Improving Soil Health on Urban Farms

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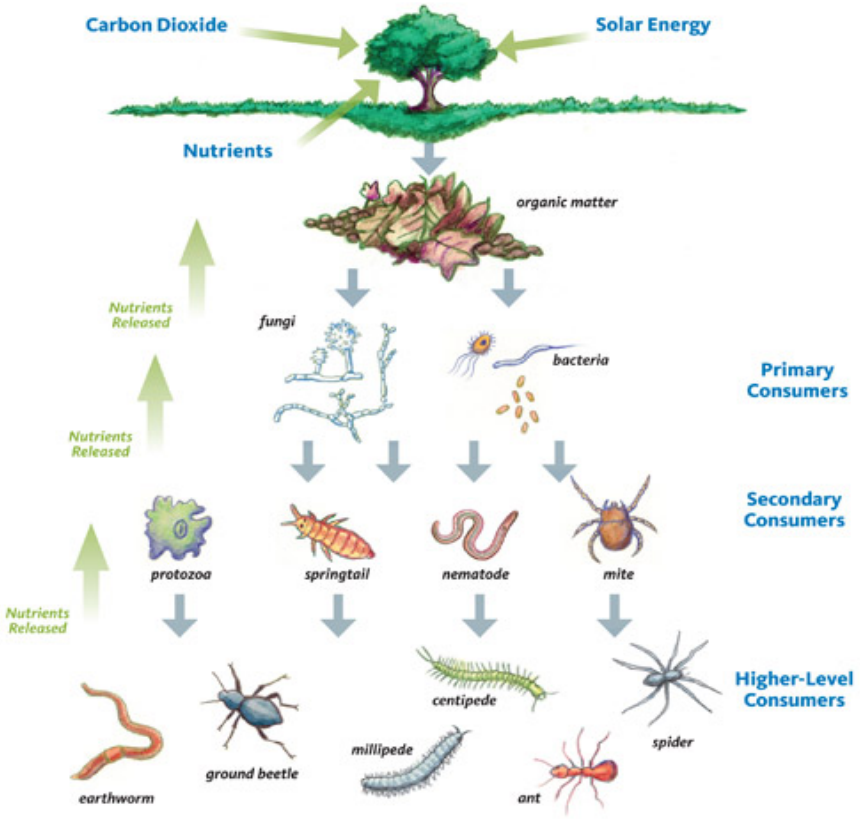
•Urban farm (in the middle of Albuquerque, NM)
• Cultivating 3.5 acres
• Mixed vegetables, cover crops, peach orchard
• Certified organic
•Surface water from canal
• Well water for drip tape

It's all about the microbes!

Bacteria, Fungi, Protozoa and Nematodes



- **Plants evolved with soil microbes**
- **Microbes break down minerals and organic matter to be available to plants**
- **Minimal soil disturbance allows microbes to grow in the soil**
- **Cover crop residue provides food for microbes**

Guiding Principles for Improving Soil Health Using a Soil Health Management System

1. Grow a crop on all the land at all times

2. Grow many different crops in diverse rotations

3. Disturb the soil as little as possible

Photos illustrate farm practices that improve the soil

1. Soil health improvement activities

2. Habitat for pollinators and wildlife

3. Farm infrastructure development

4. Pest and weed management

5. Soil nutrient management

6. Water management

NRCS Practice # 340: Seasonal Cover Crop

Practice: Cover crops

- **Field mix:** medium red clover, alfalfa, white clover, hairy vetch, native wildflowers

- **Mix of annuals and perennials**
- **Flail mow and regrow**
- **Residue is food for microbes**

- **Fall planted**
- **Follows cash crop**
- **Incorporate early spring**
- **Cool season mix**

Why? Holds moisture, pollinator habitat, increase organic matter, prevents erosion

