Asheville – June 23, 2012 outline

Part A - Maximizing Cover Crop Effectiveness

1 – Cover crops – the cornerstone of sustainable annual crop production. "Feed the soil"

2 – Organic context – *ask audience who is USDA certified or seeking certification.*

3 – What is underneath these thriving crops? – Living Soil

4 – Key elements of the soil food web, and how they hold and release N and other nutrients

5 & 6 – Organic Matter and Nutrient Cycles in Nature. N, P, S *in* organic matter, cations on CEC

7 – OM Cycle in Agriculture – harvest, tillage, bare soil (reduced input)

8 – How organic growers replenish the OM cycle. Discuss Cover crops now, amendments later

9 – Why grow cover crops? Bare soil hungry, at risk – *beware the "clean garden" impulse.*
Cover crops do the job of weeds – protect and restore disturbed and exposed soil
For crop disease or pest concerns, implement sanitation, then promptly plant a cover crop.

10 – Role of plant roots in the soil food web – *best thing for soil is living vegetative cover*

11 – Cover crops feed / protect soil – abundant root exudates from high biomass cover

12 – Cover crops manage nutrients – N (fix / recover), P, K (improve avail., don't aggravate excess)
Elaborate briefly on N, P, K behavior in soil, how cover crops help manage low and high NPK

13 – Cover crops and pest/weed management – double role for buckwheat here.

----- Virtual tour of cover crop species -----

14 & 15 – Buckwheat – for short fallow periods during moderately warm parts of frost free season (all summer in Appalachia – at least before climate change!). Excellent farmscape, excellent weed suppression (*allelopathy now well documented – caution with crops*), rapid soil coverage/protection (reduces erosion), mobilizes P despite being non-mycorrhizal.

16 & 17 – Sorghum-sudangrass – for longer summer fallow, when too hot or weedy to grow vegetables; *roots both deep and fibrous* – stops erosion, breaks up hardpan, improves tilth.
Mow periodically to send roots deeper and obtain less-woody, easier-to-handle mulch. Moderately allelopathic. Can tie up N if incorporated. *Needs high soil fertility to thrive.*
Harbors some beneficials. Closely related sorghums and non-hybrid sudangrass similar.

18 & 19 –Pearl Millet – similar niche and attributes as sorghum-sudangrass, but does not require such high soil fertility; and much easier to kill mechanically after heading.

The "prevents erosion" benefit is true of *all* grasses – grassroots hold soil directly, rapid canopy forming broadleaf crops (buckwheat, cowpea) protect soil from raindrop impact – polycultures best!
20 – Foxtail millet – closely related to foxtail weeds but not weedy. Plant before summer solstice because of daylength response.

21-22 – Cowpea – good N fixer, good companion to millets & sorghums, dense canopy can be highly weed competitive. *Biculture with millet / sorghum-sudan is especially effective.* Cowpea is sufficiently shade-tolerant and may work to relay-intercrop into wide row production crops.

23-24 – Forage Soybean – can be excellent biomass and N fixer, use Group VI or later; northern varieties will not get over a foot tall; avoid GMO grain varieties (less biomass, not NOP compliant)

Not as heat/drought tolerant as sunnhemp, cowpea.

25 – Sunnhemp – high biomass and N, companion to tall grasses, suppresses pest nematodes, tolerates lower soil fertility (thrives where soybean, sorghum-sudan fail); seeds may be expensive & hard to obtain.

[Other tropical legumes – lablab bean, velvet bean – best for really hot regions, seeds $$]

26-27 – Forage radish – 'Tillage radish' is a variety of daikon selected for efficacy as cover crop. Late summer – fall planting best – leaves seedbed ready for early spring; concern about rapid decay of residues and soil surface exposure to erosion.

28-29 – Forage radish – dramatic weed suppression without concomitant suppression of vegetables.

Enhanced spinach stands (decaying radish kills off pathogens), no effect on pea, onion, lettuce (all strong mycorrhizal hosts – radish anti-mycorrhizal effect not persistent)

Other research confirms – radish reduces weeds mostly by shading, not allelopathy.

30-31 – Spring oats – very versatile, can plant early spring or late summer, but will not establish well in hot, dry weather. *Overwintered in Floyd, VA in the non-winter of 2011-12* (two coldest nights 12 F, less than ten nights in teens). Not as apt to tie up N as some other grass cover crops.

