COVER CROPS
FOR SOIL AND
PEST MANAGEMENT

KOOK-HUI WANG, JARI SUGANO, JENSEN UYEDA
OUTLINE

- Benefits of cover cropping
- Cover crop calculator
  - Factors affecting plant available N% (PAN%)
- Sustainable approaches for pest management
  - Insect pests
  - Nematodes
  - Weeds
BENEFITS OF COVER CROPPING

1. Reduce fertilizer costs
2. Add organic matter
3. Improve yields by enhancing soil health
4. Reduce the need for herbicides and other pesticides (nematicide)
5. Prevent soil erosion
6. Conserve soil moisture
7. Protect water quality
8. Help safeguard personal health
9. Some cover crops offer harvest possibilities as forage, grazing or seed in multiple crop enterprises.
Benefits of cover cropping:

Soil Health

- Cover cropping: Cover the soil at all time
- Grow a living root 24/7
- Reduce soil disturbance
- Synergize with diversity: Crop rotation

Water Health?
Nonpoint source pollutants, such as sediments, nutrients, pesticides, herbicides, fertilizers, animal wastes and other substances that enter our water supply as components of runoff and ground water, have increased in relative significance and accounts for > 50% of the pollution in U.S. waters.
EUTROPHICATION

Excess Nitrogen and Phosphorous Spur Algal Growth, Deplete Oxygen and Kill Fish.

Many species, including fish, are sensitive to low oxygen levels and die as a result.

Algae bloom
1. **CUT FERTILIZER COSTS**

1. Contributing N to cash crops
   - 30-60% of N that the legume produced can be available for the subsequent cash crop.
   - But plant N available rates varies by cover crop and soil condition --- Cover crop calculator.
   - Examples: sunn hemp, cowpea, lablab, yellow sweet clover, white clover, hairy vetch.

2. Scavenging and mining soil nutrients
   - Fibrous-rooted cereal grains or grasses — scavenging excess N left in soil after a cash crop, reduce nutrient leach.

Cover crops can increase the amount of nutrients available for the next crop by taking up nutrients that remain in the soil and holding them in plant tissue until they are released the next spring, when they can be used by the following crops. *Courtesy: Cover Crop Solutions*
1. NUTRIENT SCAVENGING

- **Need to plant early:** Rye can take up 70 lb N/A when planted soon after termination of last crop.
- Deep-rooted cover crops (such as oil radish) draw **Ca and K** that leach down the soil profile to upper soil surface.
- Although P doesn’t leach, it is not readily available for plant to uptake. Cover crops such as buckwheat and lupins, secrete acids into soil that put P into a more soluble form for plant to uptake.
- Cover crops could also enhance plant P uptake by hosting mycorrhizae fungi.
2. ADDING SOIL ORGANIC MATTER

- Soil organic matter contributes to improve soil structure, increase infiltration and water holding capacity, increase cation exchange capacity (help soil to store nutrients).
- Two portions of soil organic matter:
  - Active fraction -- rich in simple sugars, proteins, fresh residues, microbial cells (responsible for the release of most N, P, K from organic matter)
  - Stable fraction – rich in celluloses and lignins, tougher to break down, contribute to humus (responsible for real soil organic matter, dark content, water holding capacity, cation exchange capacity or CEC)
3. IMPROVE SOIL NUTRIENT CYCLING

Cover crops enhance microbial activities involved in soil nutrient cycling.

- Detrital N, P
- Inorganic N, P
- Fungal N, P
- Bacterial N, P
- Fungal-feeding Nematode
- Bacterial-feeding Nematode
- Omnivorous and Predatory Nematode
- Plant N, P

yield
3. IMPROVE SOIL STRUCTURE

- Leguminous cover crops enhance bacteria in the soil. Bacteria produced polysaccharides that ‘glue’ soil particle together.
- Grasses have a ‘fibrous’ root system that help aggregate the soil between roots.
- Most plant roots develop mutualistic relationships with mycorrhizae fungi that produce glomalin, which glues together organic matter, plant cells, bacteria and other fungi.
- Cover crops with deep roots (sorghum-sudangrass, rapeseed, yellow sweetclover) also break up compacted soil.
- Cover crops (ryegrass) help dry out wet soils.
- Leading soil-building crops (e.g. rye)

YELLOW SWEET CLOVER (MELILOTUS INDICUS)
HOW TO SELECT COVER CROPS TO FIT YOUR NEEDS?
(EFFECTS ON ORGANIC MATTER)

- **Annual legumes:** Produce plant materials that are succulent and rich in proteins and sugars – leave little long-term organic matter.

