Grow Biointensive
Farming and Gardening
A Sustainable Agricultural System

Seasons of Sustainable Agriculture
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Historical Perspective
(Ancient)

- Chinese Agriculture - 4,000-6,000 years old
- Japanese Agriculture - 2,000-6,000 years old
- Greek Agriculture – 2,000 years old
- Bolivian, Peruvian, Mayan Agriculture – 1,000 years old
Historical Perspective

(Resent)

- Monastery “preserves”
- French Intensive
- Bio-Dynamics (Steiner)
- Bio-Dynamic/French Intensive – Alan Chadwick at Santa Cruz
Current agricultural Problems

- More people to feed and less land
- 10 calories of Fossil fuel to produce 1 calorie of food
- Declining water availability (40% of grain irrigated)
- Reduced genetic base; over 95% of seed varieties ever used have been lost
- Declining nutrient quality of food
Advantages of Biointensive Agriculture

- Produce 2-6 times as much food in the same area
- Reduce the energy demands (almost eliminate fossil fuels)
- Use water 3-8 times more effectively
- Develop a local, diverse, and secure seed base
- Provide self contained closed loop fertility
8 Basic Components of Biointensive

- Deep soil preparation
  allows

- Close plant spacing
  and the practice of

- Companion planting
  using

- Open pollinated seeds
  fed by

- Compost
  obtained from

- Sustainable soil fertility
  which provides a

- Complete diet
  within a

- Whole system
A Healthy Soil

Soil Structure

Biological Activity

Nutrient Availability
Importance of Particle Size

Approximate Relative Surface in Soil Composed of 25% Clay, 35% Silt, and 40% Sand (By weight)

Surface Exposed by Silt
Surface Exposed by Sand
Surface Exposed by Clay

Relationship Between Particle Size and Area of Surface per Unit Weight (one gram)

Surface Area per Gram (square meters)

Diameter of Soil Grains (m.m.)

Clay
Silt
Sand
Volume Composition of Soil

- **Organic Matter**: 5%
- **Air**: 20-30%
- **Water**: 20-30%
- **Mineral**: 45%
- **Soil Solids**: 50%
- **Pore Space**: 50%
Permanent Beds and Pathways
Double Digging

1.

2.

3.

4.

5.

6.

7.
The U-bar
Alternative tool for double digging
Using Plants to loosen the soil
Root Depth of Selected Vegetables
(from “How to Grow More Vegetables”)

<table>
<thead>
<tr>
<th></th>
<th>carrot</th>
<th>cauliflower</th>
<th>beet</th>
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<tbody>
<tr>
<td></td>
<td><img src="image" alt="Diagram" /></td>
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One ounce of healthy soil has...

- Several billion bacteria (15,000 different kinds)
- 3 million yeast
- 1.4 million algae
- 1 million protozoa
- Macro vertebrates:
  - (worms, mites, millipedes, centipedes and insects)
Importance of Rhizosphere

- 100 times the biological activity
- Buffers pH +/- 10 times (1 pH point)
- Solubilize nutrients from soil
Nutrient Availability

- Biological activity increases nutrients in several ways (pH and metabolic byproducts)
- Cation exchange capacity (CEC)
- Organic vs inorganic systems
  (Journal of nutrition)
Soil pH and Nutrient Availability
(from “Methods for Assessing Soil Quality”)

[Diagram showing the relationship between soil pH and nutrient availability.]

- Microbial activity
- Nitrogen
- Phosphorus
- Calcium
- Potassium
- Leaching
- Calcium and Magnesium
- Carbonates
- Sulfur
- Oxides
- Iron and Zinc
- Oxides (and Silicates)
- Manganese (and Aluminum)
- Oxides
- Copper
- Oxides
- Insolubility
- Boron
- Insoluble Molybdates
- Molybdenum
Close Plant Spacings
Blointensive fertility—four times the productivity in one-quarter the area!

(from “Lazy Bed Gardening” Jeavons and Cox)
Interplanting
Companion Planting

Borage for pollination
Insectary Crops
Open Pollinated Seeds
Velvet Roller Seed Cleaner
Rubbing Board Seed Cleaner
Compost for maximum return

- C:N ratio (45-60:1)
- Mesophylic pile temperature
- Add soil
- Use Structural carbon (waxes, cellulose, lignins)
- Correct moisture (55%)
Compost Crops

- 1/3 of total area dedicated to carbon for soil
- Multiple duty crops
- Carbon examples: Corn, Jerusalem Artichokes, Grains, Sunflowers
- Nitrogen examples: Fava beans, alfalfa, comfrey
CARBON IN COMPOST AND GREEN MANURE  (Revised)