NRCS
Practice # 327:
Conservation
Cover Crop

Practice: Cover crops

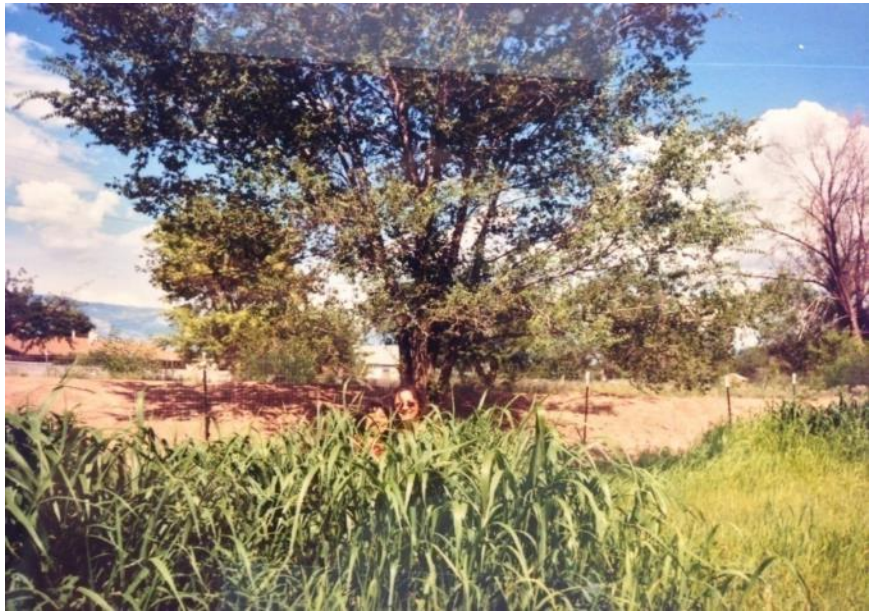
- **Permanent orchard understory**
- **Provides nutrients for trees**
- **Mowed, remains on ground**
- **Mix of clovers, vetch and ryegrass**

- **Portion is not mowed**
- **Reseeds itself**
- **Attracts Bees**
- **Increased pollination**

Why? As a BIO FARMER we always grow 2 crops: one for us, one for the microbes

NRCS
Practice # 328:
Conservation
Crop rotation

Practice: Cover crops



•Field mix:
Sudangrass,
Sorghum/Sudan,
Red clover.
Winter wheat

- **First crop after laser leveling field**
- **Mix of grasses and legumes**
- **3 years cover crop only**
- **Nothing removed from land**

- **Cover grows 6’ tall**
- **Mowed, allowed to regrow**
- **Left on ground, <u>NOT</u> incorporated**

Why? Cover Crops <u>RESTORE</u> depleted soils

Practice: Rotate cash row with alley row every 3 years

Alleyway

Alleyway

- **Alleyways planted in cover crop to enrich the soil**
- **Low growing Dutch white clover**

Why? We build soil fertility in alley rows by planting cover crops

NRCS
Practice # 329:
No till

Practice: Reduced tillage implements

- **No Till Drill**
- Plants into existing crop

- **Roller crimper**
- Kills crop without tilling

- **Flail mower**
- Lays down even band of vegetation

- **Narrow tiller**
- Tills narrow band for cash crops

Why? Less soil disturbance improves microbe population

Practice: Cover crops in alley rows

- Using a soil aerator in alley row
- Opens up soil for reseeding
- Narrow width perfect for alley row

- Hand broadcasting in alley row
- Red/white clover
- Increases soil nitrogen

Why? This year's alley row is next year's cash row (we rotate every three years)

NRCS
Practice # 345:
Reduced tillage

Practice: Cover crops in cash row

- Fall planted cover crop
- Planted in cash row, after harvesting cash crop
- Legume, grain, radish mix

- Mowed down in spring

- Residue remains on the ground

- Residue tilled in 2 weeks prior to planting cash crop
- Residue breaks down and feeds the microbes

Why? Fall cover crops in cash row improves soil for spring planting of vegetables

NRCS
Practice # 324:
Deep tillage

Practice: Single shank deep tillage

- **Cuts a slit in the soil 2 feet down**
- **Does NOT invert the soil**
- **Minimal effect on microbial life**
- **Opens up soil to air and water flow**

Why? Improves soil health through minimal disturbance of soil

Practice: Using biological inoculants

- **Bacteria fix nitrogen and solublize phosphorous: Azotobacter**
- **Used as soil drench or foliar spray**
- **Once in the soil, they spread and "colonize" the soil**

Why? Biological inoculants enhance the microbial life in the soil

Practice: Planting an orchard

NRCS Practice # 490: Tree site preparation

- Laying out tree spacing
- Close spacing: trees kept short

- Buried line for sprinklers
- Each tree has own sprinkler
- Sprinklers irrigate cover crop

Why? An orchard adds diversity to farm ecosystem- and is a great cash crop!