- **Grain and grasses, non-legumes:** Produce plant materials that are woodier or more fibrous – promote more stable organic matter (humus), increase soil structure, CEC, but might tie up nutrients temporarily.

- **Perennial legumes** such as perennial peanut, white clover or sunn hemp (if let sunn hemp grown for months) may fall in both categories – leaves will break down quickly, but stems and root systems can contribute to humus accumulation.
Selecting Cover Crops

- Benefits of cover crop for soil fertility management
- Cover crop calculator
- Factors affecting plant-available N% (PAN%)

Nematode suppressive

Cover Crop Chart for Hawaii
Koon-Hui Wang and Archana Pant, CTahr, University of Hawaii

- Selecting Cover Crops
- Nematode-resistant
- Benefits of cover crop for soil fertility management
- Cover crop calculator
- Factors affecting plant-available N% (PAN%)

http://www.ctahr.hawaii.edu/Wang

Nematode suppressive

Cover Crop Chart for Hawaii
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http://www.ctahr.hawaii.edu/Wang
Although cover crops can fix or accumulate nitrogen (N) in plant tissues, not all the N in the tissue will be released into a plant available form.

**Plant Available Nitrogen (PAN %)**

\[
\text{Plant Available Nitrogen (PAN %)} = \left( \frac{[\text{Soil nitrate with cover crop (mg/kg)}] - \text{soil nitrate without cover crop}}{\text{Total N added by cover crop (mg/kg)}} \right) \times 100
\]

At 28 days after cover crop incorporation

At 70 days after cover crop incorporation

% N in tissue × cover crop biomass = Total N

**Actual PAN** = cover crop dry biomass × % N × PAN%
FACTORS AFFECTING PAN% FROM COVER CROP

- climate conditions, season
- soil types
- cover crop species
- biomass, plant age, % N in tissue
- time after cover crop termination
- farming practice (till vs no-till)
- microbial activities in your soil

Based on studies in Kansas, Vigil and Kissel (1991) found strong correlation between PAN released % with % N in tissues

\[
PAN (\%) = -53.44 + 16.98 (\% N \text{ in tissue} \times 10)^{1/2}
\]

However, Hawaii has many micro-climates and soil types. Thus, different PAN prediction models need to be developed for different regions in Hawaii.................
### PAN FROM COVER CROPS IN POAMOHOL, OAHU (WINTER)

<table>
<thead>
<tr>
<th>Season/tillage</th>
<th>Cover Crop</th>
<th>Fresh Weight (lb/ft²)</th>
<th>Dry Content (%)</th>
<th>Dry Weight (lb/Acre)</th>
<th>Tissue N (%)</th>
<th>Total N(lb/A)</th>
<th>PAN (%)</th>
<th>Actual PAN (lb/A)</th>
<th>PAN (%)2</th>
<th>Actual PAN(lb/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter/Till</td>
<td>Sunn hemp</td>
<td>1.2</td>
<td>23.10%</td>
<td>12074.83</td>
<td>1.66</td>
<td>200.44</td>
<td>55.24</td>
<td>110.72</td>
<td>67.82</td>
<td>135.94</td>
</tr>
<tr>
<td>Winter/Till</td>
<td>Cowpea (Blackeye #5)</td>
<td>1.04</td>
<td>13.70%</td>
<td>6206.43</td>
<td>2.87</td>
<td>178.12</td>
<td>63.74</td>
<td>113.54</td>
<td>75.17</td>
<td>133.90</td>
</tr>
<tr>
<td>Winter/Till</td>
<td>Lablab</td>
<td>0.78</td>
<td>14.89%</td>
<td>5059.15</td>
<td>2.75</td>
<td>139.13</td>
<td>62.72</td>
<td>87.26</td>
<td>75.22</td>
<td>104.65</td>
</tr>
<tr>
<td>Winter/Till</td>
<td>Pigeon pea</td>
<td>0.55</td>
<td>20.47%</td>
<td>4904.20</td>
<td>3.47</td>
<td>170.18</td>
<td>66.14</td>
<td>112.55</td>
<td>81.69</td>
<td>139.02</td>
</tr>
<tr>
<td>Winter/Till</td>
<td>Woolypod vetch</td>
<td>0.55</td>
<td>9.21%</td>
<td>2206.53</td>
<td>4.43</td>
<td>97.75</td>
<td>70.52</td>
<td>68.93</td>
<td>84.19</td>
<td>82.30</td>
</tr>
</tbody>
</table>

