Oxford Keynote

Ben Hartman, author of The Lean Farm
THE LEAN FARM
Online courses and events at claybottomfarm.com
US and UK Agriculture:
Wide angle view
How many of us farm?

1790: 90%
1841: 69%
1860: 58%
1880: 49%
1900: 38%
1920: 27%
1940: 18%
1950: 12%
1970: 5%
1990: 2.6%
2010: 2 % US/1.4% UK
US: Farm size has doubled in the past 20 years, and the trend is likely to continue (USDA).
Number of Farms and Average Farm Size – United States: 2009-2016

- Number of farms (blue line): Decreasing from 2.18 to 2.06 million farms from 2009 to 2016.
- Average farm size (red line): Increasing from 415 to 445 acres from 2009 to 2016.
WORKFORCE ON BRITISH/UK FARMS

Thousands, June each year

Source: Agriculture: Historical Statistics, House of Commons Library, June 2019
In the US...
2019 farm debt: $416 billion (all-time high)

More than half of all farmers have lost money every since 2013.

2019 farm bankruptcies: up 24% from 2018
US farmers are twice as likely to commit suicide as non-farmers.

National Farmers Union

One agricultural worker per week takes their own life across the UK.

BBC, 4/19
Enter: The Lean System

Farm smaller and smarter
Incredible opportunities for lean (agile) farms

• Sales to institutions up 288%
US top restaurant concept trend: “hyper local sourcing”

UK #1 Food Trend: “Food with a story.” (Bidfood 2019)

Likely to purchase food labeled “local”: (Cowen and Co.)
  US: 43% (vs. 17% “organic)
  UK: 41%
To Japan...
Lean is a system for tough times.
Japanese industry after WWII

• Bombed out factories
• No stable supplier base
• Very little capital
• Limited market for cars in Japan
• Giant automated factories in US to compete with (Ford, GM and Chrysler)
Created the Toyota Production System

• Goals
  • Catch the US in productivity of auto worker in 3 years
  • No large capital investments
  • With rice farmers (Toyoda = “fertile rice fields”)

Necessity is the mother of invention!
Eventually Toyota become #1 in profits, #1 in employee retention, and #1 in market share. It was doing something right.
We grafted Toyota’s business model onto our farm
Who We Are...

- 4-season specialty crop farm in northern Indiana
- 15th year in operation, 3 part-time staff
- Local commitment: 100% of food ends up within 1.5 miles
- Behind the scenes farm for 6 artisan restaurants
- Leaned up: 80 to 5 crops, 60 to 35 hours, 5 acres to ½ acre, hundreds of tools to a handful
Clay Bottom Farm Metrics

- Crops need to yield $3 per square foot
- $40 should fit into a 10 gallon tote
- Crops should go from field to cooler at $100/hour
- All sales activities generate $100/hour
Our story, pre-lean

- Ben: corn, soybean, cattle, and philosophy
- Rachel: giant garden and canning
Our goal was to *grow fast*
We started with a plan

First year built up infrastructure: greenhouses, drain tiles, irrigation, fences, processing room
We worked hard (60+ hours/wk)...
....systems were low-tech
...and backbreaking.
Here’s how Toyota (the rice farmers) did it...

1. **Organize with 5S**: Be ruthless: get rid of non-essentials.

2. **Precisely identify value**: From customers, no one else can define it.

3. **Cut out the *muda*** ("waste": anything not in the service of adding value)

4. **Practice *kaizen***: continuous improvement every year
ELIMINATED WASTE = CAPACITY

4 hours per week = 1 year off every 10 years
Shave 5% cost every year over 10 years = 50% growth!
How We Applied Lean
1. 5S on the Farm: We de-cluttered

We got rid of nonessentials—so we could move faster.
A visit to the factory...

Each job has a unique mobile work station—no “extra” tools or parts.
Sort

1. Get rid of anything not used almost every week

2. Find the fewest number of tools to accomplish the most work.

3. Create a “red tag” room.

If you can’t completely sort in two days, the farm has too much stuff.
Sorting before...
After...

A tool is in a worker’s hands or in it’s place. **There is no third option.**
Red Tag Room
A vacuum cleaner sucking waste off the farm.
Set in Order

Store tools where you use them—spread them out!
Sustain with pictures

• Sorting, setting in order, and shining need to be made routine—part of everyday work

• Sustain = “do without being told”
Sustain 5S by hanging “take it to zero” pictures
The point of 5S...

Better flow and “deep work”

Workers are most productive (and happiest) when they have what they need in front of them--and no more.
2. We Precisely Identified Value
“Start with the customer and work backwards from there.”

Jim Womack
To increase value...

