Some not all species are host specific, only preying on there chosen diet.
- Habits: The female tachinid fly will lay her eggs on the host insect skin, however sometimes the eggs will be injected into the body of the host. The larvae then hatch and feed on host insect. Sometimes the host ingests the fly's eggs only to have the fly destroy the host upon hatching. Adults enjoy pollen and nectar as well, and can serve duel purpose in the garden as pollinators.
- Appearance: This large fly often will be seen with a blue metallic abdomen. There are over 1400 North American species in the family Tachinidae. Adults have incredibly distinct bristles on the end of their abdomens. They are a similar size to the common housefly but can occasionally resemble bees.

Soldier Beetle

- Prey: Soldier Beetles enjoy aphids, beetle larvae, caterpillars, moth larvae, and many other common pests. Adults and larvae soldier beetles are both predatory
- Habits: growing nectar rich flowers in the garden can attract some soldier beetles. Adult females lay their eggs in the soil, and larvae emerge shortly there after and begin to feed. Adults will often relax and wait by a good source of pollen, feeding on pollen and nectars until a good prey comes along. The adults will the take advantage of the prey insect that has landed to do the same.
- Appearance: Soldier Beetles, (a.k.a. leatherwings), get their name from the soft uniform like clothed appearance of their wings. They're about half an inch in length and generally have a yellow or reddish underbody with brown or black wings. Larvae are velvety in nature with large protrusions from their heads.

Assessment/Review

- Identify a common harmful pest. Discuss its range, host plants, appearance, habits, and methods of control.
- Identify a common beneficial insect. Discuss its appearance, habits, and its prey.

NOTES

FARM RECORDS

Learning Objectives

The learner will...

- ...understand what type of records are required.
- ...discuss the various reasons that records are important.
- ...review and have access to sample record keeping forms.

Purpose of maintaining farm records

- The practice is required by National Organic Practices for organic certification
- Records serve as documentation of the farm's standards and practices
- Records aid future planning – (amounts planted, varieties preferred, marketability of particular crop)
- Records enable comparison and tracking of farm's progress – (yields, soil fertility, crop rotations)

Required Records

Daily Log

- The daily log details any farm activity. It provides a basis for the year's master plan – (Details from daily log can be used to create a field map showing what crops were grown where. This is necessary for tracking crop rotations.) The daily log includes:
  - What was done – planting, harvesting, weeding, marketing
  - Where work was done – field, greenhouse, market
  - Who did the work
  - How long did the task take to complete
  - May also include weather, general observations, any farm related topic

Input Log

- Tracks production aids used
  - fertilizers and amendments – specific product used, application rate, where used (field, greenhouse)
  - compost – what is added to the compost pile, how often is pile turned, record of temperature readings of pile
- Tracks pest control
  - Details the pest problem, what crop, how applied and rate, degree of success

Harvest Record

- Tracks crop and variety harvested
  - Amount of harvest in pounds, bunches, or other unit
  - What field or bed harvested
  - Harvest technique used
- Tracks post-harvest handling
  - Is crop washed, if so, where and how
  - How crop is packaged
  - How crop is delivered to market or consumer

Invoices

- Invoices help record all sales of farm product.
- Must include farm name and organic certification number, date, to whom sold, item sold, amount of item, price per unit, and total price

Complaint Log

- If there is a complaint about the farm, this log records the nature of that complaint and what action was taken by the farm.

How to Keep Records

With so many other important jobs to balance, farm record keeping is often overlooked. It must be added to the list of necessary farm chores. Ideally, records are kept daily during the main growing season (Mar-Oct), and weekly in the off-season (Nov-Feb). Different records should be kept in their own binders, in a safe and consistent place, with an easy to use form. It may work well to assign the job of recordkeeping to one person on the farm.

Sample Forms

(See sample record keeping forms on the following pages)

Assessment/Review

- Why is farm record keeping important?
- Other than the essential records described in this chapter, what farm records might be particularly useful?

DAILY LOG

DATE:
WEATHER:

Time rqd Who

PROPAGATION WORK:
- Potting mix made
- Seeding – crop, variety
- Potting up – crop, size
- Inputs applied – eg foliar spray
- Location of seedlings – greenhouse, shadehouse, etc

FIELD WORK:
- Tractor work – tillage, mowing, tractor maintenance
- Planning – field and bed layout
- Direct seeding – crop, variety, field, bed, rate
- Transplanting – crop, variety, spacing
- Inputs – amendments, foliars, etc
- Harvesting – crop, amount
- Irrigation – type, layout, scheduling
- Other work – planting perennials, market/delivery, woodlot, fencing

COMMENTS, NOTES, NATURAL OBSERVATIONS

INPUT LOG

DATE:

TYPE OF INPUT:
- Potting mix
  - -recipe used
- Amendments added to field
  - -name of product
- Foliar spray
  - -recipe used
- Green manure crop
  - -approx. amount, how incorporated
- Compost
  - -substances added
  - -frequency of turning
  - -temperature record

APPLICATION RATE:
- Amount applied over a given area

LOCATION:
- Field, bed, or crop applied to

HARVEST LOG

DATE:

CROP AND VARIETY:

LOCATION:
Field or bed harvested

AMOUNT:
Expressed in pounds, bunches, count, etc

CLEANING METHOD:
Washed or not

PACKAGING:

STORAGE:

DELIVERY:

INVOICE

DATE:

FARM NAME:
- Address
- Phone #
- Organic certification #:

BUYER:

CROP AND VARIETY:

AMOUNT:

PRICE PER UNIT:

TOTAL PRICE:

COMPLAINT LOG

DATE:

NATURE OF COMPLAINT:

COMPLAINT SUBMITTED BY:

ACTION TAKEN IN RESPONSE:

FINANCIAL RECORDS

Learning Objectives

The learner will...

- ...examine various purposes of maintaining financial records.
- ...review typical income categories and expense categories essential to proper record keeping.

Purpose of Maintaining Financial Records

- Taxes
- Tracking the farm's financial progress
- A tool for future planning

Tools

- Receipts – for all purchased inputs, tools, seeds, etc
- Ledger – to track expenses and income, derive profit or loss

Income Categories

- Sale of produce, grain, seed crops, livestock, etc
- Sale of plants or nursery stock
- Cooperative distributions
- Custom hire and consultation
- Misc. payments

Expense Categories

- Vehicle – acquisition, maintenance and repair
- Equipment – acquisition, maintenance, and repair
- Custom hire
- Depreciation on equipment, buildings, fencing, implements, vehicles
- Feed
- Inputs
- Fuel
- Insurance – vehicles, buildings, crops, liability

- Seeds
- Plants and nursery stock
- Supplies
- Labor
- Utilities
- Rental/lease
- Mortgage
- Interest on loans
- Marketing

GMO's (Genetically Modified Organisms)

Learning Objectives

The learner will:

- Understand the history, significance, and risks of GMO crops and foods.
- Gain exposure to common myths and underlying truths related to GMOs.

History of GMOs

- Genetic modification refers to technology that makes it possible to manipulate the genes of living organisms to change the characteristics of that organism. Combining multiple genes from different living organisms is referred to as recombinant DNA technology. Resulting products are said to be transgenic or genetically engineered.
- First commercial GMO food crop was FlavrSavr tomatoes by Calgene released in 1992. FDA recognized the FlavrSavr as a food and therefore decreed it did not need to be labeled. Released in 1994, the tomato did poorly and was gone by 1997. Radically changed direction of GMOs

GMOs Around the World

- Transgenic crops are now grown in 42 countries on 6 continents.
- Currently over 1 billion acres of land contain GMO crops. 2/3 of that acreage is in USA. Principal crops being herbicide/insecticide resistant soybeans, cotton, corn, and canola.
- 70% of products on grocery shelves in USA contain GMO ingredients.
- Over 125 crops are currently registered in biotech database.

GMOs, WTO, USA, and the World

- The WTO (World Trade Organization) ruled the EU (European Union) broke trade rules with their de facto moratorium on the import and use of biotech products. Ban effectively denies access of US corn and corn products for sale in Europe. Case brought before WTO by USA, Canada, and Argentina.

Controversies Surrounding Biotech

- Proponents claim less use of pesticide, however studies show that GMO crops are been sprayed with up to 5 times the herbicide and insecticide than used on traditional crops.
- Loose gene syndrome, GMO crops have accidentally cross-pollinated with non-engineered crops resulting in loss of control of patented genes. This has been referred to

as "loose gene syndrome." Companies such as Monsanto have sued small farmers over "escaped" genes when their genes have turned up in other crops.

- Genetic escapees are polluting the gene pool, rendering many non GMO crop seed sterile. The result is a major threat to natural genetic diversity that has developed over a long period and is fundamentally necessary to long term genetic viability.
- Terminator genes implanted in genetic make up make seed sterile after one generation therefore making it impossible for farmers to save seeds. Seed saving is one of the longest standing and most important practices in sustainable agriculture. Because GMO genes are patented it makes it illegal for farmers to save seed, or liable for lawsuits if GMO genes drift into their fields and plants.
- The USDA has shown no restraint in pushing biotech as they have reviewed 5000 requests for field trials and not turned one down.

Common GMO Myths Perpetuated by Industry

- *GMO food will feed the hungry of the world*. Truth: GMO foods destroy diversity, sustainable agriculture, and make developing countries dependent on receiving seed from USA every year, taking more money away from local farmers and local economies and sending profits overseas.
- *GMOs are safe for our food source*. Truth: The technology is so new that we have no way of understanding the radical long-term impacts of genetically altering living organisms. The public has been used as guinea pigs for a dangerous experiment. Doctors say problems such as allergies and other complications can and will take years to develop.
- *GMO products reduce the need for chemicals on the farm*. Truth: An overwhelming number of GMO crops require the use of heavy chemicals such as the widely used Round-Up Ready line of crops produced by Monsanto. The company not only benefits from the seed profit, but from the worlds most widely used herbicide Round-Up manufactured by Monsanto.
- *GMO foods can make products more nutritious, long lasting, and more appealing*. Truth: The creation of GMO food products has nothing to do with food quality or ability to withstand shipping and distribution. Foods have been modified to withstand heavy herbicidal spraying, or to produce their own insecticides.
- *GMO products are just the logical next step in plant and organism breeding that has been happening since the beginning of agriculture*. Truth: Genetic modification crosses genes that would never interact in nature, such as the crossing of spider genes with milk goats to produce large amounts of spider silk in goat milk to be used for body armor and industrial applications.

Macro-organisms

- These organisms include earthworms, beneficial nematodes, fermentation mites, and springtails.
- Most macro-organisms feed on earlier inhabitants of the compost pile. They're beneficial

in their support of the food chain inside the compost pile.
- They produce castings, which contribute to the overall fertility of the soil.
- They aerate the compost mix, which introduces more oxygen, which in turn helps the pile finish faster and decompose more thoroughly.

Assessment/Review

- What are GMOs and why are they a significant concern to the consumer and the small-scale organic farmer?
- What in your opinion is the most dangerous myth perpetuated by the biotech industry?

NOTES

GOAT HUSBANDRY/MILKING

Goats are amazing animals; their ability to contribute to the functionality of a farm is outstanding. They provide an incredible food source in milk and meat potential, endless amounts of quality compostable manure, field and woodlot management, and hours of hilarious entertainment and frustration. When deciding the role an animal system will play on any new farm, there are very important factors to take into consideration. These factors include but are not limited to: Infrastructure available or needed, the willingness of the farmer or rancher to devote large amounts of time to integrated animal systems, the desired output of the animals (food, manure etc.), and the long term responsibilities associated with care of livestock. Every farmer has a different relationship with herd care, and animal treatment. Often a good way of judging the quality of a developed animal system is to look at the amount of coercive behavior required by the farmer or rancher to get the animals to do there requested jobs, whether it be moving from pen to pasture or participating in the milking cycle. When a farmer or rancher has to deal with large amounts of frustration with animals it is always a failure of human system design, not livestock behavior.

Learning Objectives

The learner will:

- Understand the scope of general concerns involved in raising animals on the farm by learning some of the specific concerns related to goat husbandry.
- Be able to describe the basics of ruminant digestion.
- Review the process of gestation and birthing in goats.
- Learn and discuss the processes of raising kids and milking goats.