32-33 – Winter rye – the most widely used cover crop – multipurpose workhorse: biomass, erosion control, weed suppression, N scavenging. When it gets tall, just cut it for mulch hay!

Rye allelopathy is widely researched and validated; provides selective weed control in no-till transplanted summer vegetables like tomato.

Caution: overuse (every year for a decade) *could* invite a rye disease or cause soil biological imbalance.

34 – Other cereal grains – triticale, barley, wheat – all combine well with winter legumes (more coming)

35 – Italian ("annual") ryegrass – superior erosion control and tilth improver (very dense fibrous root system) – some weedy potential (disliked by some producers) must terminate with vigorous tillage.

36 – Hairy vetch – great N fixer, viny, thrives best when supported by stiff straw grain like rye or triticale. Killed HV mulch highly beneficial to tomato – anti-senescence effect documented (modified gene expression!). Can be weedy if goes to seed. Buy scarified seed if possible (zero hard seed)

37 & 38 – Advantages of biculture, using rye + hairy vetch as example

Grass enhances legume N fixation by removing available N from the soil.

Note increasing interest in more complex cover crop polycultures among innovators and among NRCS personnel – Ray Archuleta in NC, Steve Groff in PA, Klaas Martens in NY, farmers in ND) – mixtures of 5 or more different species from 3 or more plant families. Seeding rates must be reduced accordingly so crops don't crowd each other out. Multiple benefits, wider adaptation and soil micro-biodiversity, farmscaping.

39-40 – Crimson clover – easier to manage and a bit earlier than vetch & northern rye varieties; self-seeding, can be weed in summer vegetables.

41 & 42 – Austrian winter pea – versatile, heavy N fixer, succulent, good companion to any cereal grain. Extremely hardy to -5F or colder when small, much more liable to winterkill when large – thus there are three seasons / use niches for this cover crop.

Possible disease carryover to horticultural (vegetable) peas (same species).

43 – Subterranean clover – unusual niche – potential as self seeding winter annual cover crop.

44 & 45 – Red clover is excellent for restoring worn-out soils or bringing annual weed problems under control. Breaks annual weed life cycles, harbors weed seed predators.

Can overseed red clover into standing crops – will establish and cover ground.

46 – Biennial sweetclover. Note – also fairly drought tolerant, but needs near-neutral soil pH.

47 – Selecting Cover Crops for Your Farm and Crop Rotation - **Lights On**

---- BREAK ----

Open Discussion – use real examples from audience – choosing the right cover crop for the niches in the rotation and grower objectives.

48 – How to Succeed with Cover Crops

Optimum seeding rates – "recommended rates" – may want somewhat higher for weed suppression or later-than-optimum planting. However, too high seeding rate can reduce crop vigor.

Irrigate / fertilize: cover crops are generally not fussy – however, it pays to provide water and nutrients to get the crop up and established. Can use uncomposted or cool-composted manure ahead of cover crops for P and K, legume covers for N.

49-50 – Importance of seed quality

51 – beds sown with Earthway push seeder with different plates according to cover crop seed size.

52 – Seedbed – tell my “weedy cover crop” story.

53 & 54 – Broadcast and incorporate seeding, small scale – Dayspring Farm

55 – To till or not to till a cover crop: It depends on circumstances. Tillage stimulates bacterial activity and temporarily disrupts fungal activity. Some (especially from cooler climates) argue that a tilled-in cover crop builds active SOM and releases nutrients more effectively than a cover crop mowed, rolled, or sprayed and left on the surface. Others (especially from warm climates, sandy soils; also NRCS and Monsanto) insist that no till management is best - for different reasons (warm/sandy = burn up OM, release nutrients too fast; soil conservation; sell patented herbicide-GMO package).

56 – Trying to incorporate too much OM or too much strawy, high carbon material at once can be difficult, give the soil “indigestion,” and delay planting excessively while waiting for it to break down. Instead, cut topgrowth to use as mulch or compost starting materials, till stubble (minimally) and plant.

57 – Farm-scale organic no-till methods & equipment

58 – No-till transplanter

59 – Organic no-till – when it works, when it does not – depends on weed flora (perennials will defeat the system), on cover crop (must be high biomass – 3 tons/ac aboveground *minimum*), and following crop (transplant or large seed; direct-sown small seed will not establish well most years.)

