Korean Natural Farming: Does it work? How does it work?

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Outline

- Introduction to Natural Farming
- How does Korean Natural Farming (KNF) work?
- Does KNF work?
- Cost comparison
- Challenges?
Natural Farming

Originate as an ecological farming approach established in Japan (Masanobu Fukuoka, 1913–2008). It is related to

- Organic farming
- Sustainable agriculture
- Agroforestry
- Ecoagriculture
- Permaculture

Masanobu Fukuoka
Principles of Natural Farming

- avoidance of manufactured inputs and equipment,
- exploits the complexity of living organisms that shape each ecosystem,
- “the cultivation and perfection of human beings”,
- close observation of local conditions,
- demands no inputs and mimics nature.
Food Chain

Conventional farming
Biodiversity
“Now, few farmers import hawks to strengthen their farm ecosystems. You just can’t insert something that high up the food chain and expect it to survive. Instead, build the system that supports it, and the hawks will come on their own” (Gil Caradang, a full time farmer in Phillipine, Full Bright Scholar).

Sugar, vodka, milk, garlic, mango, rice ....to cultivate microorganisms in compost piles or foliar sprays.
Biodiversity in Natural area vs Monoculture
Building the Soil Food Web in Agroecosystem

First trophic level:
Photosynthesizers

Second trophic level:
Decomposers
Mutualists
Pathogens, Parasites
Root-feeders

Third trophic level:
Shredders
Predators
Grazers

Fourth trophic level:
Higher level predators

Fifth and higher trophic levels:
Higher level predators

Organic Matter
Waste, residue and metabolites from plants, animals and microbes.

Plants
Shoots and roots

Arthropods
Shredders
Predators

Nematodes
Root-feeders
Fungi
Mycorrhizal fungi
Saprophytic fungi

Protozoa
Amoebae, flagellates, and ciliates

Bacteria

Animals
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

(modified from Ingham et al., 1985)
Basic Theories of Korean Natural Farming

- Use of indigenous microorganisms (IMOs)
- Maximize the potential of natural environment
- Minimize the use of synthetic fertilizers
- Practice no till
- Eliminate emission of livestock waste effluent
- Increase production with less inputs
Benefits of KNF

- Lower costs to the farmer (by as much as 60 %)
- More desirable crops
- Stronger, healthier and more nutritious plants
- Higher yield
- Better quality
- Farmer friendly
- Zero waste emission
- The inputs are made from natural materials, which are not only safe for the environment, but actually invigorate and rehabilitate the ecology.

(Han-Yu Cho, J. Prell)
How does it work?

1. Soil treatment: Indigenous microorganisms
   - Make your own IMO4
2. Foliar spray: nutrients inputs
How to prepare IMO4?

1. 2/3 full steam rice in a box

2. Cover the rice box and scattered with bamboo leaves

3. IMO1
   - Check the box in 4-5 days for white mold
   - Seal with paper towel.
   - Container 2/3 full.
   - Ferment for 7 days

4. Add brown sugar 1:1 (w/w)

5. IMO2
How to prepare IMO4?

6

2 oz IMO2 + 60 lb mill run + 5 gal water (with 120 ml of SES)

Compost for 7 days, < 110°F

IMO3 + field soil + soil from natural area (2: 1: 1) + 5 gal water (with 120 ml of SES), cover and composted for ~7 days.

IMO4
How to apply IMO4?

30 lb IMO4 + soil treatment solution (SOS) /1000 ft²

Cover with leaf liters for 7 days
How does it work?

1. Soil treatment: Indigenous microorganisms
   ■ Make your own IMO4

2. Foliar spray: nutrients inputs
   • BRV: brown rice vinegar
   • FPJ: fermented plant juice
   • LAB: lactic acid bacteria
   • FAA: fish amino acid
   • OHN: oriental herb nutrients
   • WCAP: water soluble Ca-Phos
   • MA: Mineral A
   • SW: sea water
Benefits of Foliar Nutrient Inputs

- Benefit young seedlings with small root system;
- Reduce the amount of N application;
  - Minimize N runoff, more environmental friendly.
- Grower can modify the nutrient inputs accordingly

Draw back:
- response to foliar sprays is often variable and not reproducible
How does foliar spray be absorbed by plant cells?