NRCS
Practice # 612:
Tree and shrub establishment
Practice 660:
Tree pruning

Practice: Orchard with cover crop understory

- Irrigating the cover crop
- Mix of grasses and legumes
- Wood mulch creates fungal environment

- Cover crop enriches soil
- Tree root zone extends into cover crop

- Trees planted as “whips”
- Tree growth after one season
- Mulch around trees but NOT at base of trees

Why? A healthy cover crop under trees provides nutrients to tree roots

NRCS
Practice # 386:
Field Border

Practice: Perennial shrubs along field borders

Before

- **Permanent perennial shrubs**
- **Watered by drip line**
- **Suppresses weeds**

After

- **Shrubs after one year's growth**
- **Apache plume, sage, chamisa, turpentine bush**

Why? Food source for bees, windbreak, retains moisture, increases diversity

NRCS
Practice # 422:
Hedgerow planting

Practice: Hedgerow Planting

Before

- **Planted along fence line**
- **Habitat for variety of beneficial insects**
- **Flowering cactus attract bees**

After

- **Shrubs in bloom**
- **Russian sage, globe mallow, catmint**

Why? Food source for bees, windbreak, retains moisture, increases diversity

Practice: Hedgerow Planting attracts pollinators

Why? Food source for bees, windbreak, retains moisture, increases diversity

NRCS
Practice # 647:
Successional habitat management

Practice: Hedgerow Planting

- Catmint comes out early

- Followed by Russian sage and globe mallow

Why? Flowering plants attract beneficial insects to the farm

NRCS
Practice # 645:
Wildlife habitat
management

Practice: Wildlife habitat

- **Raptor pole**

- **Bat box**

- **Ducks during flood irrigation**

Why? Predators (hawks, owls, bats) eat pests (mice, voles, mosquitoes). Ducks are just fun

Practice: Bees on the Farm!

- **Crop pollination**
  Particularly good for melons, squash, cucumbers, pumpkins

- **Topbar hive**
  Easier to maintain than Langstroth hive

Why? Bees increase yields and improve diversity

Practice: Bees on the Farm!

- **Bee water station**
  Living plants keep water clean

- **Hangin out!**

Why? Bees increase our yields and improve diversity

NRCS
Practice # 390: Riparian cover
Practice #644: Wetland habitat
Practice # 603: Herbaceous wind barrier

Practice: Vegetation along ditchbank

Why? Provides habitat for wildlife and flowering plants for beneficial insects

Practice: Greenhouse

- **Maintains quality control**
- **Start transplants from seed**

Why? All aspects of plant propagation under our control

Practice: Trellis system for vertical growing

Rebar Trellis

- Welded rebar trellis has long life
- Perfect for vining plants
- Saves space
- Easy to move and install

- Crops we grow vertically
  Beans, peas, tomatoes, melons, cucumbers, squash

Why? Growing plants up on a trellis saves space and disrupts pests

Practice: Vertical Growing of Tomatoes

• Tomatoes growing vertically

• 6 varieties of cherry tomatoes

Why? Saves space and ease of harvesting

Practice: Vertical Growing of Melons

- Melons will climb a trellis

- Melons hang naturally without support

Why? Saves space and confuses squash bugs

Practice: High Grow/Low Grow System

- Tractor can navigate
- We spray three sides
- Intercropping confuses pests

- Low grow crops:
  peppers, sweet potatoes, garlic, potatoes, onions, beets, radish, carrots

- Tractor fits between trellises
- Drives over low crops no problem

Why? Efficient use of row space

Practice: Low Growing Crop- Sweet Potatoes

- Low growing sweet taters

- All purple sweet potato

Why? Can easily drive tractor over row

Practice: Low Growing Crop- Eggplant

- Low growing eggplant

Why? Can easily drive tractor over row

Practice: Rows on 30” Centers

- Alley row and cash row on 30” centers
- Every row has buried irrigation outlet for driptape

Why? We alternate cash and alley rows every 3 years

NRCS
Practice # 561: Heavy use area protection
Practice #342: Critical area planting