60 - Questions? **Lights on**

----- BREAK -----

<u>Part B – Sustainable Soil and Nutrient Management and Using Soil Tests and Compost Analysis</u>

61 – Title slide

62 – Feed the soil / feed the crop. In practice, will need supplemental inputs – avoid “mining” soil

63 – Organic nutrient management – site specific – optimize, then replenish what is removed in harvest
I tend to think in terms of “total nutrient input” rather than “available nutrients” – long term goal is to rely mainly on soil life to make nutrients available to the crop.

64 – Soil test – discuss what is reported on the test – a chemical snapshot of the soil

65 – interpretation and deficiency / sufficiency ranges M (25-50) is often sufficient for micronutrients

66 – look at sample tests from the two labs. **Lights on** – go over tests, and interpret.

67 – how conventional lime & fertilizer recommendations are developed.

68 – effect of soil life on crop response to added nutrient. *Tell story of AD garden.*

69 – nutrient recommendations for organic systems – hard to "translate" – may need less or more

70-73 – nutrient sufficiency and causes of deficiency. Al toxicity in acid subsoil ~ "chemical hardpan"
- 70 – sufficiency – this is what AD garden had for all nutrients but one
- 71 – nutrient is actually in short supply – this is what AD had for Boron
- 72 – soil appears biologically active at AD
- 73 – soil is soft (non-compacted) to depth of at least 27 inches (≤250 ppm on penetrometer)

74 – Field affected by all three causes of crop nutrient deficit.

75 – How to take a sample and use a soil test.

Go outdoors and demonstrate taking soil sample, digging soil profile, and using penetrometer.

76 – Soil amendments – what to use based on soil test and USDA Organic rule?

77 – Soil pH, lime, and sulfur

78 & 79 – Nitrogen in soil and plant; N cycle; C:N ratio – important in organic nutrient dynamics!

80 – organic N fertilizers – cover crops the most economical, and do not add P.
National Organic Standards Board may soon prohibit Chilean sodium nitrate.

81– N budgeting – note that too little available N is often limiting in organic vegetables, especially cool season, when soil is not yet built up, or the OM C:N ratio is too high.
The 20 lb N/a-yr per % SOM is based on Cornell research – cool temperate, loam – silt loam)

I tend to think in terms of balancing inputs and outgoes of <u>total</u> N rather than available N – based on an assumption that healthy soil food web will convert organic N to available N efficiently in the crop rhizosphere.

Tell story about overfed / underfed broccoli debate with Dr. Morse – he was right – cool season heavy feeder. Tell story about how I overfed peppers with rye+vetch and a handful of low-analysis compost.

82 – Phosphorus in soil and plant; P cycle; important role of soil life & mycorrhizae in crop P nutrition
Adding a lot of soluble P to soil at one time is not efficient – promotes mineral fixation from which it is hard to retrieve P.

83 – organic P fertilizers – estimate cost based on "available" vs total phosphate; manure P source

84 – N:P ratio – soil N does not "stick around"; soil P does.

85 & 86 – organic N and P management based on soil test – role of legume-grass cover crops
Grass will enhance total legume N fixation and improve potassium availability

87 – Potassium in soil and plant, K cycle, role of soil life and plant roots.

88 – organic K fertilizers

89 – K and nutrient balance – more often challenged to ensure enough K, especially on larger farms, hay fields (often "mined" of P and K)

90 – NPK fertilizers – most useful as starter (low rates) or on soils with low P levels (higher rates)

91 & 92 – Magnesium and Mg sources. Use sul-po-mag if both K and Mg are needed.

93 & 94 – Calcium. Localized Ca deficiency disorders not usually "cured" by lime.
Speak briefly to the "Ca craze" in some organic circles. Ca and cation ratios important to consider, but do not need strict, narrowly defined ratios.

95 – Sulfur and sulfur sources. Watch for S deficiency on sandy soils, seedling stage most vulnerable

96 & 97 – Micronutrients. Boron is often deficient in VA soils. Other micronutrients occasionally.
B supplement through Seven Springs – or laundry borax.

98 – **What does Your Soil Test tell you? – Lights on for open discussion.**