Housing and Bedding Needs

There are two basic types of housing: stalls in which the goats have individual pens and housing where all the goats have a communal living and bedding area. When selecting a style of housing, one must consider the welfare of the goats as well as preserving efficiency for the goat farmer.

- Shelter from wind
- Good ventilation
- Clean dry bedding
- Accessibility to clean water
- Contamination free feeders
- Shelter from precipitation

Feeding and Nutrients

Overview of ruminants

- Goats have four stomachs
- Large numbers of protozoa and digestive bacterium live in the rumen. Their job is to breakdown protein, starch, fats and cellulose through a process of fermentation.
- Rumen occupies eighty percent of stomach space in a mature doe.
- Goats are browsers, and need to eat with head drawn in so food enters the slit in the esophagus and moves towards the rumen.

- Goats then regurgitate masticated food and chew their cud during times of rest.

Proper feed rations

- Goats must have quality roughage such as alfalfa or grass hay.
- Concentrated grain rations are required for milking does due to heavy protein output.
- Proper mineral intake is extremely important for pregnant and lactating does.
- The proper feed ration for milking does ration should be sixteen to seventeen percent protein. Twelve percent protein is sufficient for a dry doe or a buck.
- Feed goats a minimum of one pound of grain ration for health maintenance, and one-pound ration for each 2.5 pounds of milk.
- Make sure goats have free choice minerals at all times.

Basic Needs and Feeding Systems

- Goats should never feed off the ground due to the risk of feed contamination with fecal worm load and unhealthy coccidiosis load.
- Water should be clean and free of phytoplankton (algae caused by sunlight and organic matter) and zooplankton (algae caused by fecal contamination)
- Water kept slightly warmed will encourage increased consumption and therefore benefit overall health.
- Feed and feeders should be free of mold and mildew. This is very important.

The Pregnant Doe

- Average gestation for a goat is 146 to 155 days.
- Goats can be bred when they are 60 to 75 percent of their adult body weight.
- Twins are the most common at around 65% of the time, but triplets and singles also occur regularly. Quads and quints are rare, but do occur.

Signs of approaching birth:

- Goats should be checked regularly for signs of kidding 140 days from breeding. Signs include, hollow flanks, discomfort, nervousness, widening of the space between the pin bones, and rapid filling of udder.

Kidding

- 90% percent of goat births go unassisted
- Many different kid presentations are possible. The normal being front legs first with the nose resting on the hoofs.

Stages of kidding:

- Colorless discharge changing to thick and white when delivery is immanent.
- The goat may paw her bedding, lie down and get up restlessly.
- She will lie stretched out flat pushing with her hind legs against the floor or wall.
- Water bag will appear and in most cases burst revealing legs and/or nose.
- Doe will generally rest at this point for a moment and then birth kid with several strong pushes.

- Following kids will be born at varying intervals with no exact time passing between each birth.
- The afterbirth will be passed for each kid and a double afterbirth for identical twins.

Post kidding

- First time fresheners often need assistance in helping their kids to stand and begin nursing. Kids sometimes need help cleaning the mucus out of their nose and mouth.
- Kids should begin nursing within the first ten minutes.
- Kids born during cold spells should be dried and encouraged to drink as soon as possible.
- Dip umbilical cord in weak solution of Betadyne to prevent bacteria from traveling up cord.

Complications and remedies:

- If kid is stuck at the shoulders during birth and the goat is exhausted and not making progress pull down on hoofs away from birth canal.
- If kid is born listless and unresponsive a mixture of colostrum and strong black coffee may be given as well as a vitamin sucrose mixture. This may stimulate body heat and encourage nursing. It is important that the mixture be delivered to the stomach via tube so young kid does not aspirate and asphyxiate.
- Kids born during extreme cold should be warmed up by the assistance of goat keeper.
- It is very important that all kids born are drinking colostrum within a few minutes of being born.

Raising Kids

There are many different ways to raise kids; your kid-raising program is dependent on your end goal and style of management

- Kids should be fed their mother's colostrum for at least seven days.
- Separate the kids from their mothers after that first week. This will allow you to feed kids based on their individual needs therefore assuring consistent growth.
- The first week kids should be bottle-fed every six hours receiving four to eight ounces per feeding. The second week, twelve ounces eight hours apart. By the third week each kid can receive one quart of milk twice a day. These amounts are all dependent on the size and appetite of the kid, when the kids stomach is tight, the kids is full.
- The kids can have free choice of good hay and water once they are a month old.
- Kids should be weaned when they are two and a half to three times their birth weight. This generally occurs at around two months.

Standard procedure for kids in a dairy herd:

- All males should be castrated as soon as possible or when testicles drop (usually around seven to ten days.) The easiest way is by use of the elastrator, which applies a tight band around testicles and sack to cut off blood flow, and causes sack and testis to fall off.
- All kids in the dairy herd should be disbudded when appropriate. A dairy herd with horns will cause added expense and labor as adults due to accidental injury. Disbudding is done using a disbudding iron, when the nubs of horns become evident on the head.

- The disbudding iron is applied in a circular fashion around the nub until a distinct copper ring appears. Then the top of the nub is scraped off using a hot edge of the disbudding iron. It is important when disbudding for the first time that there is an experienced goat keeper at hand, due to the danger in applying the iron incorrectly.
- Disbudding can be done with one person and a disbudding box or with several people working together to immobilize the kid.
- Many goat keepers give their kids injections of essential trace nutrients and or vaccines just following birth but this should be done only after consulting your veterinarian.

Milking

Goat should be milked consistently at twelve-hour intervals. Variation of routine will result in loss of milk production.

Milking equipment used can be as simple or complex as the dairy farmer chooses.

- The milking stand is a very important piece of equipment for farmer and doe. The milk stand must be comfortable for both human and goat and must provide feeding and confinement for doe.
- The milk receiving equipment can be a stainless steel pail or an automatic milking machine. Most farmers will begin with hand milking and graduate to a machine milking as needed.
- Proper stool height is essential to developing good milking posture for the farmer.

Step by step milking procedure:

- Bring doe into the milking parlor from the loafing pen and secure in the milk stand.
- Provide food.
- Wash the udder with a warm water bath and then spray down using a weak iodine solution. Use a fresh towel for each goat.
- Dry udders and milk the first stream from each teat through strip cup. Strip cup identifies any abnormalities in milk that would be early signs of bad health such as mastitis.
- Completely milk goat out on both halves of udders taking special care that the udder is completely stripped of milk. Massage or stimulate udders to ensure thorough milking.
- Dip teats in dip cup to prevent bacteria from traveling up milk canal.
- Release and return goat to the herd.

Milk Handling

Good milk handling procedures are essential to producing a quality tasting, safe and healthy dairy product

- Strain milk through specially designed inline milk filters.
- Cool milk down to 35 degrees Fahrenheit within thirty to forty-five minutes of leaving the udder.
- Rinse milking equipment with cold water followed by warm water and an anti-bacterial alkaline soap.
- Air dry all equipment inverted on rack. Store all equipment upside down.

Diseases and Common Ailments of the Goat

Bloat

- Symptoms - tightly inflated flanks, extreme discomfort, collapse and eventual death.
- Cause - Over eating of lush wet grass or clover, breaking into food bin, over eating of anything unsuitable or foreign.
- Remedies - Feed eight ounces of vegetable oil for adult or two ounces for kids. Massage flanks. Walk goats about continually until symptoms subside.

CAE (caprine arthritis encephalitis)

- Symptoms - Swollen knees and joints and uneven development of one of the sides of the udder and loss of appetite.
- Cause - A viral infection caused by contagious contact by other CAE positive goats.
- Remedies - Pasteurizing all milk and colostrum fed to kids, blood testing of goats in herd. There is no known cure for CAE.

Hoof Rot

- Symptoms - Lameness in foot or feet, pungent stinking order in hoof, black soft deterioration of inner ridge of hoof.
- Cause - Prolonged exposure to wet ground or pasture, hoof trimming negligence.
- Remedies - Regular exercise on dry ground, proper and regular trimming of hoofs.

Internal Parasites

- Goat herd should be on regular worming schedule as advised by local veterinarian in your region.

Mastitis

- Symptoms - Hardening of udder, clotting and blood streaking in milk, fever, and tenderness in udder.
- Cause - Bacterial exposure, poor hygienic conditions.
- Remedies - Correct management, overall health, treatable with injectable antibiotics and intra-udder injectable.

Lice

- Symptoms - Weakness, anemia, listlessness in kids, emaciation.
- Cause - Exposure to domesticated fowl, poor living conditions.
- Remedies - topical and inject able parasite controls designed specially for use in blood sucking ways.

(These are only a few examples of the more common diseases and afflictions encountered by goat farmers. Most goat husbandry books have a complete list of common goat disease symptoms, causes and cures.)

Assessment and Review

- Describe the basics of ruminant digestion.
- Describe the signs of impending birth and the stages of kidding.
- Discuss basic milking procedure.
- Name a common ailment of the goat, describe symptoms and suggest a remedy.

NOTES

GRAZING SYSTEMS

Learning Objectives

The learner will:

- Understand the ecology of pastures and key biological attributes of pasture plants.
- Learn to identify important pasture species.
- Become familiar with grazing systems that build or maintain soil fertility and pasture diversity.
- Learn how to calculate and manage forage production.
- Learn strategies for extended season grazing and winter-feeding.
- Learn how to manage hay fields as part of the pasture rotation.

Pasture Ecology

- Biotic diversity
- Functional roles of different plant groups
    - Grasses fine, fibrous roots hold and build soil
    - Legumes fix nitrogen
    - Other plants (chicory) have deep taproots to keep soil open deeper down
    - Plants that scavenge and accumulate certain minerals or compounds are important to the health of livestock and wildlife.
- Below ground productivity, diversity (more livestock below than above) greater than in annual cropping systems
- Grassland plants and herbivory

Pasture Renovation

- Establish vs. Improving existing pastures
    - Establishment expensive and takes time; tilling, seeding, weed management, no grazing until plants well established
    - Drilling or broadcasting/harrowing into existing pastures

Forage Production

- Seasonal growth curve
- How to calculate forage production using small plots
- Warm season vs. cool season species
- Pasture mixes: legumes, grasses and “weeds”
- Stockpiling
- Rotation Grazing Systems

Management Intensive Grazing (MIG)

- Some history: Andre Voisin, Allan Savory, Joel Salatin
- Stubble height: no less than 3-4”
- Rest periods: depends on season
- Fencing
- Water
- Minerals
- Labor requirements

Fertility Management

- Root production and die-off plays key role in maintaining fertility
- Nutrient cycling:
    - Livestock return most nutrients to the soil:
        - 70% of what goes in comes out again
        - Phosphorous and minerals returned through manure
        - Nitrogen and potassium returned through urine
- Manure/compost/compost tea applications
    - Timing is important
    - Good to know what is in manure or compost
    - Recycle winter feed if possible
    - Tea cost effective way to cover lots of ground
- Mineral may be required
    - Avoid dolomite lime
    - Gypsum good for this area (helps increase Ca:Mg ratio)
    - Other mineral sources

Winter Feed

- Hay production from pastures (spring cutting)
- Hay vs. silage
- Feeding facilities/areas: considerations

Assessment/Review

- Describe forage plants you would hope to fine in a healthy perennial pasture.
- How do you measure forage production?
- Describe nutrient cycling in pastures.
- What is Management Intensive Grazing?

References:

OSU Small Farms Program website has many resources for pasture management
http://smallfarms.oregonstate.edu/pastures
ATTRA resources for grass farming:
http://attra.org/livestock.html#Grass
PSU online pasture grass identification tool
http://www.forages.psu.edu/topics/species_variety_trials/commonpagrasses/index.html
National Forages & Grassland Curriculum Materials for Plant Identification
http://forages.oregonstate.edu/nfgc/eo/onlineforagecurriculum/instructormaterials/availabletopics/plantid
Drawings and diagrams for vegetative ID (collar region):
http://www.caf.wvu.edu/~forage/library/cangrass/index.htm
http://www.ag.ndsu.edu/pubs/ansci/range/eb69-2.htm#INDEX
More online ID tools:
http://www.noble.org/WebApps/PlantImageGallery/PlantList.aspx?PlantTypeID=2&IndexType=CommonName
http://www.hcs.ohio-state.edu/hcs612/forageID.htm
http://www.forages.psu.edu/topics/species_variety_trials/commonpagrasses/index.html

NOTES

GREENHOUSE 101

Learning Objectives

The learner will...