- % Tissue N varied among cover crop species.
- Some cover crop released PAN more efficiently than others (70.5% vs 55.2%).
- Actual PAN can be strongly influenced by cover crop biomass.

http://www.ctahr.hawaii.edu/WangKH/cover-crop.html
PAN from Cover Crops in Poamoho, Oahu (Summer)

<table>
<thead>
<tr>
<th>Season/tillage</th>
<th>Cover Crop</th>
<th>Fresh Weight (lb/ft²)</th>
<th>Dry Content (%)</th>
<th>Dry Weight (lb/Acre)</th>
<th>Tissue N (%)</th>
<th>Total N (lb/A)</th>
<th>PAN (%)</th>
<th>Actual PAN (lb/A)</th>
<th>PAN (%)</th>
<th>Actual PAN (lb/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter/No-till</td>
<td>Sunn hemp</td>
<td>1.07</td>
<td>24.62%</td>
<td>11475.19</td>
<td>2</td>
<td>229.50</td>
<td>56.85</td>
<td>130.47</td>
<td>56.6</td>
<td>102.93</td>
</tr>
<tr>
<td>Winter/No-till</td>
<td>Cowpea (Blackeye #5)</td>
<td>1.47</td>
<td>14.20%</td>
<td>9092.71</td>
<td>2</td>
<td>181.85</td>
<td>56.6</td>
<td>102.93</td>
<td>65.42</td>
<td>118.97</td>
</tr>
</tbody>
</table>

**Summer**

<table>
<thead>
<tr>
<th>Season/No-till</th>
<th>Cover Crop</th>
<th>Fresh Weight (lb/ft²)</th>
<th>Dry Content (%)</th>
<th>Dry Weight (lb/Acre)</th>
<th>Tissue N (%)</th>
<th>Total N (lb/A)</th>
<th>PAN (%)</th>
<th>Actual PAN (lb/A)</th>
<th>PAN (%)</th>
<th>Actual PAN (lb/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer/No-till</td>
<td>Sunn hemp</td>
<td>0.72</td>
<td>21.34%</td>
<td>6692.91</td>
<td>2.72</td>
<td>182.05</td>
<td>60.54</td>
<td>✓ 110.21</td>
<td>75.14</td>
<td>✓ 136.79</td>
</tr>
<tr>
<td>Summer/No-till</td>
<td>Cowpea</td>
<td>1.54</td>
<td>14.24%</td>
<td>9552.53</td>
<td>2.83</td>
<td>270.34</td>
<td>67.57</td>
<td>✓ 182.67</td>
<td>74.43</td>
<td>✓ 201.21</td>
</tr>
<tr>
<td>Summer/No-till</td>
<td>Lablab</td>
<td>0.34</td>
<td>13.31%</td>
<td>1971.26</td>
<td>3.13</td>
<td>61.70</td>
<td>78.05</td>
<td>48.16</td>
<td>81.91</td>
<td>50.54</td>
</tr>
<tr>
<td>Summer/No-till</td>
<td>Sudex</td>
<td>0.96</td>
<td>16.02%</td>
<td>6699.18</td>
<td>1.33</td>
<td>89.10</td>
<td>43.48</td>
<td>38.74</td>
<td>54.95</td>
<td>48.96</td>
</tr>
<tr>
<td>Summer/No-till</td>
<td>Oat (TAM406)</td>
<td>0.51</td>
<td>14.72%</td>
<td>3270.14</td>
<td>1.84</td>
<td>60.17</td>
<td>46.25</td>
<td>27.83</td>
<td>62.55</td>
<td>37.64</td>
</tr>
<tr>
<td>Summer/No-till</td>
<td>Oil Radish</td>
<td>0.55</td>
<td>6.40%</td>
<td>1533.31</td>
<td>2.49</td>
<td>38.18</td>
<td>70.8</td>
<td>✓ 27.03</td>
<td>77.00</td>
<td>✓ 29.40</td>
</tr>
</tbody>
</table>