Assumptions:
- 100 sq ft (= 1 bed) of each crop at intermediate Biointensive yields
- Initial C:N ratio of 30:1 (except for Green Manure Clover), using other nitrogenous or carbonaceous material in the compost pile, and optimal decomposition of combined materials
- Similar curing of Green Manure (with lower C:N ratio in soil, less cured carbon may be produced)

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TIME TO GROW CROP</td>
<td>YIELD / BED lb [kg]</td>
<td>% DRY MATTER</td>
<td>DRY MATTER lb [kg]</td>
<td>% CARBON</td>
<td>&quot;BUILT&quot; CARBON lb [kg]</td>
<td>CURING FACTOR</td>
<td>CURED CARBON lb [kg]</td>
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<tr>
<td>CORN, Fodder for Compost</td>
<td>1 crop* (3-6 mo.)</td>
<td>48.5 @ [22.0] dry</td>
<td>x 90.6%</td>
<td>= 43.9 [19.9]</td>
<td>x 52.3%</td>
<td>= 23.0 [10.4]</td>
<td>+ 2</td>
<td>= 11.5 [5.2] [4.4 units]</td>
</tr>
<tr>
<td>ALFALFA for Compost</td>
<td>6-month harvest from</td>
<td>275.6@ [125.0] green</td>
<td>x 26.3%</td>
<td>= 72.5 [32.9]</td>
<td>x 54.3%</td>
<td>= 39.4 [17.9]</td>
<td>+ 2</td>
<td>= 19.7 [8.9] [7.6 units]</td>
</tr>
<tr>
<td>CLOVER, Medium Red for</td>
<td>6-month harvest from</td>
<td>162.5@ [73.7] green</td>
<td>x 27.5%</td>
<td>= 44.7 [20.3]</td>
<td>x 54.4%</td>
<td>= 24.3 [11.0]</td>
<td>+ 2</td>
<td>= 12.2 [5.5] [4.7 units]</td>
</tr>
<tr>
<td>Compost</td>
<td>established plants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>ALFALFA or CLOVER, Med. Red, for Green Manure</td>
<td>newly sown, ~4 months to</td>
<td>51.2 [23.2] green</td>
<td>x 18.7%**</td>
<td>= 9.6 [4.3]</td>
<td>x 54.4%</td>
<td>= 5.2 [2.3]</td>
<td>+ 2</td>
<td>= 2.6# [1.2] [1 unit]</td>
</tr>
<tr>
<td></td>
<td>first cutting; + ~1 month to decompose</td>
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* If conditions are optimal, two crops of corn may be grown within 6 months, therefore doubling the carbon produced.
@ Enough corn for one compost pile; enough alfalfa for 2.4 compost piles; enough clover for 1.4 compost piles, assuming a "built" volume of 27 cu ft and equal volumes of dry and green materials.
** Red Clover, before bloom, from Morrison's Feeds and Feeding. May be lower at point when used for Green Manure. Alfalfa may be somewhat higher.
# Probably less because of low C:N ratio.

Complete Diet

- Calorie efficient
- Kitchen efficient
- Space efficient
- Carbon efficient
- Storage efficient
Crop Selection for Maximum Production of Calories

60%
Grain Crops
for maximum carbon and satisfactory calorie production.

30%
Key Root Crops
for maximum calories (e.g. potatoes.)

10%
Vegetable Crops

For vitamins and minerals (e.g. salad crops.)
No Till
Permaculture

- Use the natural properties of your land
  - Sun
  - Wind
  - Shade
  - Slope

- Add enhancements
  - Rain water collecting
  - Extend the season
  - Container gardening
  - Indoor gardening
Energy Use in Chemical Agriculture

- 17% of US energy is used for Agriculture
- The Green Revolution increased the energy flow by an average of 50 times
- In 1990 we used 100 gal of oil to produce food on one acre
- Oil reserves will be insufficient to meet demand by 2020 (UN Development Programme)
Energy Use in Organic Agriculture

- Uses less fossil fuel fertilizers (31% of chemical agriculture budget)
- Many studies have indicated that organic is only 58-90% as productive
- As a result, in some cases, organic actually uses more energy per yield than chemical agriculture.
Agricultural Productivity

- Peppers; 11 times (1100%) the US Average
- Eggplant; 7 times the US Average
- Carrots; 7.4 times the US Average, 487 lbs./bed (100 sq. ft.)
- Onions; 4.2 times the US Average, 380 lbs./bed
- Rye; 12 times the US Average
- Garlic; 3 times the US Average
Plant to Invite Beneficial Insects
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For more information on Biointensive contact:

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