- Understand the purpose, types, and needs of various greenhouse systems.
- Examine various pest and disease control issues related to greenhouse use.

Purpose

- Propagation of plants that will be transplanted
- Raising crop from seed to harvest
- Perennials

Types

- Fully enclosed, automated air, heat, and water systems
- Hoophouses
- Cold frames

Needs

- Heating/cooling – provides optimal temp range for germination and growth
    - Active vs. passive heat
    - Heating to aid germination
    - Temperature ranges – cool crops 50 – 70, hot crops 60 – 85
    - Shade cloth
- Air circulation – strengthens plants, reduces chance for fungi and disease
    - Automated vents and fans
    - Opening doors or roll-up side
- Light – in winter, supplemental light could be used to speed growth
- Growing infrastructure
    - Beds – in ground or raised – mostly used for crops to be harvested in greenhouse or perennials
    - Flats and pots – used for crops to be transplanted
- Water – ranges from hose to fully automated sprinkler/mister systems

Pests and Disease Control

- Common greenhouse pests

    - Aphids
    - Scales
    - Meolybugs
    - White Flies
    - Cabbage Loopers
    - Flea Beetles
    - Mites
- Healthy plants are most resistant when you provide the following
    - Sanitary conditions – wash flats, pots, tools, do annual cleanout
    - Regular monitoring – remove diseased plants immediately
    - Mechanical monitoring – pick or spray off insects
    - Biological monitoring – use of predatory insects
    - Healthy seed source – seeds can carry disease

Container Formats

- Cell/Plug trays
    - Advantages
    - Disadvantages
- Traditional wooden flats/Soil Blocks
    - Advantages
    - Disadvantages

Assessment/Review

- Discuss various types of greenhouse construction.
- What are the basic needs to be provided for in any greenhouse?

Resources

OBC Northwest Nursery and Greenhouse supplies
http://www.obcnw.com/greenhouses.php

NOTES

HEDGEROWS

A hedgerow is a densely planted pattern of trees or shrubs used to create a protective barrier around a field of crops.

Learning Objectives

The learner will:

- Identify multiple purposes for hedgerows on the farm
- Recognize factors influencing hedgerow design
- Learn the basics of plant selection, planting, and caring for hedgerows.

Functions of Hedgerows

- Physical barrier – to humans or livestock
- Visual barrier – aesthetically pleasing
- Wind barrier – block wind, thus decreasing evapotranspiration in fields
- Create shade – creates niches in field for shade tolerant plants; stops evaporation of water from soil
- Temperature regulation – vegetation tends to moderate climate extremes
- Create habitat – habitat for pollinating insects, birds and small critters
- Create food source – fruits and nuts
- Create usable material – fuel wood, fencing material, weaving material, posts
- Prevent erosion – root mass holds soil and blocks runoff

Design *Factors influencing layout and species selection of hedgerows*

- Environmental Factors
    - Climate – (average high and low temperatures, precipitation)
    - Soil type – (composition and fertility)
    - Prevailing wind direction
    - Aspect –(e.g. north facing slope for fruit trees to avoid early bloom)
- Site Factors
    - Location of roads, fields, buildings, waterways, etc.
- Goals of Designer
    - What purpose(s) will the hedgerow achieve?
- Opportunities
    - Create edge - An edge exists where two systems meet and overlap. (i.e. where a forest meets a meadow.) Maximum biological activity takes place along edges. The designer emphasizes this effect by planting a curving hedge because a curving line has more linear distance between two fixed points than a straight line.
    - Pathways - The paths between hedgerows can be either clean cultivated, meaning bare-earth with vegetation either hoed or tilled; or paths can have vegetative cover

which is managed to fix nutrients, choke weeds, hold soil, and provide mulching material. (i.e. buckwheat, clover, fescue.)
    - Special plants - Certain nitrogen-fixing shrubs can be planted amongst fruit and nut trees to provide nitrogen to the trees. (i.e. ceanothus, pea shrubs, eleagnus)

Planting Stock

- If from a nursery, plants should be grown in a similar climate. Plants can come from the nursery in a variety of forms: potted, balled and burlap, and bare root (most common)
- Home sourced plants can be grown from seed, transplants or cuttings and are especially good because they come from the same climate and ecosystem in which they will live.

Planting

- Choose a time to plant that is appropriate for species and region
- Scalp surrounding area clean of any competing vegetation
- Make a hole large enough not to impinge roots
- Trim off broken roots
- Plant to proper depth (avoid creating a basin for the trees to be submerged in if the rainy season is long.
- Use appropriate soil amendments. Too much can coddle the tree and the roots will remain in the planting hole and not venture out into native soil.
- Pat soil around roots until firm but not compacted
- Water in thoroughly

Care and Maintenance

- Protection
    - Use fencing to protect from deer, beavers, etc.
    - Line the planting hole with poultry netting before planting to protect from gophers, moles, and voles.
    - Paint tree trunks of fruit and nut species with white latex paint diluted 50% with water to protect from sun, cold, and borers
- Mulching
    - Retains moisture in the soil
    - Smothers weeds
    - Moderates soil temperature
- Pruning
    - Prune fruit and nut species
    - Follow specific instructions for type of tree
    - Pruning is critical in the first few years to maximize tree health and productivity
- Irrigation - if required
    - Determine irrigation schedule (see "Irrigation" chapter)

    - Ensure schedule is adequate by observation
- Annual fertilization
    - Fertilize during period of dormancy
    - Foliar spraying is acceptable in the spring
- Thinning
    - If hedgerow becomes too crowded, thin out selected trees to create spaces for others

Assessment/Review

- How many distinct functions of hedgerows can you identify?
- What are some care and maintenance needs of hedgerows?

Resources

Gaia's Garden- Toby Hemenway

NOTES

HISTORY OF FOOD AND AGRICULTURE

Learning Objectives

The learner will:

- Gain an understanding of the history of agriculture, both globally and nationally.
- Develop a context with which to engage in agricultural training.
- Become familiar with patterns of irresponsible agricultural practices through case studies of historical events.

History of Agriculture

- Humans as Hunters and Gathers
    - Humans, as in our genus Homo, existed 2 million years ago.
    - Humans lived as hunters and gatherers from then until approximately 12,000 years ago, when we developed agriculture.
    - While hunting, fishing, and gathering in the wild, humans had a limited impact on the environment.
    - Such humans did not have the idea that products of nature could be private property.
    - Populations were smaller and land base was larger. Food sources were dependable. Science and Anthropology have proven that although disease and violence were issues during that time, hunger was not.
- Early Agriculture and the Domestication of Plants
    - If our history extended over a period of 24 hours, agriculture became a practice in the last 5 minutes.
    - As populations grew, wild plants and animals were taxed, humans depended more on farming and herding, which, in turn, allowed for increased population.
    - 12,000 years ago, Agriculture was independently and simultaneously adopted in the Middle East, China, Mesoamerica, and Peru.
    - Factors that contributed to the adoption of Agriculture

        12,000 years ago there was a warming trend in each of these regions.

        Decrease in large mammals such as mammoths and bison.
    - Areas agriculture spread to and the native origin of many of our domesticated plant and animal species.

        Southwest Asia – soft wheats, lentils, chickpeas, many vegetables and cows.

        Southeast Asia - barley, oats, millets, soybeans, cabbage, plum/cherry/peach trees.

        Mediterranean – hard wheats, peas, olives, sheep and Goats.

        The Americas – maize, potatoes, beans, tobacco.
- Civilization and Surplus
    - Over the last 12,000 years, agriculture has enriched our lives. It has brought us our favorite foods, beverages, and culinary traditions. It has allowed for fibers, textiles and clothes. It has brought us into domesticated relations with animals. It has fed the inventions of tools, the

freedom to specialize, the pride of tending the earth, and the art and culture of civilization.
    - Agriculture created surplus. Surplus allowed for some individuals to spend time doing specialized activities that gave birth to industry, art, and culture.
    - The sedentary life made possible by agriculture created more complex social relationships that gave birth to more complicated societies.
- The Power of Trade
    - Archaeological sites offer proof of trade.
    - Humans began to desire special tools, fibers, or foods. Surplus allowed for trade within one society or between neighboring societies. This desire to trade motivated the valuing of land and increase in production.
    - Control of land and agricultural surplus becomes key to wealth and power.
- Humans begin to manipulate nature on a larger scale without concern for consequences.
    - Genesis I:26: "then God said, 'Let us make man in our image, after our likeness: and let them have dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth, and over every creeping thing that creepeth upon the earth.'"

History of Agriculture in the United States of America

- Colonization, Land Use, and Settlement
    - First residents are ancestors of Native Americans. Their presence dates back 14,000 years. They lived as hunters and gatherers, and practiced subsistence agriculture.
    - Most settlers were not farmers and relied on assistance from native peoples.
    - Colonial power inflicted genocide on native peoples and appropriated over 1 billion acres.
    - 1775 – 1855, 73.5 million acres given away to men who enlisted and served in the army and navy. In fact, free land was their incentive.
    - Generally land is sold to timber companies, railroads, speculators, developers, and ranchers.
    - 1840's – After pressure to liberalize the distribution of public lands, reformers attempted to pass homestead legislation: made connection between industry/urban development and diminishing self-sufficiency and demanded land be given to urban residents for free as a means alleviating bad economic conditions of urban factory workers. This didn't pass, eastern industrialists opposed it because it would have deprived them of a work force, western landowners opposed it because they felt it would depreciate land values, and southern planters opposed it thinking it would limit the potential expanse of slave-based agriculture.
    - 1870's – Acts, encourage cutting of forests, planting of plains, and irrigation of desert. No ecological awareness.
    - Abundant and cheep land, scarce labor, no markets made pioneer farmers invest mainly in the short term: building infrastructure and clearing forest

rather than soil or food/animal production. Improved land was more marketable than food.

- Deforestation and Desertification
  - Forests covered half of U.S. land, grasses covered 4/10$^{ths.}$
  - First century began with clearing of over 300 million acres of forest and plowing up over 300 million acres of native grassland.
- Human Exploitation/Labor
  - Indentured servants

    Mostly European immigrants working in exchange for their passage from Europe.

    Average contract was 5-7 years. Many were not fulfilled.
  - Slavery

    4,000,000 slaves by late 1800's.

    One slave per 10 acres.

- Regional Specialization

  Corn - Midwest: Illinois, Ohio, Missouri, and Indiana – leading corn producing states in the union. Grown for: the family, feed for workers (often transported to the South), and feed for livestock. Some used for whisky.
  - Pork, 1860 — hogs used to run wild. Now fenced and fattened on corn, hogs gave cities like Cincinnati the name 'Porkopolis.' A new industry was born: growing corn, feeding it to hogs, and then slaughtering and processing for shipping.
  - Beef, 1850's – Completion of the railroad brought an end to cattle drives, which birthed a new industry of farmers (in Ohio first) fattening their cows off corn.
  - Barbed wire invented in 1880.