Practice: Roadways and Critical Areas Planted in Cover Crops

Drivepath

- **Drivepath planted in Dutch white clover and perennial rye**

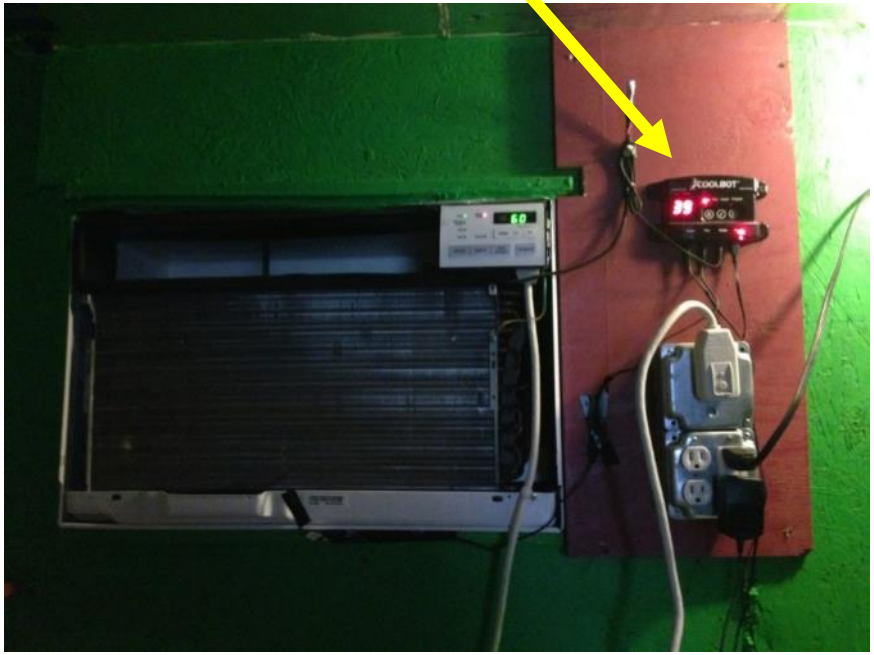
Why? Protects and enriches the soil and prevents erosion.

NRCS
Practice # 672:
Building envelope
improvement

Practice: Walk in cooler

20’ steel container

Coolbot Unit



- **20’ container converted to a cooler**
- **Insulated and secure**

- Coolbot technology
- Uses a regular air conditioner
- Low cost
- Very efficient

Why? Efficient, low cost cooling assures food safety

NRCS Practice # 595: Integrated Pest management

Practice: Companion Planting for Pest Suppression

Garlic sprouts

- **Garlic planted under peach trees**
- **Repels peach tree borer**

French marigolds

- **Marigolds in tomatoes**
- **Repels whiteflies and nematodes**

Why? Many flowers, alliums and herbs repel insect pests

Practice: Insect Pests Traps and Lures

Cucumber beetle lure and trap

Peach tree borer trap

- **Lures attract specific insect pests**
- **Sticky traps capture pests**
- **Sticky trap without a lure is a monitoring tool for presence of pest**

Why? A natural control not toxic to beneficial insects

NRCS
Practice # 585:
Strip cropping

Practice: Intercropping

- Different crops in each row
- Disrupts the feeding and reproduction cycles of pests
- Increases diversity supporting beneficial insects

Why? Intercropping confuses insect pests

Practice: Habitat for Beneficial Insects

- Spider eating grasshopper

- Ladybugs eating aphids

Why? A natural control not toxic to beneficial insects

Practice: Organically Approved Pesticides

- Pure oils such as Neem, Karanja and Castor
- Soaps such as Dr. Bronner's
- Biological agents such as:
  - Beauveria fungus
  - Nosema fungal spores
  - Bacillus thuringiensis bacteria
  - Spinosad bacteria

Why? Controls insect pests naturally

Practice: Weed Suppression- Landscape Fabric

- Fabric reusable, lasts 5 years
- Used in all cash crop rows
- Blocks weeds
- Drip tape laid under fabric