- More absorption during late afternoon or evening.
- More absorption on young growth than old leaves (more waxy cuticle).
- Absorption also varies by crop type.
Outline

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- How does Korean Natural Farming (KNF) work?
- Does KNF work?
- Cost comparison
- Challenges?
Testimonies Regarding the Benefits of KNF

Web resources in Hawaii:
- Hawaiian Homegrown Food Network: http://hawaiihomegrown.net/reports/97-natural-farming-primer
- Richard Ha: http://hahaha.hamakuasprings.com/
- Drake Weinert: http://naturalfarminghawaii.net/

Articles:
Questions remain......

- Scientific evidence is lacking.
- What made IMO4 and other KNF practices so great?
Side by Side Comparison of KNF vs CONV

Measurement:
- Plant health
- Soil health
- Soil tilth
- Mycorrhizae
- Weed pressure
Measurements

- Plant health
  - Crop yield
  - Leaf weight
  - Chlorophyll meter

- Soil health
  - Nematode analysis
  - Enchytreid worm
  - Mycorrhizae
  - Soil compaction tester
Why do we use nematodes as soil health indicator?

- Bacterivore
- Fungivore
- Herbivore
- Omnivore
- Predator

SI = Structure index
EI = Enrichment index
CI = Channel index

+ richness, diversity
Materials and Methods

Three farmers in Pahoa area conducted independent trials at their farm comparing KNF to their choice of conventional (CONV) practice in Dec 2011- May 2012.

<table>
<thead>
<tr>
<th>Farm</th>
<th>Crop(s)</th>
<th>Plot size (# plots/treatment)</th>
<th>Surface mulch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm #1</td>
<td>soybean</td>
<td>$8 \times 20 \text{ ft}^2$ (4/treatment)</td>
<td>Sunn hemp cover crop</td>
</tr>
<tr>
<td>Farm #2</td>
<td>kabocha squash</td>
<td>$2 \times 2 \text{ ft}^2$ (10/treatment)</td>
<td>Wood chips</td>
</tr>
<tr>
<td>Permaculture</td>
<td>kale, beet, broccoli, onion, leek</td>
<td>$4 \times 100 \text{ ft}^2$ (2/treatment)</td>
<td>Macademia nut husks</td>
</tr>
</tbody>
</table>
Farm #1 (Soybean)

Results (Plant Health)

- **KNF** (greener)
- **CONV**

![Image of crops]

- **Yield (kg)**
  - **CONV**
  - **KNF**

- **Chlorophyll content (µmol m⁻²)**
  - **CONV**
  - **KNF**

- **N (%)**
  - **CONV**
  - **KNF**

*Significant differences indicated by asterisks:*  
** = P < 0.01  
* = P < 0.05
Farm #1

Results (Soil Health)

<table>
<thead>
<tr>
<th></th>
<th>No. nematodes/250 cm³ soil</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bacterivore</strong></td>
<td><strong>CONV</strong></td>
</tr>
<tr>
<td><strong>Fungivore</strong></td>
<td><strong>CONV</strong></td>
</tr>
<tr>
<td><strong>Omnivore</strong></td>
<td>KNF</td>
</tr>
<tr>
<td><strong>Predator</strong></td>
<td>KNF</td>
</tr>
</tbody>
</table>

Notes:
- **CONV**: Conventional system
- **KNF**: KNF system
- **No. nematodes/250 cm³ soil**: Number of nematodes per 250 cm³ of soil
- **Bacterivore**: Bacterivorous nematodes
- **Fungivore**: Fungivorous nematodes
- **Omnivore**: Omnivorous nematodes
- **Predator**: Predatory nematodes

**Significance Levels:**
- ****: Significant difference
- ****: Extremely significant difference
Farm #1

Results (Soil tilth)

![Graph showing Enchytreid worm numbers and soil depth.](image-url)
Farm #1

Results (Weed Pressure)

After soybean harvest

KNF

CONV (with herbicide)
Mycorrhizae

- a mutualistic association between a fungus (Myco) and the roots (rhiza) of the plants.