  South – cotton

  Deep South, coastal area – rice

  Northeast – dairy, vegetable, horse - more local demand because of urban population
- Farm Prosperity, 1885-1930
  - Frontier settlement era is over.
  - Dryland farming is growing in Great Plains.
  - Increased immigration increases farm output.
  - Government funded R & D, credit, cooperative marketing
- The New Deal
  - The Agricultural Adjustment Act

    The first farm bill

    Paid farmers to reduce crop area

    Decreased surplus

    Raised prices

    Deemed illegal but lead to . . .
  - The Agricultural Readjustment Act

Price supports for major storage crops to maintain sufficient supply
Beginning of farm subsidies: Corn, wheat, rice, cotton, and tobacco

- World War II
  - High demand & high prices for food
  - Food rationing
  - Off-farm employment
- Beginning of Commercial Agriculture After WW II: 1950-1970
  - In one generation, the workforce involved in agriculture declined by half
  - The value of agricultural products increased by 40%
  - Modern era of convenience
  - G.I. Bill sent people to universities instead of learning through generational knowledge transfer
- Technological Advancements
  - Electrification
  - Refrigeration
  - Advances in processing, packaging
  - Development of the highway system
  - Price of store-bought goods decreased
  - Availability of goods increased
- Mechanization
  - By 1925, tractors were becoming a profitable investment
  - Free up 25% of land under cultivation
  - By 1950, almost completely replaced horses and mules
- Chemical…
  - The TVA started selling NH4 to farmers in 1943 as fertilizer
  - Insecticides, fungicides, herbicides
  - Rapid growth of monocultures, no till, labor
- "Green Revolution"
  - Technology transfer initiatives to Developing Nations, 1943-1970
  - High-yielding varieties
  - Irrigation infrastructure
  - Hybridized seed
  - Synthetic fertilizers and pesticides
- Biological…
  - Hybridized Corn- most important plant breeding innovation in the U.S.
  - Decrease in genetic diversity, increase in yields
  - Wheat, rice, animals…
  - Genetically-modified organisms
- Livestock Industry
  - Without electricity, antibiotics and hormones, confinement operations would not be possible
  - Became easier and cheaper to buy meat, eggs and milk than to raise animals
  - 100-fold in labor productivity
- Government and Policy

- "The Farm Problem"
    - Incentives for home production lessened, no more sugar rations, homegrown meat, Victory Gardens
    - Now, farms were consistently producing more crops than they could sell
    - Instead of controlling production, had to manage surplus
- "Get Big or Get Out"
    - In 1971, Nixon appointed Earl Butz as Secretary of Agriculture
    - Encouraged commodity production from fencerow to fencerow
    - Rise of agribusiness

- Onset of Crisis and an Un-level Playing Field
    - 2005 Top Crop Payments:
        - Corn
        - Cotton
        - Soy
        - Wheat
        - Tobacco
        - Dairy
- Consolidation in seed, livestock and organic industries
- Farm Population
    - 1900: 6 million farms, 38% of work force
    - 1930: 7 million farms, 21% of work force
    - 1950: 5 million farms, 12% of work force
    - 1970: 3 million farms, 4.5% of work force
    - 2007: 2 million farms, 1-2% of work force
    - Average age of farmers = 57
- Human Health
    - 1950: 10% of income on health care, 22% on food
    - 2007: 10% of income on food, 22% on health care
    - Globally, 1 billion adults are overweight
    - Type II Diabetes
- Environmental Impact
    - Soil erosion
    - Climate change
    - Dead Zone
    - Air and water emissions from industrial agriculture
- Energy Use
    - Grain-fed beef: requires 35 calories for every one produced
    - Agriculture contributes 12-15% of annual GHG emissions
- Around the World
    - Farmers in India & Africa are still fighting for debt relief incurred from the Green Revolution
    - India reports 16,000 farmer suicides due to devastation
    - Climate change, deforestation, desertification
- Here We Are Now

Historical Case Studies

- Irish Potato Famine and Monoculture
- Haiti and Deforestation and Soil Erosion
- The Dust Bowl and the Destruction of Native Plant Ecology
- Australia and Salinization
- Cuba and Self-Sufficiency

Ideology and Practices of the Present and Future

- Alternatives to industrial agriculture and factory farming.
- Preserving small and family farms.
- Remediation of the economic, social, and environmental consequences of Agriculture's history.

Assessment/Review

- Consider the context in which you are choosing to become a farmer.
- How has the historical information learned affected your interest in small and sustainable farming operations?
- Discuss relevance of historical examples of poor agricultural practices and how to apply lessons learned.

IRRIGATION

Learning Objectives

The learner will:

- Understand reasons for irrigation
- Learn to recognize the effects of water stress
- Learn methods of determining the proper frequency of irrigation
- Examine various system designs and delivery methods and investigate specific advantages and disadvantages.

Why Irrigate?

Maintain and moderate best temperature for plant life
Gives structure and support to plant – water molecules in tissue
Unlocks biological and chemical processes in the soil that support plant growth
Plants use water to form oxygen and carbohydrates
Irrigation protects crops from frost

Effects of Water Stress

- Water stressed plants have lower immunity to pests and disease
- Decreased yield. Plants are particularly sensitive at these stages
    - Flowering stage
    - Fruit/yield set
    - Seedling
    - Fruit ripening

Terms and Definitions

- *GPM (gallons per minute)* – A measurement of flow (volume of water from given source in one minute)
- *PSI (pounds per square inch)* – A measurement of water pressure (the force that water exerts on a given area)
    - (e.g. Water coming out of a pipe can be expressed both in terms of rate of flow and the force applied to that flow, as in 35 GPM @ 50 PSI.)
- *Velocity* – Rate at which water moves through a pipe system. As velocity increases, pressure decreases. Velocity should be 5ft/sec or less. (Use table to determine.)
- *Evaporation* – Loss of water from soil to atmosphere
- *Transpiration* – Loss of water from plant to atmosphere
- *Evapotranspiration (ET)* – Evaporation plus transpiration

- *Evapotranspiration rate (ETo)* – Measurement of ET in inches/day
- *Hygroscopic Water* – Water held too tightly in soil to be available to plants
- *Capillary Water* – Water that is held in pore spaces of soil; available to plants
- *Gravitational Water* – Water draining from soil; not available to plants
- *Capillary Action* – Movement of water in soil from wet to dry areas
- *Percolation* - Movement of gravitational water down through soil
- *Permanent Wilting Point* – Boundary between capillary water and hygroscopic water. Plant begins to sustain damage and will die if water is not applied.
- *Field Capacity* – Boundary between gravitational water and capillary water (upper limit for soil moisture available to plant)
- *Available Water* – Amount of water available to plants

Frequency of Irrigation

Soil Test Method

- Manual test – Soil is felt and observed at the root zone of the plant. Water is applied when soil is at 50%-75% of field capacity (depends on crop specifics). Charts are available as a guide to this method, but judgment is largely based on site-specific experience.
- Mechanical test – Tensiometer

Soil Budget Method

- Calculate site ETo
    - Get from local extension office
    - Measure time for one inch of water to evaporate from a pan.
- Replace water as it evaporates from field capacity using measured amounts from an irrigation system.
- Example/Exercise: *If local ETo is .4in/day, how much water needs to be applied in a week?*
    - Formula is PR = (96.3xGPM)/(SxL)
    - PR = precipitation rate measured in in/hr
    - 96.3 = constant
    - GPM = gallon per minute water flow in measured area
    - S = in-line spacing of sprinklers or emitters in feet
    - L = lateral spacing of sprinklers or emitters in feet

Factors Affecting Irrigation Frequency

Climate

- As temperature increases, ETo increases
- As wind increases, ETo increases
- As humidity increases, ETo decreases
- As precipitation increases, ETo decreases

Soil Type (see charts)

- Coarse – sand – drains quickly, increase frequency of irrigation
- Medium – loam – drains moderately
- Fine – clay – drains slowly, decrease frequency of irrigation

Slope (see charts)

- The steeper the slope, the less water the soil can absorb before run-off.

Crop Specifics

- Water loving or drought tolerant
- Germinating direct seeded crops
- Dry down during ripening
- Perennials

Irrigation Systems Design Considerations

Determine Source

- Pond or other open source (gravity feed or pump)
- Well

Determine GPM and PSI at delivery point

- Flow test with bucket and stopwatch
- PSI test with gauge
- Determine pipe size using tables
- Determine delivery method based on GPM, PSI, and field requirements

Drip or Micro

- For row crops, typically T-tape coming from 1/2" to 1" manifold, with filters and pressure regulators.
    - *Advantages*
        - *Good for limited water source*
        - *Efficient direct delivery of water to root zone*
        - *Fewer Weeds*
    - *Disadvantages*
        - *Maintenance on filters*
        - *Limited life*

Overhead Sprinkler

- Buried PVC (A system in which sprinklers come directly from a buried PVC via a vertical riser)
- Must be designed correctly and buried deep enough to avoid cultivation
    - *Advantages*
        - *More ambient cooling*
        - *Longer life*
    - *Disadvantages*

- *Less efficient*
- *Can promote mold/disease*
- *Takes higher flow*

Aluminum Hand Line (Pipe and sprinklers are all above ground and are supplied with water from a riser valve coming off of the main system at the top of the row or field)

- Requires less buried PVC.
- -20'-30' pieces are moved as needed. Have impact heads. Connect to fittings at top of field or row.

Flood

- Sheet of water over established vegetation. Best for pasture or cover crop.

Assessment/Review

- What are the symptoms and effects of water stress in plants?
- What are some factors affecting irrigation frequency?
- Name several types of irrigation systems and discuss advantages and disadvantages of each.

Resources

Rain Bird Drip/Standard Irrigation Design Manual
Turf Irrigation Manual

NOTES

Organizing 101: Farm & Food Advocacy

Learning Objectives

The learner will:

- Understand the purpose, types, and functions of various forms of organizing and activism.
- Examine usefulness and role of goals, strategies and tactics in organizing & activism.

Purpose

- Create clear solid platform from which to present convincing message.
- Impacting targeted audiences to produce change or improvements.
- Influence public perception and attitude.
- Empowering people to enrich and impact their farm community.
- Foster teamwork, collaborative projects and create social well-being.

Types

- Overview of approaches to include; media, political campaigning, protest (demonstration, direct action, theater, music), strike/boycott, civil disobedience, lobbying, modeling and propaganda.

Function

- Greater understanding of the disconnect between producer & consumer.
- Challenging accessibility misconceptions.
- Changing regulations to accommodate scale.
- Understanding the true cost of food.
- Understanding subsidies.
- Understanding the role of consumers.
- Revive community-based food production.
- Local and seasonal food verses convenience consumerism.
- Provide understanding of the importance of a local economy.

Assessment/Review

- Why are the various types of organizing & activism important and how do they serve the movement?
- What are the benefits of organizing & activism?

PLANT PATHOGENS

Learning Objectives

The learner will:

- Become familiar with various types of plant pathogens or disease agents.
- Examine various methods of disease management.

Plant Pathogen Overview

- A plant pathogen is any harmful introduced infectious agent, organism, or condition that reduces a plant's overall vitality, inhibits its growth, or limits the ability of the plant to survive and reproduce.
- Pathogens can be delivered in a multitude of different ways. These include: bacteria, fungi, viruses, nematodes, oomycetes, and abiotic toxicities.
- There are several different factors that need to be present in order to create an outbreak of disease on the farm. The pathogen must be present. There must be suitable host plants around. And there must be favorable environmental conditions for the growth and development of that particular plant pathogen.

Disease Agents

- Bacteria: These single cell organisms absorb the nutrition from their host plant and thrive by killing the plant and living off of their decomposing organic matter. This is often described as a saprophytic relationship. Bacterial pathogens cause blights, rots, and wilts.
- Fungi: Fungal pathogens are spread by many different environmental conditions such as wind water, seeds, human and other non-human vectors. (A vector is a host capable of transferring a particular pathogen.) Fungi that are capable of regenerating spores during the growing season and re-infecting plants are known as polycyclic. Fungi that must wait for next season are monocyclic.
- Viruses: Viruses are pieces of genetic material (RNA/DNA) and disturb the plants by mimicking naturally occurring genetic abnormalities. There are more than 700 plant viruses known. Viruses can be spread by tractors or equipment, tainted seed, or by a traveling vector.
- Nematodes: Nematodes are both a pathogen and a vector. Nematodes are microscopic worms and are one of the most abundant phyla with over 20,000 different species. A nematode either infects a plant by injecting a needle like mouth into the plant or it actually enters the plant with its entire body. The nematode's saliva is the infecting agent and disturbs the metabolic process of the plant and causes disease and death.
- Abiotic: This refers to deficiencies in the soil or surrounding environment that cause a debilitating illness that is harmful or fatal to the plant.
- Oomycetes: These organisms act much like a fungi, however they have a very different evolutionary history. They have mobile spores and can be primarily spread by both wind and water. Vectors can also spread them. An example of an oomycetes is "downy mildew" also known as "damping off."