- PAN released % was higher in summer than winter.
- Grassy cover crops had lower % N and slower PAN released % compared to legumes, but that in oil radish was equivalent or higher than legumes, thus a good nutrient scavenging crop.
### PAN FROM COVER CROPS IN LALAMILO, HAWAII

<table>
<thead>
<tr>
<th>Season/tillage</th>
<th>Cover Crop</th>
<th>Fresh Weight (lb/ft²)</th>
<th>Dry Content (%)</th>
<th>Dry Weight (lb/Acre)</th>
<th>Tissue N (%)</th>
<th>Total N (lb/A)</th>
<th>PAN (%)</th>
<th>Actual PAN (lb/A)</th>
<th>PAN (%)</th>
<th>Actual PAN (lb/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter/Till</td>
<td>Bell bean</td>
<td>0.78</td>
<td>10.60%</td>
<td>3601.54</td>
<td>4.2</td>
<td>151.26</td>
<td>64.03</td>
<td>96.85</td>
<td>69.95</td>
<td>105.81</td>
</tr>
<tr>
<td>Winter/Till</td>
<td>Austrian Winter Pea</td>
<td>0.6</td>
<td>11.70%</td>
<td>3057.91</td>
<td>4.9</td>
<td>149.84</td>
<td>63.34</td>
<td>94.91</td>
<td>67.72</td>
<td>101.47</td>
</tr>
<tr>
<td>Winter/Till</td>
<td>Annual ryegrass</td>
<td>0.36</td>
<td>13.42%</td>
<td>2104.47</td>
<td>4.72</td>
<td>99.33</td>
<td>54.76</td>
<td>54.39</td>
<td>60.58</td>
<td>60.17</td>
</tr>
<tr>
<td>Winter/Till</td>
<td>Woolypod vetch</td>
<td>0.45</td>
<td>11.20%</td>
<td>2195.42</td>
<td>5.32</td>
<td>116.80</td>
<td>58.46</td>
<td>68.28</td>
<td>66.57</td>
<td>77.75</td>
</tr>
<tr>
<td>Winter/Till</td>
<td>Oat (Cayuse)</td>
<td>1.15</td>
<td>17.20%</td>
<td>8616.17</td>
<td>2.34</td>
<td>201.62</td>
<td>42.55</td>
<td>85.79</td>
<td>53.28</td>
<td>107.42</td>
</tr>
</tbody>
</table>

- PAN released % could change from location to location.
- Although N % in these cover crops were higher than the tropical legumes tested earlier, the actual PAN released were lower.
- Farmers could calculate amount of N fertilizer needed to full-fill the crop requirement.

```
Total N requirement for your crop: A = 180
N available from your cover crop: B = 105
Amount of N you need to fertilize for your crop: A-B = 75
```
1. Estimate cover crop dry biomass (lbs/acre)
2. Send tissue to analyze for tissue N content (%)
3. Find a location in Cover Crop Calculator similar to your area, calculate actual PAN at 4 or 10 weeks after cover crop termination.

\[
\text{Amount of } N \text{ fertilizer input that farmers can cut back} = \text{Actual PAN} = \% N \times \text{cover crop dry biomass} \times \text{PAN%}
\]
In the event that you grow a cover crop mix, you can send a sample of your cover crop tissue at crop termination to Agriculture Diagnostic Service Center (ADSC) to assay for tissue N (%), and estimate the dry weight of your cover crop biomass in lb/acre. Estimate dry weight by collecting fresh cover crop biomass in lb/ft², dry tissue in sun, and weigh.

Estimate plant available Nitrogen (PAN) from your cover crop mix by using PAN-N regression lines generated for your location.