- Endomycorrhizae (vesicular-arbuscular mycorrhizal, VAM), generally associated with grasses, row crops, vegetables, and shrubs.

- Ectomycorrhizae generally associated with trees.
Mycorrhizae

- Enhance water and nutrient uptake efficiency
- Reduce fertility and irrigation requirements
- Increase drought resistance
- Increased pathogen resistance
- Enhancing plant health and vigor
- Enhanced seedling growth
- Enhanced plant transplant establishment
Arbuscular and vesicular structures of mycorrhizae on soybean roots were counted, but no difference between KNF and CONV plots. More intense sampling might be needed,
Cost Evaluation in Farm #1

<table>
<thead>
<tr>
<th></th>
<th>Input/ft(^2)</th>
<th>Labor/ft(^2)</th>
<th>Total/ft(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONV</td>
<td>$0.073</td>
<td>$0.094</td>
<td>$0.167</td>
</tr>
<tr>
<td>KNF (Optional input)</td>
<td>$0.044</td>
<td>$0.21</td>
<td>$0.26</td>
</tr>
<tr>
<td>KNF (without optional input)</td>
<td>$0.04</td>
<td>$0.132</td>
<td>$0.17</td>
</tr>
</tbody>
</table>
Farm #2 (kabocha squash)

At the end of a kabocha crop

KNF  Conv  Untreated Control (no herbicide)
Farm #2: Heavy infestation of powdery mildew and pickle worm.

KNF did not protect the plants from powdery mildew and pickle worm.
Farm #2

Results (Kabocha Yield)
Plants in KNF are greener

Farm #2

Chlorophyll content

Kobocha

KNF Conv Control

a b ab
Farm #2

Results (Soil Health)

- KNF did not improve soil health condition in Farm #2.
- Possibly due to interference from pests infestation.
Farm #2

Results (Soil tilth)

KNF did increased enchytreid worm that could contribute to better soil tilth in Farm #2.
Farm #2 (kabocha squash)

At the end of a kabocha crop

- KNF
- Conv
- Untreated Control (no herbicide)
Farm #2

Result (Weed Pressure)

Weed densities (Horsefall-Barret Scale 1-12)

Control  CONV  KNF

Horsefall-Barret Scale 1 = 0%, 12 = 100% weed coverage
## Cost Evaluation at Farm #2

<table>
<thead>
<tr>
<th></th>
<th>Total yield (kg)</th>
<th>Year 1 input ($/2000 ft$^2$)</th>
<th>Estimate Year 2 input ($/2000 ft^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KNF</td>
<td>23.15</td>
<td>2,155</td>
<td>400</td>
</tr>
<tr>
<td>CONV</td>
<td>31.78</td>
<td>2,320</td>
<td>600</td>
</tr>
<tr>
<td>Untreated</td>
<td>0.57</td>
<td>1,510</td>
<td>200</td>
</tr>
</tbody>
</table>

Farmer #2: The conventional row required 90 gallons more water than the NF row over the course of the growing season.
Permaculture = Organic farming + agroforestry + sustainable agriculture + agroecology
Seedling die back

% plant death at seedling stage

- Kale
- Broccoli
- Leek
- Beet
- Lettuce

Legend:
- KNF
- Org
Korean Natural Farming vs Permaculture

Permaculture Organic

Korean Natural Farming

2.18.2012
Adjusted KNF to IMO5

Permaculture Organic

Korean Natural Farming
Farm #3 (Burdock and Leek)

Results (Plant Health)

**Burdock**

- Leaf weight (g)
- Chlorophyll content (µmol m$^{-2}$)
- N (%)

**Leek**

- Leaf weight (g)
- Chlorophyll content (µmol m$^{-2}$)
- N (%)

- CONV
- KNF

* Significant difference
@ Representative sample
* Representative sample
Farm #3

Results (Soil Health)

- KNF tended to increase fungal and bacterial decomposition, but did not increase more structured organisms in the soil food web.
Farm #3

Results (Soil Health)

- KNF tended to increase fungal decomposition and slightly increased the structure of the soil food web.
Farm #3