Disease Management

- Plants often have developed natural defenses against pathogens. Some plants have developed disease tolerance. Some plants have developed disease resistance. Plants that are disease resistant will exhibit characteristics that actually repel certain harmful disease known to attack that particular plant. Plants that are disease tolerant can live with a problem pathogen but survive without any substantial reduction in yield or overall health.
- Proper greenhouse management can be extremely helpful in the control of outbreak and spread of pathogens. Disinfecting all soil trays and propagating mediums greatly reduces the incidence of pathogens.
- A solid approach to crop rotation will also limit the spread and overall effect of certain diseases. This is a result of diversity increasing overall vitality, limiting host species, and reducing environmental conditions needed for disease to flourish and spread in similar varieties or families of plants.
- Recognizing pre-existing factors that may contribute to pathogen outbreak is an important aspect of disease control. An example would be being vigilant and wary of downy mildew in a very wet or coastal environment.
- In some organic situations, chemical control of disease is necessary and allowed by organic standards. Effected host plants can be physically removed or treated with such elements as copper, sulfur, or neem. It is always recommended that you consult with an expert before using or adding any amendment to your fields to help control disease.
- Overall plant vitality is probably the single most important element for fighting and combating disease in your garden or field. Pathogens have the tendency to attack weak or stressed plants in the garden. If a disease establishes itself using the weaker plants it can often jump to the stronger crops. Therefore, maintaining conditions favorable to general plant vitality can significantly reduce the occurrence of disease. Removing harvested plants quickly and composting effectively will reduce instance of pathogens as well.

Assessment/Review

- What is a vector?
- What are several types of pathogens and how do they affect the plant?
- What essential disease prevention methods should be used on the farm to reduce the risk of pathogens?

NOTES

POULTRY MANAGEMENT

Learning Objectives

The learner will…

- Understand the role livestock (specifically poultry) in farm system
- Learn how to care for chicks
- Learn how to raise chickens for eggs, meat, and other
- Learn about pasture-based production models
- Gain a basic understanding of the legalities of pasture slaughter

Why Raise Chickens

- Entertainment
- Eggs
- Meat
- Fertilizer
- Bug and Weed Control
- Breeding Stock

Chicken Terminology

- Hen — mature female chicken > 1 year
- Pullet — immature female chicken < 1 year
- Cockerel — male chicken < 1 year
- Rooster male — chicken > 1 year
- Straight / hatchery run — unsexed
- Molt — natural process of shedding feathers
- Brood — to care for batch of chicks
- Broody — hen that sets
- Crop — pouch where chicken digests food
- Vent — opening through which hens lay eggs

Brooding

- Equipment
- Feeders
- Waterers
- Temperature
- Litter
- Nutrition
    - Grit critical - use stream sand - usually higher mineral content

    - Add hay chaff - seeds of perennials generally higher in nutrition than annuals (grains)
    - Fresh green vegetable matter - garden waste, grass clippings (not too much, especially meat birds - bred for hot feeds)

Chicken Breeds

- Layers
- Meat

Egg Production

- Production layers: 250-280 eggs / year
- Average brown egg layer: 150-200 eggs / year
- Hens begin laying at about 5-6 months of age
- Production falls off as hens age - replace every 2-3 years to maintain profit
- Egg color:
    - White (Leghorns)
    - Brown (Barred Rock, Rhode Island Reds, Buff Ophington, Black Australorp, New Hampshire Reds)
    - Colored (Auracana/Americana) 1 egg every 3 days
- Yolk Color - affected by plant pigments beta carotene and xanthophylls (green plant material or yellow corn will turn yolks orange)

Winter Production

- Egg production will decline in the fall and may cease during Nov - Jan
- Can sustain with lighting:
    - 40-60 watt bulb, 16 hours / day on timer
    - 15 watt bulb 24 hours / day

Egg Processing

- Storage:
    - 1 month or more in the fridge
    - 2-3 months < 55 degrees at 75% humidity
    - Egg quality diminishes in storage

Chicken Coop Design

- Stationary vs. Mobile
- Should provide protection from weather, drafts
- Need adequate ventilation
- Feeders - 5-6 inches per bird
- Waterers - 1-2 inches per bird
- Roosts - 8 - 12 inches roost space per adult, 15 inches between roosts (sloping)
- Nest boxes - 12" x 12" spacing, 4" lip across front, 2 feet above floor, 1 box per 5 birds

Disease Prevention

- Sanitation
- Adequate space
- Fresh air / ventilation
- Proper nutrition
- Cull as needed
- Protect from predators

Pastured Poultry Production

- Feed requirements drop 30 - 50%
- Housing:
    - Eggmobile (henabago)
    - Hoop houses
    - Variations on the chicken tractor
- Grass height important (too tall, will be trampled)
- Rotation with other livestock

Pastured Poultry Processing

- Requirements for Federal Inspection
    - FSIS overseas and licenses facilities
    - Inspects birds themselves
- Exemptions from Federal Inspection
    - No more than 1,000 birds per year
    - All poultry must be raised on producer's own farm
    - Producer may not buy or sell offsite birds
    - No poultry is distributed outside state
- State of Oregon
    - Currently Oregon law does not allow open-air slaughter of poultry for sale. Producers wanting to slaughter their own birds, up to 20,000 per year, must build a state-licensed and-approved facility. (Contrary to what you may have heard, our state doesn't recognize USDA's 1,000 bird exemption, only the 20,000 bird exemption).

- This might change. Lauren Gwin is working with the Oregon Department of Agriculture on a proposal to allow poultry producers to slaughter up to 1,000 birds (any poultry) per year on their farm, for on-farm fresh sales only. Exact requirement are still being discussed, but producers would likely be required to keep sales records and a customer list.
-

Marketing

- Eggs: Direct vs. Retail
  - Designations: certified organic, free-range, free-nested, cage free
- Meat

Assessment/Review

- What role can chickens play in an agricultural ecosystem?
- What are the benefits of pastured poultry production models?
- List important considerations for care of chicks.
- What are the basic feed requirements of chicks? Chickens?

References

ATTRA (Appropriate Technology Transfer for Rural Areas) Website: http://attra.ncat.org/.

The Chicken Health Handbook. Damerow, G. 1994, Storey Books, North Adams, MA.344 pp.

Pastured Poultry Profits. Salatin, J. 1993, Polyface, Inc, Swoope, VA.371 pp.

www.sustainablepoultry.org

Diagrams of poultry and incubation charts:

http://www.ansi.okstate.edu/resource-room/general/poultry/chicken.htm

http://www.ansi.okstate.edu/resource-room/general/poultry/turkey.htm

http://www.ansi.okstate.edu/resource-room/reprod/poultry/incubation.htm

Sources for Chicks

Phinney Hatchery, 1331 Dell Ave., Walla Walla, WA

Murray McMurray, Webster City, IA

NOTES

SEEDS

Learning Objectives

The learner will:

- Understand the basics of seeds, including botany, pollination, breeding and saving.

Basic Botany

- Nomenclature (Family->Genus->Species->Variety)
  Ex. Carrots = *Apiacea* -> *Daucus* -> *carrota* - > "Scarlet Nantes"
- Plants cross within a species (i.e. Zucchini (*Cucurita pepo*) will cross with pumpkins (*C.pepo*), but not with buttercup squash (*C.maxima*) but rarely across species barriers (think mules)
- Flower parts (Pistil/ Stamen/ Anther/ Style/ petals /sepals / ovary)
- Annual vs. biennial seed producers
- Biennials include carrots, beets, parsley, cabbage family, kale, onions, leeks, Swiss chard
- Monecious vs. Dioecious (i.e. spinach)

Pollination

Insect Pollinated – cucurbits, Brassicas, onions, leeks, carrots, parsley
Wind Pollinated – grasses (corn), beets, chard, spinach, oaks,
Self-Pollinated – Tomatoes, peppers, eggplant, lettuce, beans, peas
Extra-floral nectarines – plants entice pollinators with the sweet stuff!

Cross Pollinated Crops – need isolation from one another (usually a minimum of ½ mile)

Self Pollinated Crops – less or no isolation requirements

Timed Isolation – planting times are staggered to avoid overlapping flowering (work well with corn)

Inbreeding Depression – minimum population sizes are needs with the cross-pollinated crops to avoid "bottlenecking" the genetic diversity of the population.

- Generally 120 plants are required, an exception is the cucurbits, where you only need 10 plants.
- Inbreeding depression is the result of too small of a population = reduced vigor, smaller yields, more susceptible to pests and disease.

Hybrid – refers to a crossing of two separate varieties. An F1 hybrid is generally when two uniform inbred lines are crossed. The resulting generation is the F1 (for first filial), and then next season would be the F2 and so forth.

Heterosis – is the term to describe hybrid vigor which results from broadening the genetic base (the opposite of inbreeding depression)

Grex- a hybrid with many parents

Strain cross – crossing two strains of the same variety

Advantages to saving your own seed – save money, seed security, and possible to select for adaptation to disease, pests, climate and soils; provide nectar source for pollinators and beneficial insects. Fun, Learning and seed to share!

Wet Processed vs. Dry Processed seeds – Wet processed include tomatoes, melons, eggplant, squash, cucumbers, peppers. Most all others are harvested when seedpods are dry.

NOTES

SOIL SCIENCE

The understanding of basic soil science is important for many different reasons on the farm. It offers long-term farm security and viability through proper management of any farms most valuable resource, soil. It also plays a larger role in the health of a watershed or regional eco-system by combating erosion or nutrient pollution in our streams and rivers. Individuals who study and pay close attention to there soils structure and content will see far better results in cultivation and yield and will better be able to address negative issues encountered while growing on, and managing farmland.

Learning Objectives

The learner will understand the following basics through in-field study:

- Understand how soils form
- Understand soil characteristics and how they effect crop growth
- Learn why and how to take soil samples, what to test for and what to do with the results
- Learn how to manage for healthy soil ecosystems, increased fertility, and sustainable crop production

How Soils Form

- ClORPT Concept: Climate, Organisms, Relief, Parent Material, Time
- Soil Toposequence: Moving from the ridge top to valley bottom, soil characteristics vary greatly.

Soil Characteristics

- Soil Components: Minerals (45%), Air and Water (25% each), and Organic Matter (usually 2 - 5%)
- Soil Texture: Sand, silt, & clay, the soil triangle, and associated properties:
    - Sandy soils - low water and nutrient holding capacity, droughty
    - Clay soils - high water and nutrient holding capacity, but low permeability, poor tilth
- Soil Nutrient Profile: major and minor nutrients, trace elements
- Cation Exchange Capacity: capacity of negatively charged humus and clay particles (colloids) to hold cations (Calcium, Magnesium,
- Potassium - also sodium & ammonia) - importance
    - Albrecht system
- PH (and its relation to CEC - if your bases are balanced, pH will take care of itself)

Soil Biotic Community

- We know that an acre of soil can support or produce 2000 lbs of beef (cow / calf pair), 5 sheep, and lots of chickens, for example, but we rarely consider the extent of the soil fauna living underground: 1 acre of topsoil contains approximately 900 pounds of earthworms,

2,400 pounds of fungi, 1,500 pounds of bacteria, 133 pounds of Protozoa, 890 pounds of arthropods and algae, and small mammals.

- Earthworms – air & water penetration, high-nutrient castings, secretion of plant growth stimulant, natural soil tiller.
- Arthropods – sow bugs, centipedes, slugs, snails, and springtails: primary decomposers.
- Bacteria – make plant growth hormones, make nutrients and minerals available to plants, fix atmospheric nitrogen, fight root diseases, and detoxify soils.
- Fungi – break down OM and release nutrients available to plants, produce plant hormones and antibiotics, mycorrhizal associations.
- Actinomycetes – threadlike bacteria that look like fungi: decompose OM, produce root disease-fighting antibiotics, and produce a sweet, "earthy" smell.
- Algae – upper ½ inch, fix nitrogen and enhance soil structure by producing biologic glues.
- Protozoa – free-living organisms that swim in soil water, eating bacteria and speeding up the nutrient cycle.
- Nematodes – eat decaying plant litter, bacteria, algae, protozoa, and other nematodes – only a few species harmful to plants.

Key to managing for a healthy soil community: build soil organic matter

Soil Organic Matter

- Carbon Cycle: role of C (CO2) and how to manage it.
- Humus, Humic Acid (organic compounds containing displaceable hydrogen), Humate (the salt of a humic acid, where hydrogen has been displaced by cations such as potassium, calcium, and magnesium)
- Managing SOM: cover crops, field rotations, compost and compost tea applications, etc.
- Tillage systems
- Nitrogen Cycle: role of N, and how to manage it.