<table>
<thead>
<tr>
<th>Location</th>
<th>Dry Weight (lb/ft²)</th>
<th>Dry Weight (lb/Acre)</th>
<th>Tissue N (%)</th>
<th>Total N(lb/A)</th>
<th>Actual PAN (%)</th>
<th>Actual PAN (lb/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poamoho</td>
<td>0.15</td>
<td>6534</td>
<td>2</td>
<td>131</td>
<td>55.4</td>
<td>72</td>
</tr>
<tr>
<td>Walmea</td>
<td>0.15</td>
<td>6534</td>
<td>2</td>
<td>131</td>
<td>38.31</td>
<td>50</td>
</tr>
<tr>
<td>Kula</td>
<td>0.15</td>
<td>6534</td>
<td>2</td>
<td>131</td>
<td>39.342</td>
<td>51</td>
</tr>
<tr>
<td>Hoolehua</td>
<td>0.15</td>
<td>6534</td>
<td>2</td>
<td>131</td>
<td>30.179</td>
<td>39</td>
</tr>
</tbody>
</table>

Actual PAN = Cover crop biomass (dry weight in lb/acre) \times Tissue N\% \times PAN\%
PAN% prediction curve based on %N in cover crop tissues (any cover crop mix will work) generated from Waiakea and Poamoho are very different from that predicted by VK equation.
• In general, PAN% of tissues with %N between 2-4% are higher in Hawaii than that using VK prediction.
• But PAN% of tissues with %N higher than 4% might result in reduction of PAN% in HI possibly due to N immobilization.
<table>
<thead>
<tr>
<th></th>
<th>Dry wt (tons/A)</th>
<th>Tissue N (%)</th>
<th>28 day PAN (%)</th>
<th>28 day Actual PAN (lb/A)</th>
<th>40 day PAN (%)</th>
<th>40 day Actual PAN (lb/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hirayama</td>
<td>1.94</td>
<td>4.05</td>
<td>61.73</td>
<td>95.08</td>
<td>68.77</td>
<td>106.03</td>
</tr>
<tr>
<td>Bonk</td>
<td>1.38</td>
<td>4.77</td>
<td>62.92</td>
<td>90.53</td>
<td>71.42</td>
<td>93.64</td>
</tr>
<tr>
<td>Robbs</td>
<td>2.64</td>
<td>2.64</td>
<td>62.22</td>
<td>89.60</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cover crops mix</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hirayama</td>
<td>Vetch, red clover, spring pea, oats</td>
</tr>
<tr>
<td>Bonk</td>
<td>Oil radish, vetch</td>
</tr>
<tr>
<td>Robbs</td>
<td>Cayuse oat, bell beans, purple vetch, Austrian winter peas</td>
</tr>
</tbody>
</table>

Majority of the PAN was released during the first 28 days after cover crop termination, thus additional fertilizer should be added there after.
CONCLUSION

✓ Although PAN release rates at 70 days after cover crop termination were similar among all legumes and oil radish tested, actual PAN released varied mainly due to the biomass generated. Thus, it is a good practice for farmers to estimate cover crop biomass accumulated prior to termination of cover crop.

✓ Graminaceous cover crops generally had lower PAN%, resulted in lower actual PAN regardless of the biomass generated. None-the-less, graminaceous cover crops are good nutrient scavenging crops, and soil C builders.

✓ Majority of the PAN was released during the first 28 days after cover crop termination, thus additional fertilizer should be added there after.
BENEFITS OF COVER CROPS FOR PEST MANAGEMENT
BENEFITS OF COVER CROPPING

1. Reduce fertilizer costs
2. Add organic matter
3. Improve yields by enhancing soil health
4. Reduce the need for herbicides and other pesticides (insecticide, nematicide)
5. Prevent soil erosion
6. Conserve soil moisture
7. Protect water quality
8. Help safeguard personal health
9. Some cover crops offer harvest possibilities as forage, grazing or seed in multiple crop enterprises.
4-1. REDUCE THE NEED FOR HERBICIDES

Cover crops can effectively suppress weeds by:

- Producing allelopathic compounds that provide natural herbicidal effects (e.g. sudangrass, rye)
- Smothering / outcompetes weeds for water and nutrients (e.g. buckwheat, yellow sweet clover, woollypod vetch)
- Shading weeds (e.g. sunn hemp)

Ex. Fall planted brassica cover crops coupled with mechanical cultivation help potato growers with a long growing season maintain marketable yield and reduce herbicide applications by 25% (Stark, 1995).
Buckwheat smothered weeds between zucchini rows
INSECTARY PLANTS

Plants that attract insects, either produce flowers with pollen and nectar for beneficial insects, or lure insect pests away from the cash crop.