Results (Soil tilth)

Soil depth (cm)

Leek

Burdock

- KNF
- Org

Significance levels:
- *: p < 0.05
- **: p < 0.01
Summary

- Results of KNF on plant and soil health varied, but it consistently increased soil tilth and suppressed weeds.
- It improved plant health when not challenged by pests and diseases.
- Areas with high rainfall might need to build shelters for KNF.
- IMO4 did not improve soil health condition in long-term permaculture site, but incorporating animal manure to prepare IMO5 improved plant health conditions in this site.
- More data on mycorrhizae colonization is needed. Properties of KNF in increasing soil tilth could be attributed to earthworm, enchytreid worm and mycorrhizal fungi.
- KNF required less irrigation.
- Integration of sunn hemp cover cropping with KNF showed promising results.
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Appendix I (KNF inputs)

- FPJ = 1:3 brown sugar : Portulaca (~7 days)
- LAB = 1: 10 rice water : milk in 2/3 full jar (~2 days)
- FAA = 1:1 fish waste (head, skin, bones, guts): brown sugar (w/w) in big cooler to 2/3 full for 10 days to 3 months
- WCAP = 1: 10 charcoal bone: brown rice vinegar in 2/3 full jar (1 wk)
- WCA = 1: 10 vinegar: peel & low heat cook eggshell (1 wk)

- OHN = 1/3 full of (2 jars angelica root, 1 jar licorice root, 1 jar cinnamon bark) + 1/3 beer+1/3 air space; 2 days later add brown sugar to 2/3 full; leave for 7 days, add vodka to the top of container, seal, collect 1/3 liquid from each jar every two weeks, refill with vodka, repeat 5 times.
# SOS Solution

*(Soil Treatment Solution)*

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>rate</th>
<th>ml/5 gal</th>
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<tbody>
<tr>
<td>Liquedifies IMO4</td>
<td>1: 500</td>
<td>40</td>
</tr>
<tr>
<td>BRV</td>
<td>1: 500</td>
<td>40</td>
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<tr>
<td>FPJ</td>
<td>1: 500</td>
<td>40</td>
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<tr>
<td>LAB</td>
<td>1:1000</td>
<td>20</td>
</tr>
<tr>
<td>FAA</td>
<td>1:1000</td>
<td>20</td>
</tr>
<tr>
<td>OHN</td>
<td>1:1000</td>
<td>20</td>
</tr>
<tr>
<td>WCAP</td>
<td>1:1000</td>
<td>20</td>
</tr>
<tr>
<td>MA</td>
<td>1:1000</td>
<td>20</td>
</tr>
<tr>
<td>SW</td>
<td>1:30</td>
<td>600</td>
</tr>
</tbody>
</table>
**SES Solution**  
*(Seed Treatment Solution)*

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<tr>
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<tbody>
<tr>
<td>FPJ</td>
<td>1:500</td>
<td>8</td>
</tr>
<tr>
<td>BRV</td>
<td>1:500</td>
<td>8</td>
</tr>
<tr>
<td>OHN</td>
<td>1:500</td>
<td>4</td>
</tr>
<tr>
<td>NMA</td>
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## Foliar Spray

### Type II Solution

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<tbody>
<tr>
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<td>1:500</td>
<td>8</td>
</tr>
<tr>
<td>FPJ</td>
<td>1:500</td>
<td>8</td>
</tr>
<tr>
<td>OHN</td>
<td>1:1000</td>
<td>4</td>
</tr>
<tr>
<td>FAA</td>
<td>1:1000</td>
<td>4</td>
</tr>
<tr>
<td>MA</td>
<td>1:1000</td>
<td>4</td>
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</table>

### Type III Solution

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<th>Rate</th>
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<tbody>
<tr>
<td>BRV</td>
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<td>8</td>
</tr>
<tr>
<td>FPJ</td>
<td>1:500</td>
<td>8</td>
</tr>
<tr>
<td>OHN</td>
<td>1:1000</td>
<td>4</td>
</tr>
<tr>
<td>WCA</td>
<td>1:1000</td>
<td>4</td>
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<tr>
<td>SW</td>
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<td>600</td>
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