Soil Testing and Assessment

- What to test, how to test, when to test: texture, major nutrients, minors and trace, pH, CEC, soil biotic community.
    - Conventional
    - Emphasis on Mineral Analysis: Albrecht System
    - Soil Biotic Communities
    - USDA Soil Quality Test

Assessment/Review

- How is soil formed?
- What are some important soil characteristics?
- Explain cation exchange capacity and how to improve it.
- Describe a cropping system that improves soil organic matter and enhances the soil biotic community.

NOTES

TRANSPLANTING

Learning Objectives

The learner will:

- Gain a solid understanding of proper transplanting techniques, and in doing so create the best environment for transplanted starts to thrive.

Why are Certain Crops Transplanted?

- Greenhouse advantage
    - Greater climate control
    - Greater season extension
    - Intensive rather than extensive management of seedlings
    - Rapid crop successions
- Root nature of transplanted crops
- May allow for greater control over specific density of crops

Assess Plant, Soil, and Environmental Conditions Prior to Transplanting

Assess the compatibility of the following environmental conditions and seedling maturity with the planned tasks.

- Seedling development necessary for successful transplanting
    - Shoot development
    - Root development
- Seedling pre-treatments necessary for successful transplanting
    - Soil/mix moisture
        - Cell-grown seedlings at field capacity
        - Flat-grown seedlings at 50%-75% of field capacity
- Transition from Greenhouse to Field
    - Hardening-off period: Hardening off reduces amount of stress for start by gradually increasing amount of exposure to outside elements. Hardening off should start at least 15 days prior to acceptable field transplant date.
        - Move starts to cold frame two weeks before they are ready to enter the field, cover off in the day and on at night
        - Leave the starts exposed to the elements for a half hour to an hour longer each consecutive day.
        - Finally, leave them exposed all day and all night the final three days.
- Soil conditions favorable for successful transplanting
- Optimal physical environmental conditions favorable for successful transplanting of flat-grown seedlings
    - Low light levels
    - Low temperature
    - Low wind speed
    - High humidity

Transplanting Starts

- Starts should be thoroughly watered before being transplanted. This greatly reduces shock. Using a weak fish emulsion solution just prior to transplant will also encourage plants to take off quickly.
- Keep starts in shaded area until they enter the ground.
- When pulling apart individual soil blocks or removing starts from trays, carefully separate the intertwined root growth, causing as little trauma as possible, while still remaining efficient.
- Do not expose tender root systems to direct sunlight (as little as fifteen seconds of exposure can kill off roots).
- Using your hand or a planting tool create the right depth and size hole in the bed or row being planted.
- Some farmers will sprinkle a little organic fertilizer in the hole just prior to planting. This should be done only if the quality of the soil requires that extra boost.
- Gently tease the roots before planting the start; this encourages new outward growth of the roots.
- Take special care to insure the top of the soil block or cell being planted is covered with native field soil; this greatly reduces the natural drying out process during the beginning of the plants field life.
- Some farmers apply a gentle amount of pressure to the base of transplants after planting; others allow the natural "watering-in" process to settle the soil around the new transplant. What works for one may not work for another, and much of that has to do with the style of irrigation being used. An overhead irrigation system is going settle the soil around the plant much better than a drip system. Using our drip system at Boones Farm we've found applying a gentle amount of pressure encourages the pooling of water around the base of the start.
- Always water in a new start. This is the highest preventative measure you can take against shock.
- The best time to transplant any start is in the cool of the evening. This allows the plant a nice buffer to become acquainted with its new surroundings before dealing with a hot sun.

NOTES

WATER HARVEST THROUGH KEYLINE DESIGN

Learning Objectives

The learner will...

- Understand the basics of keyline design.
- Review opportunities for different types of water storage and water delivery systems.

Purposes of Keyline Design

- Maximize water resources through systems designed to catch, direct, and store water in ponds and soil
- Use gravity to move water
- Provide a system of whole farm design, including all roads and surfaces that drain water

Background

- History: P.A. Yoemans of New South Wales, Australia developed the keyline method to stretch water resources available on his ranch in its arid climate. The practice became a model for sustainable agriculture.
- Important definitions:
    - *Keypoint* - any point in a watershed where the slope changes by 5% or more
    - *Keyline* - the contour line which would intersect a keypoint
- Theory: Keypoints are typically places where water tends to collect. This point may be a spring, a point of increased stream flow, or simply underground water nearer the surface. The keypoint and keyline serve as points to harvest water into catchment systems or soils in the desired area.

Water Storage in Ponds, Reservoirs and Tanks

Placement

- Pond should be designed so that the elevation of its maximum water level is slightly below the elevation of the water source. Typically, a drop in elevation of 1 vertical foot for every 100-300 horizontal feet is used.
- Pond should be placed out on a ridge, away from the drainage in a watershed. Ponds placed in-stream will always blow out. Ponds placed out on the slope maximize the amount of land available to be gravity irrigated by keeping water higher on the landscape.

Sources of Catchment

- All road surfaces inwaled to direct water into catchment system
- Spring or stream flow captured in pipe and delivered with gravity to system

- Rainfall: slopes carry water to system
- Increase catch area: using small gently sloping ditches, direct water shed from adjacent slopes to the catchment system

Lining
- *Earth lined*: best for ponds that can be kept full. Clay or bentonite seals will crack when exposed to long periods of sun and dry.
- *Plastic liner*: good for ponds where water resources are scarce

Delivery Systems
- *Siphon*: using suction to pull water through a pipe over the dam wall and to an irrigation system at the head of a field below
- *Lock pipe*: draining water from the bottom of the pond to field via a pipe buried beneath the dam wall.
- *Pump*: using solar, gas, or electricity to power a pump to pull water out of the pond and to the field.

Considerations
- Local codes and requirements
- Need for engineer in pond design
- Careful, professional construction of all systems

H2O Storage in Soil

1) Soil contouring via swales
- A swale is a ditch laid out on contour so that it holds water instead of drains water.
- The long-term effect of a swale is the same as that of an unlined pond – to create an underground stored lens of water, which deep-rooted plants are able to tap.

2) Soil cultivation
- All fields laid out on contour to minimize erosion and maximize water storage capacity
- Soil is ripped with subsoil or chisel plow (a “keyline plow” is a specific type of subsoil plow) on contour, slowing the flow of water off of a slope, encouraging water to seep into rips.

Benefits of contour/subsoil cultivation:
- Increases water holding capacity of soil
- Breaks up hardpan and loosens clay soil
- Encourages formation of topsoil
- Retains soil structure – passive tillage does not invert soil
- Enables better root growth of crops
- Lifts rocks out of soil
- Aerates soil

Mulch

- Regulates soil temperature
- Reduces water evaporation from soil surface
- Smothers weeds

Assessment/Review

- What are a keyline and a keypoint?
- What are the three basic water storage methods discussed in this section?
- What practices can increase the soil's ability to store water?

Resources

Water for Every Farm by P.A. Yeoman’s

NOTES

WEED MANAGEMENT

Pre-Assessment Questions

- What is a weed?
- How are weeds dispersed?
- What are some benefits of weeds in a cropping system?
- What are some of the characteristics of weeds that allow them to compete so well in cropping systems?
- Why control weeds?

Definition-What is a weed?

A weed is any plant, native or non-native, that interferes with crop production by doing more harm than good and has a habit of encroaching where it is not wanted.

Weed Problems

- Crop competition and its effect on crop yield and quality
    - Nutrient competition
    - Light competition
    - Water competition
- Interference with harvesting operations
    - Example: Weed roots such as bindweed wrap around sub-soil blades used for undercutting root crops during harvest

Weed Benefits

- Enhance soil structure
- Improve soil tilth
- Cycle nutrients
- Provide habitat for beneficial insects
- Improve soil water infiltration

Weed Prevention Strategies

- Improve soil tilth, aeration, water infiltration, and fertility to optimize crop growth and minimize weed pressure
- Thoroughly clean equipment before moving it from one farm or location to another
- Do not allow weeds to form seed heads and/or perennial rooting structures in the cropping system.
- Thoroughly compost all imported animal manures to insure destruction of viable weed seed
- Filter surface irrigation water to avoid importing weed seeds
- Work with neighbors to eliminate or minimize the potential for spread of noxious and problematic weeds from adjacent lands

Identification

- Tour fields and identify most common weeds (star thistle, pigweed, purslane, chicory,

wild lettuce, grasses, etc.)
- Pull or dig selected weeds and examine root system

Management through Manual Cultivation

- Demonstrate and practice proper techniques with various tools - wheel hoe, stirrup hoe, collinear hoe, and Mexican hoe. Discuss need for follow-up cultivation.
    - Benefits - eliminates weeds, stirs soil and breaks crust (allows for easier penetration of air and water)

NOTES

FARMING ON THE WILD SIDE

Learning Objectives

The learner will:

- Learn about the different approaches to ecological farming and give examples
- Understand ecological processes underlying ecological farming approaches
- Understand attributes of natural systems farming, agroforestry systems, and wild farming approaches

Ecological Farming Systems

- Farming in Nature's Image: Natural Systems Farming
    - Home Gardens/Forest Gardens
    - Land Institute & Perennial Polyculture
    - Rotational/Mixed Species Grazing Systems (Savory & others)

- Agroforestry/Silvopastorialism/Agrosilvopastorialism
    - Agroforestry: growing herbaceous crops and trees together
    - Silvopastorialism: raising livestock and tree crops together
    - Agrosilvopastorialism: livestock, crops and trees
    - Agroforestry System Attributes
        - Deep nutrient cycling
        - Enhanced wildlife/livestock habitat
        - Increased biotic diversity
        - Increased crop diversity
    - Examples:
        - Windbreaks/hedgerows
        - Live fences
        - Alley cropping
        - Field/Pasture Trees (Acacia albida, Oregon white oak)
        - Taungya
        - Forest Gardens

- Wild Farming: Biodiversity on Farms and Ranches
    - Importance of biodiversity
    - Wild Farming Practices
        - Water Conservation
        - Soil Conservation
        - Soil Fertility Management
        - Livestock Management
    - Biodiversity: Incorporating Natural Areas on the Farm Practices
        - Riparian Areas
        - Woodlands
        - Hedgerows
        - Beetle Banks
        - Field Margins

- Biodiversity Within Farmed Areas
    - Cover Crops
    - Intercropping
    - Strip Cropping
    - Insectaries & Pest Strips
    - Low or no till
    - Alternate Mowing

Ecological Processes in Healthy Agroecosystems

- Nutrient Cycling (deeper, balanced cycles)
- Hydrology (enhanced infiltration, soil moisture storage)
- Energetics (enhanced capture of solar and water inputs)
- Soil Conservation and Building
- Predator – Prey Relationships (beneficial insects, birds and mammals for pest control)
- Disturbance (herbivory)

Assessment/Review

- How would you mimic a prairie in an agroecosystem? A savannah? A forest?
- Describe the ecological processes functioning in an agroforestry system.
- Why is biodiversity important on a farm?
- Describe wildlife-friendly elements in a farming system.

References:

Imhoff, Daniel. 2003. Farming With the Wild: Enhancing Biodiversity on Farms and Ranches. Sierra Club Books, San Francisco, CA. 182 pp.

Jackson, Dana, and Laura Jackson. 2002. The Farm as Natural Habitat: Reconnecting Food Systems with Ecosystems. Island Press, Washington, DC. 295pp.

Soule, J. and J. Piper. 1993. Farming in Nature's Image: An Ecological Approach to Agriculture. Island Press, Washington, DC. 305pp.

Wild Farm Alliance: www.wildfarmalliance.org

NOTES

WINTER FARMING

Learning Objectives

The learner will:

- Identify opportunities for winter farming and season extension.
- Receive an introduction to production aids relative to winter farming.

Climate

Crop possibilities vary widely with climate, but generally there are crops that are well suited to winter production in most cold climates (i.e. cabbage family, roots, and greens.)

- Maritime Pacific Northwest climate
  - Good for winter crops, ground generally does not freeze
  - Cool and moist means no irrigation required, but promotes rot and disease
  - Production aids are beneficial
- Colder climates
  - Winter harvest possible with production aides. (see "Production Aids" section of this chapter.)