- **Burning holes for transplants**

- **Holes in fabric are specific to each crop**

Why? Fabric suppresses weeds in cash rows

NRCS
Practice # 484:
Mulching

Practice: Weed Suppression- Straw Mulch

- Straw mulch around garlic

- Straw mulch around beans

Why? Straw mulch suppresses weeds, retains moisture, enriches soil

NRCS
Practice # 484:
Mulching

Practice: Weed Suppression- Wood Chip Mulch

- Wood chips from on-farm debris

- **Wood mulch around trees in orchard**
  Note breakdown of chips turning into soil

Why? Wood chip mulch suppresses weeds and produces rich fungal dominant soil

NRCS Practice # 590: Nutrient Management

Practice: Biological Inoculants

- **Foliar spraying young plants**

- **Azotobacter bacteria**
  - solubilizes phosphorous in soil (side drench)
  - extracts nitrogen from the air (foliar spray)

Why? Biological inoculants "super charge" the soil with helpful microbes

NRCS Practice # 590: Nutrient Management

Practice: Green Manure

• Small scale: mower keeps residue on the ground

- Residue chopped up into small pieces
- Evenly distributed on the ground
- No-till drill through the residue

Why? Residue left on the ground becomes food for the microbes in the soil

NRCS
Practice # 317:
Composting

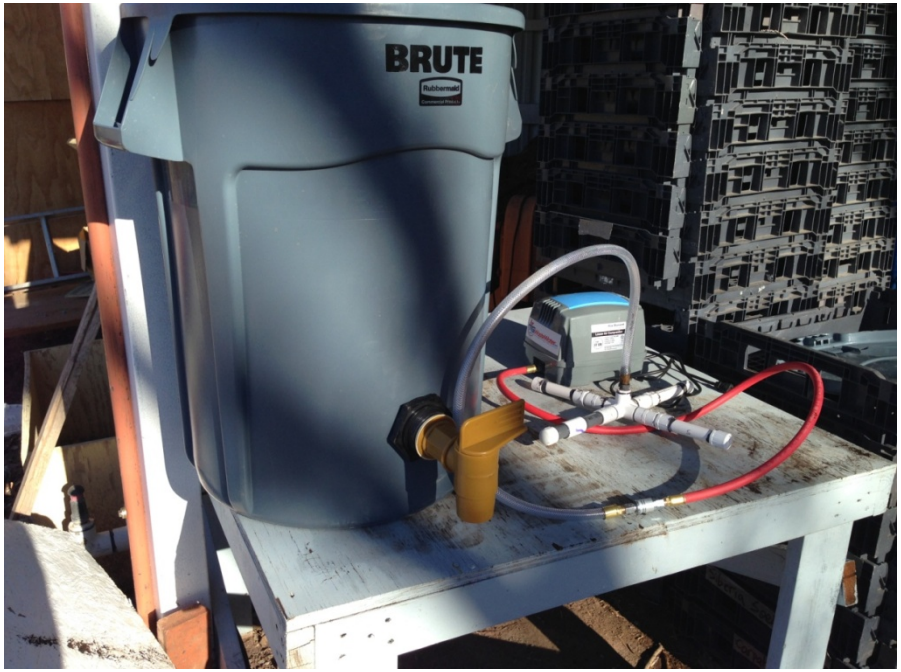
Practice: Compost

Compost from certified organic source.

Compost added to all cash crop rows

Why? Compost is a biological soil amendment containing billions of microbes

Practice: Compost Tea



40 gallon brewer with aerator

Foam is evidence of microbial growth

- **Brewed liquid extract from compost**
- **Amplifies the microbes in compost**
- **Foliar spray or side dress**

Why? Compost Tea increases the microbial population in the soil, improving soil health

Practice: Injection of Soluble Nutrients

- Inject seaweed and soy based nitrogen
- Use 40 gal sprayer to inject into drip lines

- Nutrients pumped into drip line

Why? Nutrients go right to the root zone of plant

NRCS
Practice # 320:
Irrigation Canal

Practice: Installing an Irrigation Canal Turnout

Digging channel for culvert into field

12” turnout into field

Why? Controls flow of surface water from canal into field

NRCS Practice # 587: Water control structure

Practice: Concrete Box to Distribute Water Into Pipeline

Forming water control structure

Finished water control structure

Why? Distributes surface water into buried 12" pipeline

NRCS
Practice # 430:
Irrigation Pipeline
Practice # 443:
Surface irrigation system