- Hoverflies on buckwheat and cilantro
- Sunn hemp flowers attracts Lycaenidae butterflies that drawn Trichogramma wasps to lay eggs on the Lepidopteran eggs.
- Uhaloa attracts wasps and bees
- Lady beetles on Aweoweo
BORDER COVER CROPS ALSO SERVE AS FOOD SOURCE FOR POLLINATORS

Pollinators visiting sunn hemp flowers

- Sweat bee
- Carpenter bee
- Leaf cutter + Sweat bee
- Green bee
- Leaf cutter bee
- Leaf cutter+honey bee

Amaranth

Yellow Crown Beard
HOW TO USE COVER CROPS AS INSECTARY PLANTS?

1. As border crop
   - Sunn hemp and corn

2. As intercrop
   - Buckwheat and zucchini

3. Insectary plant corridors
   - (Nicholls, Parrella, and Altieri, 2000)
3. As organic mulch (no-till)

Cowpea and buckwheat as insectary borders, and sunn hemp organic mulch harbor natural enemies or parasites against insect pests (thrips, leaf miners) and fungal disease (purple blotch).

4. As trap crop / virus sink theory
5. Cover crop in strip-till system: as living mulch and surface mulch

Sunn hemp (Crotalaria juncea)
SUNN HEMP SERVES AS TRAP CROP FOR WHITEFLIES, THUS REDUCING SILVERLEAF SYMPTOMATIC ZUCCHINI

Zucchini intercropped with sunn hemp.

Zucchini in bare ground showing silver leaf symptom.
Insectary Planting System for Hydroponic Production

- Sunn hemp attracts Trichogramma wasps
- Buckwheat attracts hoverflies
- Wasp nesting block attracts keyhole wasps
WASP NESTING BLOCK

**Pollinators**
- Leaf cutter bee
- Hylaeus bee

**Predators**
- Key-hole Wasp
  [http://bugguide.net/node/view/241212](http://bugguide.net/node/view/241212)
- Aphid-collecting Wasp

Untreated wood
Hoverflies

HOVERFLIES

Buckwheat just started flowering

Hoverfly larva/plant

Buckwheat planted into insectary plots

Hoverfly larva eating aphid

Insectary
Metallic
Control

Hoverfly larva/plant

3/14/13
3/28/13
4/11/13
4/25/13

Buckwheat
planted into insectary plots
Reflective board reduce whiteflies and thrips damage
Main insect pests on brassica

- Diamondback moth (DBM) larva
- Imported cabbage web worm larva
- Imported cabbage worm larva
- Aphids

Insectary setting suppressed aphids and caterpillar damage
**BENEFICIAL INSECTS**

*Trichogramma* wasp

- **Parasitized aphids**
- **Evidence of the DBM parasitoid wasp**
- **Hoverfly larvae eating an aphid**
- **Hoverfly eggs among aphids**

**Trial I**

- **Hoverfly eggs**
  - Insectary
  - Control
  - Metallic

**Trial II**

- **Aphid parasitoid**
  - Insectary
  - Metallic
  - Control
Insectary box:

• yielded similar to other treatments despite loosing one row of crop for buckwheat plants.
• had less unmarketable pak choi than the other treatments.
1. Reduce fertilizer costs
2. Add organic matter
3. Improve yields by enhancing soil health
4. Reduce the need for herbicides and other pesticides (insecticide, nematicide)
5. Prevent soil erosion
6. Conserve soil moisture
7. Protect water quality
8. Help safeguard personal health
9. Some cover crops offer harvest possibilities as forage, grazing or seed in multiple crop enterprises.
5. PREVENT SOIL EROSION

- Topsoil is the most fertile portion of a field that contain the highest % of organic matter and nutrients. Thus, it is wise to protect soil from erosion.

White clover as ground cover between zucchini rows. Planting field border with vetiver grass with deep root system is perfect for soil erosion prevention.
5. PREVENT SOIL EROSION

- Select quick-growing cover crops could protect soil against wind and rain erosion.
- Grain cover is better than legumes for erosion control because legumes decompose quickly.
- Shoots of cover crops protect soil from the impact of rain-drops.
- Long-term use of cover crops, increase soil organic matter, improve soil structure, thus increases water infiltration and reduces runoff.
6. CONSERVE SOIL MOISTURE

- Organic surface mulch provided by cover crops (especially grassy cover in conservation till system) increase water infiltration and reduces evaporation.
6. CONSERVE SOIL MOISTURE

• Soil water holding capacity was higher in NT.
• Water infiltrated through NT soil faster than that in BG and Sol.
OUTLINE