Winter Harvest Means Summer Planting

- The key to fall/winter harvest is to seed crop in the summer to achieve adequate growth by the end of October.
- Decreasing levels of light in fall will slow plant growth to near dormancy. Growth resumes in late winter when the light levels increase.
- Due to the seasonal lack of light and growth, vegetables harvested from November through March must be mature by the end of October. (The exception is over-wintered crops - see "Over-Wintered Crops" section of this chapter.)
- Growth resumes in late winter when most plants will start to flower. If greens become bitter or roots become woody, crops are past their harvest window.
- Lots of space required. No succession planting is possible after this harvest because the soil is too wet, (or even frozen in northern interior climate zones.)

Over-Wintered Crops

- Planted in late summer for a spring harvest. (An exception to this would be garlic that should be planted in the fall for a summer harvest.)
- Successfully over-wintered crops achieve enough growth by the end of October to survive the cold, possible snow, and lots of rain.

- Growth resumes in late winter and crop reaches maturity in spring.

Production Aids

- Season Extension using farming techniques and/or structures to increase soil temperature or shield crop from extreme weather, which enables steady crop growth, extends later into fall and begins earlier in spring.
    - December and January- lowest light but warmth will aid slower growth
    - Nov, Feb, March – more light and higher outdoor temps mean slightly faster growth
- Warm and sheltered spot
    - South facing slope
    - Windbreak
- Mulches
    - Straw moderates soil temperature; prevents freezing
    - Plastic raises soil temperature
- Low covers
    - Remay or plastic over wire hoops to create a tunnel over a row crop
- Cold frames
    - Low wood frame with glass or plastic over top
- Walk-in tunnels
    - Plastic over hoops, tall enough to work in
- Greenhouses
    - Permanent, framed skeleton with glass or plastic for roof

Storage Crops

- Grown in Summer, harvested in Fall, stored for Winter use
    - Potatoes- Store @ 35 degrees and high humidity
    - Winter Squash- Store @ 50-55 degrees and dry
    - Onions and Garlic- Store @ 40 degrees and dry

Assessment/Review

- Can you differentiate between the planting and growth schedules of Fall/Winter harvest crops and over-wintered crops?
- Name several ways of extending the season by using production aids.
- What crops are generally well suited to winter production in most climates?

Resources:

Four Season Harvest by Elliot Coleman

NOTES

DIRECT SEEDING
(Field Exercise)

First, discuss what crops to direct seed and why.

I. Preparation of bed
   A. Incorporation of green manure crop (discuss)
   B. Subsoiling (discuss)
   C. Forming bed, addition and incorporation of amendments – activity/demonstration. Use tractor and rototiller. Discuss that seed size dictates fineness of soil needed to direct seed. Base amendments on needs of crop.

II. Seeding
   A. Methods
      1. Seeder – choose correct plate for seed, troubleshooting, gauging success
      2. Hand – slower but more accurate, inappropriate for larger scale
   B. Determining depth of seed – rule of thumb
   C. Covering seed – with soil or sand – discuss pros and cons

III. Subsequent
   A. Irrigation – frequent and sufficient enough to ensure good germination – critical at seedling stage in hot weather.
   B. Thinning – when plants reach appropriate size, thin to desired spacing – based on desired size at harvest. Demonstrate/practice thinning.

Harvest/post-harvest handling and Food Safety

Learning Objectives

The learner will:

- Understand the importance of attentive harvest, packing, storage and transportation to providing quality product.
- Understanding how management practices affect post-harvest condition.
- Understanding how food safety practices begin in the field and carry through harvest & post-harvest handling.
- Provide resource access.

Harvesting Demonstration

- Roots - carrots, beets, radish, parsnips, etc. Use digging fork or shovel to loosen soil, if necessary. Pull roots, using wooden baskets for container. Should be set in shade until washed. If this will be more than an hour and it's a hot day, remove greens from the roots to prevent dehydration.
- Fruits - nightshades, cucurbitae, etc. Determine which will be harvested based on ripeness. For nightshades, gently pull, or snip, the fruit from the plant. For cucurbitae, cut at stem with knife. Skin of fruits is more sensitive, so a lined wooden basket or a plastic container is used. Should store in shade until washing or boxing.
- Greens - lettuce, spinach, broccoli. Determine which plants to harvest based on maturity. Demonstrate proper use of harvest knife for cutting heads. Also demonstrate picking or cutting technique if only leaves are harvested. Quick cooling of greens is essential. Keep out of sun and wash as soon as possible.

Decision Making for Harvest

- Type of produce being harvested: Care should be taken to understand the ability of any given item to hold up post harvest in the field. There are some that can endure a lot of stress and go to market looking great and others such as lettuce that need utmost sensitivity.
- Time until sale: Leafy produce should be harvested and cooled just prior to distribution or market (unless refrigeration is available). Some produce like winter squash or garlic can be processed and stored for months prior to distribution.
- Weather conditions outside: The time of day a certain item is harvested, and the time that item sits in the field after harvest can differ greatly depending on the weather outside. If the temp is 50 degrees, under an overcast sky, your urgency is greatly reduced. Beans and other produce, which should be dry upon harvest, should not be harvested in the rain or first thing in the morning when dew is present.
- Cold Storage/Cool Pack resource availability: If refrigeration is available on site, taking the "field heat" out of an item is often enough cooling before going into reefer storage. If there is no onsite reefer, top icing wax boxes is often necessary

to keep produce in prime condition before delivery.

- Field durability: Some items hold up just fine under the sun for a brief time. Other items like greens and lettuce should be shaded immediately after harvest and hydro-cooled as soon as possible.

Specific Handling Procedures Based on Type of Produce

- Greens and Lettuces should not spend any significant time in the field or without adequate shade. They should generally be harvested first, and cooled in cold water/ice bath immediately after leaving the field. Lettuces and greens should be inspected and cleaned before entering bath.
- Green beans should be harvested before mid-day heat is present. Beans cannot be hydro-cooled (cold bath) because of rust due to excessive moisture, therefore, should be cooled in reefer as soon as they are harvested to preserve crispness.
- Beets and Carrots should be forked, followed by simultaneous washing and hydro-cooling. Pull off any ugly greens of carrots; be slightly less critical of beets due to the fact that there greens are so widely enjoyed. They should be bunched and stored below forty degrees. Carrots do well in bins or perforated bags in cold storage.
- Broccoli and Cauliflower should be iced and or hydro-cooled immediately following harvest. Special care should be taken to insure green caterpillars are not present under the "trees".
- Cucumbers should be hydro-cooled immediately and washed down to remove any "spike" that may be present. Cucumbers can be stored in lugs or flats with lids and should be kept cool between forty and fifty degrees.
- Eggplants should be handled with delicate care following harvest. The skin shows rough treatment and punctures with ease. Eggplants should be sold as soon as possible.
- Tomatoes can be harvested at any time of the day, and should be packed gently into a box immediately following. Egg crate packaging is the best for avoiding tomato damage and layers should not be stacked more than four high in a box. Large heirloom varieties have a tendency to be VERY delicate and should be handled appropriately. Green tomatoes gleaned from vine before frost can be wrapped individually in newspaper and stored in a cool area inside a wax box. They will slowly ripen and provide you with tomatoes from your garden long after the last plants outside have died off.
- Salad Mix is generally placed in cold-water bath after harvest. This keeps temperature down while providing the farmer a good opportunity to thoroughly mix the salad for good uniformity. It is during this time in which you can pick out weeds and ugly leaves. Following the washing and mixing the salad should be thoroughly spun dried. It is important that the mix is relatively dried before being bagged, excessive moisture can lead to rot. Perforated bags are helpful.
- Melons can be harvested at your leisure although a melon harvested in the cool of morning will have a better texture down the road than a melon harvested in the deep heat. They should be stored around 45 degrees and can last for a couple of weeks.

- Potatoes can be harvested anytime of the day but should be handled carefully afterwards. It is now the accepted method of post harvest handling of tubers to either not wash them at all or give them the lightest of dustings. This reduces the chance of disturbing or tearing their skin and thus greatly reducing there storage time. Potatoes can be stored in jute bags or bins. Store in a cool dark place for optimal length of storage.
- Onions/Garlic generally need some curing after harvest. This provides an opportunity to dry the stem, making it possible to clip then store the produce. Garlic is often cured by hanging it in bunched of ten to twenty in a relatively cool dark space. Onions can be cured by laying them out on mesh wire with decent airflow above and below them. This insures good even drying of the stem and will provide the neck a good closure. This is important to promote good storability.

Food Safety

Key production considerations:

- Water & irrigation
- Soil amendments - manure
- Equipment cleaning

Key harvest considerations:

- Food contact surfaces
- Soil contact
- Tools
- Water used during harvest
- Transportation
- Containers
- Cooling

Key processing considerations:

- Wash water
- Personal health & hygiene
- Effective sanitation practices for facility, equipment, utensils

Key storage considerations:

- Temperature/proper cooling
- Moisture/respiration
- Packaging

Food Safety Issues:

- Why have on-farm practices become a focus?
- Risk management
- Understanding pathogens
- Statistics
- Legal perspective/liability
- Traceability

Safe practices:

- HACCP
- GAP

Assessment/Review

- Why are all the considerations in the field, during harvest and post-harvest so imperative to the flavor, nutrient profile, shelf life, safety, texture and aesthetics of produce?
- Why are food safety considerations and regulations increasing?

MILKING
(Field Exercise)

The purpose of this field exercise is to learn and experience the proper way to set up, and perform milking responsibilities in a way that is beneficial and efficient for the producer, as well as comfortable and healthful for the herd.

Milking Parlor

- A proper milk parlor should contain milk stands with feeders, a reserve of mixed grain for feeding, stainless tables for milk equipment, stools at an ergonomically proper height for milking, goat sanitizing supplies, running water for hand washing, a complete line of milking equipment, and a lidded trash can for waste disposal.
- The milk parlor should have a sloped concrete drain floor, washable walls, screen doors, and good ventilation.
- The milk parlor should be far enough away and enclosed from goat housing to insure against dirt or fecal cross contamination.

Pre-Milking Procedures

- Goat(s) are brought into milking parlor and immediately climb onto milk stand.
- Goats are fed in grain dishes attached to milk stand.
- If long hair is present on goat's belly or inside of upper legs, goat should be thoroughly shaved.
- Goat's belly and udders are then rubbed down with warm water. This accomplishes two simultaneous goals: First being removal of dirt, loose hairs, and any other fine particulate that could potentially fall into milk pail during milking. The second function is that warm water stimulates milk movement to the bottom of the udder and makes milking the goat thoroughly much easier.
- The goat is quickly dried using one paper towel.
- Goat belly and udders are then sprayed down with diluted iodine solution; teats are washed and dried first, followed by remainder of udder, then the rest of belly. *(It is during this stage of cleaning the udders that a thorough inspection of the entire udder and teats takes place. Any abnormality should be noted and dealt with promptly. Possible abnormalities could be bumps or other external anomalies on the udder and teats.)*

Milking Properly

- The first stream of milk from each teat is deposited in strip cup. Strip cup is simple aluminum receptacle with a fine screen designed to trap any fluid abnormalities in milk. These abnormalities could be lumps or stringiness in milk, which would indicate possible early detection of mastitis.
- Milking begins at this point. The milker should hold the teats in the space between thumb and pointer finger.
- Proper milking should involve the filling of teats followed by "inching" or squeezing the top of the teat so upon use of finger rolling, milk does not flow upward back into the udder.
- Milk should be "rolled" out of the teat, alternating both hands to find a rhythm that is comfortable for both milker and goat.
- It's very important that the farmer doing the milking does not grab above the point where the teat meets the udder. This is due to the fact that the cells inside the teat are able to handle intense pressure without the worry of cellular rupture, and cells at the base of the udder are more susceptible to rupture leading to infection or possible mastitis.
- As the milk flow decreases, the milker should simulate the feeding behavior of kids to help urge any remaining milk in the udder to drop down lower where it would be accessible to milk out completely. This is done by using an upward-facing open palm and firmly "popping" or "massaging" the entire udder in an upward movement. This knocks any remaining milk in the upper portion of the udder down closer to the teat where it can be easily milked out. Immediately following the coaxing of remaining milk, continue milking for a short time, then repeat coaxing and milking several times.
- Finish milking goat by "stripping" out teat. This is done by gathering and expelling last little milk from udder and teat by narrowing your grasp where the udder meets the teat and GENTLY apply a squeezing motion down the teat.
- Immediately following milking, each teat should be dipped in a teat dip cup filled with a post milking product designed to seal off milk canals that have been opened during milking. This product is also an anti-bacterial. This application prevents any possible bacteria from traveling up the open milk canal.