Practice: Buried Pipeline with Alfalfa Valves

12” buried pipeline

Alfalfa valves

Why? Buried pipeline distributes surface water to alfalfa pop-up valves

NRCS
Practice # 362:
Diversion

Practice: Berms to Control Water Flow

Berm covered in vegetation

Why? Controls flow of surface water within the field and adds habitat

NRCS
Practice # 464 Irrigation
land leveling

Practice: Field Laser Leveling

Disked and ready for leveling

After laser leveling complete

Laser level field with cover crop

Why? A level field assures even water flow and conservation of water

NRCS
Practice # 642:
Water well
Practice # 355
Well water testing

Practice: Drilling a Well

- **Use with drip tape and micro-sprinklers**
- **Year-round farming**
- **Water testing for quality is important**

Why? Well water is ideal for drip tape and micro irrigation systems

NRCS
Practice # 441:
Micro irrigation

Practice: Drip Tape Micro Irrigation

Permanently buried manifold and distribution lines

Irrigation lines spaced every 30”

Every row has buried control box

Why? Permanently buried lines assure ease of operation

NRCS Practice # 449: Irrigation water management

Practice: Drip Tape Irrigation Zone Control Station

Zone control station directing well water into drip lines

Flow rate meter and valves

Why? Controls and monitors the flow rate, volume and pressure in the drip lines

NRCS Practice # 449: Irrigation water management

Practice: Tensiometers

Prepping tensiometers for placement in field

Field placement at different depths

- **Measures soil moisture**
- **Replicates root osmotic pressure**
- **Measures true water needs of plant**

Why? Assures accurate irrigation based on plant needs

NRCS Practice # 557: Row arrangement

Practice: Drip Tape in Cash Crop Rows

- 1,2 or 3 drip lines per row
- Long lasting (4-5 years) 15 mil thick tape
- Each row with own control box

Why? Efficient use of water, able to inject nutrients

NRCS Practice # 442: Sprinkler irrigation

Practice: Micro Sprinklers in Orchard

- **Waters both trees and cover crop**
- **One sprinkler head per tree**
- **Efficient use of water**

Why? A healthy orchard cover crop provides nutrients to trees

Summary

1. As a soil health Bio Farmer, we are always growing 2 crops: one for us (cash crop) and one for the microbes (cover crop).

2. Quality compost- either made on farm or brought in- is most important amendment

3. Use biological inoculants and biologically based pesticides: they work with nature rather than against it.

4. Grow cover crops on all fields: before and after a cash crop.

5. Avoid chemicals and pesticides that will kill the microbial life in the soil.

6. Your farm is a unique eco-system where every practice affects all aspects of your farm.

NRCS Practices Listed by Category

1. Soil Health Improvement Practices
   - #340- Cover Crops
   - #327- Conservation Cover
   - #328- Conservation Crop Rotation
   - #329- Tillage Management, No till
   - #345- Tillage Management, Reduced Till
   - #324- Deep Tillage
   - #612- Tree Establishment
   - #490- Tree site Preparation
   - #660- Tree Pruning

2. Habitat enhancement for pollinators
   - #386- Field Border
   - #422- Hedgerow Planting
   - #647- Habitat Development
   - #645- Wildlife Habitat Management
   - #390- Riparian Cover
   - #644- Wetland Wildlife Habitat
   - #603- Wind Barrier

3. Farm Infrastructure management
   - #561- Heavy Use Area Protection
   - #342- Critical Area Planting
   - #672- Building Envelope Improvement

4. Pest and weed management
   - #595- Integrated Pest Management
   - #585- Strip Cropping

5. Soil nutrient management
   - #484- Mulching
   - #317- Composting
   - #590- Nutrient Management

6. Water management
   - #320- Irrigation Canal or Lateral
   - #587- Structure for Water Control
   - #430- Irrigation Pipeline
   - #362- Diversion Channel
   - #443- Irrigation, surface and subsurface
   - #464- Laser Land Leveling
   - #642- Water Well
   - #355- Ground Water Testing
   - #441- Micro Irrigation
   - #449- Irrigation Water Management
   - #557- Row Arrangement
   - #442- Sprinkler System

Minor is available to consult on:

- Transitioning to organic practices
- Organic System Plan development
- Holistic farm planning
- NRCS practices
- Soil Health Management Systems
- Biologically based farm practices

THANK YOU!

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