- Benefits of cover cropping
- Cover crop calculator
  - Factors affecting plant available N% (PAN%)
- Sustainable approaches for pest management
  - Insect pests
  - Nematodes
  - Weeds
ALTERNATIVE NON-CHEMICAL BASED PEST MANAGEMENT

Banker plant, High Tunnel Screenhouse, Hot water treatment, etc
Dr. Robert Hollingsworth, USDA ARS, Hilo introduced Macaranga male flowers (minute pirate bug) into orchid nurseries to control thrips.
Insect Exclusion Screenhouse: Pumpkin / Cucumber

17 mesh-insect exclusion screenhouse

Hand pollinate pumpkin

Minimal damage from pickle worm or fruit flies

Parthenocarpic cucumber

Pickle worms on cucumber

Fruit flies/melon flies damage

But plants die prematurely from root-knot nematode infection that cause the plant to wilt.
Luring and Trapping

Rose Beetle Light Trap

https://vimeo.com/166306170

Fruit flies methyl eugenol/cue-lure traps

Pin worm Nomate
WEED MANAGEMENT
Solarization for weed management

- Soil solarization involves covering the soil with transparent mulch (25-μm-thick, uv-stabilized, low-density polyethylene mulch) for 6 weeks so that it reaches temperatures detrimental to soilborne pests and pathogens.
SOLARIZATION TEMPERATURE SCHEME IN HAWAII

6-Week Solarization

Maximum temperature (°C)


Sol  SHSol

107°F

(Wang 2011)
Solarization for Weed Management

Solarization reduces weed seed bank effectively.

If solarization mulch is not available, flush the planting beds with water over 2-3 weeks, then kill the weeds with weed flamer when weeds are young also significantly reduce weed seed bank.
Cover with weed mat for 2 weeks to suppress weeds.

Plant oil radish for 4 weeks as trap crop for root-knot nematodes.
Field plots were covered second time for one week to kill additional weeds prior to cucumber planting.

Trap crops were terminated, lightly tilled into soil, tarp with solarization mulch or just weed mat. Let glucosinolate convert into isothiocinate for biofumigation.

Weed mat was used again to help suppress more weeds, and break down oil radish residues.
Turn-the-page Technique for No-till Nematodes and Weed Management

TTP method does not suppress weed seed bank, but works well for transplanting crops that have higher weed tolerance level. Post plant weeding is needed but manageable.
Chicken Tractor in Hawaii

Grazing cages by Glenn Fukumoto Kona

- Suitable for wide row spacing orchard system.
- Chicken likes to dig out nutsedge tubers.
ALTERNATIVELY........
(HEAVY MULCHING)
Three Sisters Cropping System

Any question?
HOW TO SELECT COVER CROP THAT FIT YOUR NEEDS?

<table>
<thead>
<tr>
<th>Needs</th>
<th>Cover crop suitable for Hawaii climate</th>
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<tbody>
<tr>
<td>N source</td>
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<tr>
<td>Add Org matter</td>
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<tr>
<td>Drought tolerant</td>
<td></td>
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<tr>
<td>Acid soil</td>
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<td>Salt tolerant</td>
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Summary
HOW TO SELECT COVER CROP THAT FIT YOUR NEEDS?

<table>
<thead>
<tr>
<th>Needs</th>
<th>Cover crop suitable for Hawaii climate</th>
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<tbody>
<tr>
<td>Weed suppressive</td>
<td></td>
</tr>
<tr>
<td>Weed suppressive</td>
<td></td>
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<tr>
<td>Nematode suppressive</td>
<td></td>
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<tr>
<td>Deep root</td>
<td></td>
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<tr>
<td>Nutrient scavenging</td>
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Shelby Ching, Shova Mishra, Philip Waisen, Josiah Marquez, Donna Meyer, Gareth Nagai, Archana Pant.

Marla Fergerstrom, Susan Migita, Pam Shingaki and Farm Crews from Mealani, Poamoho, and Kula Experiment Stations and Randy Hamasaki, Maria Derval Diaz, Brian Bush.

http://www.ctahr.hawaii.edu/WangKH/cover-crop.html
http://www.ctahr.hawaii.edu/WangKH/Downloads/P-High-elevation-covercrops.pdf
https://youtu.be/cBP52egYG9s
https://vimeo.com/166306088

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