Post Milking Milk Handling

- Milk should immediately be poured from pale to lidded stainless storage tote.
- All milk collected should be transported to available facility for cooling. Milk should not be left for more than forty-five minutes in tote. The faster the milk is brought down to an appropriate temperature (low forties) the better quality milk.
- All stainless milk receiving equipment should be immediately washed with lukewarm water and anti-bacterial soap.
- All equipment should then be rack dried thoroughly.
- All milk should be cooled in heat exchanger or ice water bath immediately after being received at the creamery or kitchen.

STARTING PLANTS IN A GREENHOUSE
(Field Exercise)

I. Making the soil mix
   A. Ingredients
      1. For air porosity, drainage, and texture: sand, perlite, pumice, vermiculite, etc.
      2. For fiber, body, organic matter, water holding capacity: peat moss, coconut fiber
      3. For introduction of soil micro-organisms; biological aspects of soil: compost or soil
      4. For nutrition: addition of NPK and trace minerals
   B. Method
      1. Mix ingredients starting with the driest (perlite,etc) and ending with the wettest (compost/soil).
         a. Mix with shovel in contained area
         b. Mix with cement mixer
      2. Add water and continue mixing. Add until water can be squeezed from the soil by hand.

II. Making soil blocks
   A. Advantages
      1. More soil for root development
      2. Roots do not circle
      3. Easy to transplant
      4. Saves space in greenhouse

   B. Make flat of 1" soil blocks with floor blocker – for most seeds
   C. Make flat of 2" soil blocks with hand blocker – for large seed

*Size of block also depends on type of plant and length of time in the greenhouse

III. Seeding
   A. Seeding method in soil block - seed three different size seeds into soil blocks. Try different methods of dropping seed – by hand, with moist toothpick, with folded seed packet.
   B. Covering seed for darkness – cover with porous medium that will not crust – sand or vermiculite is best. Also provides a base of support for seedling.

IV. Supplemental care
   A. Watering method – water immediately after covering seed. Must be kept moist for seed to germinate, and obviously for continued growth. Discuss subsequent irrigation options.

   B. Nutrition – best provided with foliar spray of compost tea. Aids in rapid plant growth, disease prevention. Adds live component through compost. Make compost tea: 4 cup compost, 1 cup liquid fish and kelp, 1 tbsp molasses, two gallons water. Mix well and aerate for 24 hours. Apply with backpack sprayer.

TRACTOR 101

This lesson plan is geared towards the operation of a Kubota 3410; nearly all the information is transferable to most small farm tractors. However, it is very important when operating any tractor that one has a solid fundamental understanding of the particular tractor's nuances, lever and gear positions, and safe operating guidelines.

Learning Objectives

The learner will:

- Understand the basic functions and operations of a Kubota tractor.
- Understand the basic safety features and concerns of operating a Kubota tractor.

Understanding the Various Controls on the Tractor

- **Starting the Tractor**
  - The Kubota and most small farm tractors are started by turning the key to the right one click until the light for the glow plugs comes on and then goes off again. You may then depress the clutch and turn the key all the way to the right until the engine turns over.
  - On cold mornings the choke may be required. This is operated by pulling the choke (located near the key) all the way out. As you turn the engine over, slowly push the choke back in until the engine kicks on.
  - It is very important that the throttle be pushed all the way in the upward (turtle) position before starting the tractor. This gives the tractor an opportunity to warm up in the idle position, which is very important for any diesel engine.

- **Throttle Control**
  - The throttle can be located sticking out of right side of the dash. It is an orange handled lever equipped with a turtle and a rabbit symbol.
  - Pulling down on the lever towards the rabbit increases the amount of fuel fed into the engine and therefore increases RPM's and available power to the tractor.

- **Clutch Pedal**
  - This pedal is found on the left side of your foot controls. It is a single pedal.

- **Forward and Reverse Pedal**
  - This "rocker" pedal makes the tractor go forwards and backwards and can be found on the right side of your foot controls. It sits on the floor of the tractor.

- **Brake Pedals**
  - These pedals sit above the "rocker" pedal and can be operated as one pedal or split to brake the individual rear wheels.

Understanding the various parts of a small farm tractor and their functions

- **PTO (power take off)**
  - A PTO is used for powering a tiller, auger, or any other implement that is actively driven by the tractors engine.
  - The PTO can be located in the back of the tractor.
  - Hooking up the PTO drive shaft to the PTO and running the engine so the tachometer reads 540 RPM's use the PTO.
  - To engage the PTO the clutch must be depressed. Once the clutch is depressed you may shift the PTO lever forward and then slowly release the clutch pedal to begin spinning the PTO. The lever can be found next to your right hip on the tractor.
  - It is important when engaging the PTO not to "shock load." A "shock load" happens when the clutch is popped and the engine is revved to a running RPM level. "Shock loading" the PTO stresses the metal on the tractor and the implement being driven. To avoid this, run the tractor's engine with the lowest RPM's possible when taking your foot off the clutch and engaging the implement.

- **Three-Point Hitch Hydraulic**
  - The hydraulic unit and three-point hitch system is designed to raise and lower the implement positioned on the rear of the tractor.
  - The hydraulic is used to determine the operating depth of both active (PTO driven) and passive implements. This will determine the depth of tillage, subsoil ripping, plowing, etc of any given implement in use.
  - The lever that controls the three-point hitch can be found on the right side of the tractor driver's body around the height of the knee.
  - If the lever is pushed towards the ground at maximum depth the implement will be forced down as far as it may go by the hydraulics of the tractor.

- **Front Bucket Loader**
  - The front bucket loader is used for scooping large loads and moving heavy objects or masses of earth around the farm.
  - The front bucket loader is hydraulically operated using the ball lever located on the right hand side of the tractor directly across from the tractor driver's shoulder.
  - There are two different ranges of motion available to you when using the front loader.
  - The arm of the bucket may be raised or lowered and the bucket may be tilted forward and backward.
  - The controls are "reversed" in that to make the arm of the bucket come up, you pull down on the ball lever. To lower the arm, you push up on the ball lever.
  - To dump the bucket, you move the ball lever to your right. To tilt the bucket back, you move the ball lever to your left.
  - These are the four main movements of the ball lever. Each movement is accomplished by moving the lever in the primary directions (north, south, east and west).
  - There are four other movements that incorporate both ranges of motion simultaneously. In other words, they move the arm and the bucket at the same time. These movements can be found by engaging the ball lever at the secondary

directions (i.e., southwest, northeast, etc). These movements require more skill and experience and will make your movements more fluid.

Basic Tractor Safety Principles

- Always wear your seatbelt! Most tractors are equipped with a roll over protection device that is built to protect you if the tractor rolls. A seatbelt will save you from getting crushed!
- Never stand near a spinning PTO! The PTO and connected drive shaft spins with incredible force. Keep clothing and body parts away from the spinning shaft, or risk dismemberment and death!
- Do not rest arms or hands in the joints of any hydraulic part! Or risk dismemberment.
- Never put your hands inside or around active implements when the tractor is running! Turn off tractor if any jamming or other obstructions occur when using PTO driven implements.
- Do not operate tractor on a dangerous slope! Be aware of rollover dangers.
- Always move very slowly when moving heavy loads in the bucket! Driving with a heavy load greatly changes the balance and stability of the tractor. Heavy loads encourage tipping and rolling.

NOTES

Transplanting
(Field Topic)

The purpose of this field topic is to gain a solid understanding of proper transplanting techniques, and in doing so create the best environment for transplanted starts to thrive.

Transition from greenhouse to field

- Starts grown in a greenhouse are accustomed to a controlled environment. Air temperature, humidity, wind, soil temperature, and exposure to direct sunlight are all controlled factors in the greenhouse.
- Starts must have transition time from greenhouse to field. This process is called "hardening off."
- Hardening off reduces amount of stress for start by gradually increasing amount of exposure to outside elements.
- Hardening off should start at least 15 days prior to acceptable field transplant date.
- This process can be done several ways: One good way is the use of a cold frame. A cold frame is a mini-greenhouse that is constructed using a wooden box with either a glass or plastic lid cover.
- Plants can ease out of a controlled greenhouse using the following schedule:
    - First, the plants are moved to the cold frame two weeks before they are ready to enter the field.
    - The plants should spend these two weeks with the cover off the cold frame during the day and protected with the cover on at night.
    - Leave the starts exposed to the elements for a half hour to an hour longer each consecutive day.
    - Finally, leave them exposed all day and all night the final three days.
    - The transition is complete. They are ready to go to the field.

Transplanting Starts

- Starts should be thoroughly watered before being transplanted. This greatly reduces shock. Using a weak fish emulsion solution just prior to transplant will also encourage plants to take off quickly.
- Keep starts in shaded area until they enter the ground.
- When pulling apart individual soil blocks or removing starts from trays, carefully separate the intertwined root growth, causing as little trauma as possible, while still remaining efficient.
- Do not expose tender root systems to direct sunlight (as little as fifteen seconds of exposure can kill off roots).
- Using your hand or a planting tool create the right depth and size hole in the bed or row being planted.
- Some farmers will sprinkle a little organic fertilizer in the hole just prior to planting. This should be done only if the quality of the soil requires that extra boost.
- Gently tease the roots before planting the start; this encourages new outward growth of the roots.
- Take special care to insure the top of the soil block or cell being planted is covered with native field soil; this greatly reduces the natural drying out process during the beginning of the plants field life.
- Some farmers apply a gentle amount of pressure to the base of transplants after planting; others allow the natural "watering-in" process to settle the soil around the new transplant. What works for one may not work for another, and much of that has to do with the style of irrigation being used. An overhead irrigation system is going settle the soil around the plant much better than a drip system. Using our drip system at Boones Farm we've found applying a gentle amount of pressure encourages the pooling of water around the base of the start.
- Always water in a new start. This is the highest preventative measure you can take against shock.
- The best time to transplant any start is in the cool of the evening. This allows the plant a nice buffer to become acquainted with its new surroundings before dealing with a hot sun.

TREE PLANTING
(Field Exercise)

Layout

- Consider goals of tree planting – reforestation, food crop, windbreak, shade, etc.
- Consider environmental factors – soil, climate, aspect, etc.
- Consider the needs and optimal conditions for the trees to be planted.

Planting

- Bare root trees
  - Dig hole – should be deeper and wider than roots
  - Trim off any broken roots
  - Place roots in hole. Ensure that tree is straight. Slowly fill the hole and gently tamp the soil in around the roots.
  - Depth of planting depends. Generally, in climates with a long wet season, the tree should be planted high – not in a basin – to ensure that the roots do not drown. A basin around the tree is helpful to capture and concentrate rainfall around the root zone, if the rain comes gradually over the course of the year.

- Potted trees
  - Dig hole – slightly bigger than the pot
  - Remove tree from pot, and massage the potting soil so as to break compaction and offset any root binding.
  - Place tree and soil into hole, slowly backfill with native soil around the potting soil, gently tamp.
  - Depth depends – see above.

Irrigation

- Discuss need for irrigation based on site specifics.
- Demonstrate proper installation of drip irrigation.

Mulching

- Discuss pros and cons.
  - Pros – smothers weeds, conserves water, attracts earthworms.
  - Cons – attracts mice, moles, and gophers.

- Demonstrate using straw or cardboard, or both.

WEED MANAGEMENT
(Field Exercise)

Identification

- Tour fields and identify most common weeds (star thistle, pigweed, purslane, chicory, wild lettuce, grasses, etc.)
- Discuss why weeds are threatening to production – competition for water, nutrients in soil, light, etc.
- Pull or dig selected weeds and examine root system

Management through manual cultivation

- Demonstrate and practice proper techniques with various tools – wheel hoe, stirrup hoe, collinear hoe, and Mexican hoe. Discuss need for follow-up cultivation.
- Benefits – eliminates weeds, stirs soil and breaks crust (allows for easier penetration of air and water)