- What customers want
- When they want it
- The amount they want
- An agreeable price

Increase precision

Be scientific: What, When, How much
Clay Bottom Farm Value Sheet

Chef Name: **Jesse**

Preferred communication method and time: texts noon-4pm

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Bulb fennel, tops left on, no roots</td>
<td>Tues and Fri noon-4, Sept-Jan</td>
<td>About 10 per week</td>
</tr>
<tr>
<td>Salad mix, any kind just not too much spinach</td>
<td>Tues and Fri noon-4 all year</td>
<td>9# per week</td>
</tr>
<tr>
<td><strong>Tomatoes</strong>—mix of colors, lots of green zebra, ripe</td>
<td>Tues and Fri noon-4 May-Oct</td>
<td>50-60# per week May-June 30# per week July-Oct</td>
</tr>
</tbody>
</table>

<p>| | | |</p>
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</tr>
</tbody>
</table>
Keep management systems visual
We survey to determine preferred communication methods.
How to triple your sales? Co-created your products.
3. We tackled the *muda* (waste)
3 TYPES of ACTIVITY on a FARM

- TYPE 1 MUDA: NECESSARY ACTIVITIES THAT DON'T ADD VALUE
- TYPE 2 MUDA: PURE WASTE
- VALUE-ADDING ACTIVITIES

MINIMIZE

ELIMINATE

MAXIMIZE

TYPE 1 MUDA

VALUE-ADDING ACTIVITIES
Value Stream Mapping

A Danish dairy farm: suspicious about “muda.” Photo by Susanne Pejstrup, Lean Farming
THE LAST TURN: VALUE ADDING
Taichii Ohno’s Seven *Mudas*:

1. Overproduction
2. Waiting
3. Transportation
4. Overprocessing
5. Inventory
6. Defect
7. Motion
Waiting Waste

- When is your product in stasis?
- When are workers waiting around?
We eliminated the walk-in cooler.

Instead, all of our crops are delivered within four hours.
Defect waste

“Every seed should turn into cash.”
1200 W hot water heater element in 14” x 18” x 8” deep pan OR crockpot

Durostat or Inkbird thermostat with external probe
3 Temperatures settings for germination (Germination Chamber):

85 F: Peppers, eggplant, cucumbers, beans

78 F: Tomatoes, kale, carrots, turnips, alliums, brassicas, herbs

68 F: Greens
“1/2” to zero” bottom watering
garden tray

made from recycled plastic

made in England

Just one of a wide range of garden trays available from Garland.

Multi purpose, injection moulded tray.
Ideal for plant pots and seed trays

Applications include watering tray,
mixing tray and spill tray

Tough rigid plastic - resistant to all
garden chemicals and oils

Garland
PRODUCTS LIMITED
KINGSWINFORD ENGLAND
www.garlandproducts.com
Leaning up Transplanting
We transplant almost everything in paper pots:

Turnips
Spinach
Head lettuce/salanova
Beets
Cilantro
Basil
13,000+ seedlings per 10’ x 10’ space!
200+ plugs in 40 seconds
# Paperpot Cheat Sheet

<table>
<thead>
<tr>
<th>Crop</th>
<th>Seeder size</th>
<th>Paper chain size</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basil</td>
<td>Hand seeded</td>
<td>4”</td>
<td>3 seeds per cell</td>
</tr>
<tr>
<td>Green beans</td>
<td>Hand seeded</td>
<td>2”</td>
<td>1 seed per cell</td>
</tr>
<tr>
<td>Edamame</td>
<td>Hand seeded</td>
<td>2”</td>
<td>1 seed per cell</td>
</tr>
<tr>
<td>Beets</td>
<td>4mm</td>
<td>4” for lg, 2” baby</td>
<td>Pellets not needed</td>
</tr>
<tr>
<td>Carrots</td>
<td>4mm</td>
<td>2” double seeded</td>
<td>Pelleted seed</td>
</tr>
<tr>
<td>Fennel, bulb</td>
<td>Hand seeded</td>
<td>4” every other cell for 8” btw plants</td>
<td>1 seed per cell</td>
</tr>
<tr>
<td>Green onion</td>
<td>4mm</td>
<td>2”</td>
<td>Aim for 3 per cell</td>
</tr>
<tr>
<td>Head lettuce, salanova</td>
<td>4mm</td>
<td>6”</td>
<td>Pelleted seed</td>
</tr>
<tr>
<td>Mizuna</td>
<td>2.8mm</td>
<td>2”</td>
<td>Aim for 4-6 seeds per cell</td>
</tr>
<tr>
<td>Radish</td>
<td>2.8mm</td>
<td>2”</td>
<td>Aim for 1-2 seeds per cell</td>
</tr>
<tr>
<td>Romaine heads</td>
<td>4mm</td>
<td>4” every other cell for 8” btw plants</td>
<td>1 seed per cell</td>
</tr>
<tr>
<td>Salad mix, baby</td>
<td>2.8mm or hand seeded</td>
<td>2”</td>
<td>4-6 seeds per cell, sometime easier to seed by hand</td>
</tr>
<tr>
<td>Shallots</td>
<td>2.8mm</td>
<td>2” or 4” depending on size desired</td>
<td>Aim for 1-2 per cell</td>
</tr>
<tr>
<td>Spinach</td>
<td>5mm</td>
<td>2” baby leaf or 4” mid-size leaf</td>
<td>3-4 per cell</td>
</tr>
<tr>
<td>Turnip</td>
<td>2.8mm or hand seeded</td>
<td>6”</td>
<td>Aim for 3-4 per cell</td>
</tr>
</tbody>
</table>

Note: best to hand seed small multi-plant crops
Motion waste

“Can we short, straighten, or eliminate noodles?”
Leaning up bed preparation
Old field management
Old field management

1. Plow or till old crop
2. Seed cover crop
3. Pack seeds
4. Mow cover crop
5. Plow or till in cover crop
6. Till again for seedbed prep

“Turnover” time: 3-6 months
Work time: 1-2 hours per bed
Lean Field Management

1. Pull out old crop
2. Loosen/raise the bed *if needed*
3. Add 2” of compost, leave it on top

“Turnover” time: 30 minutes per 100 sq ft. bed
Removing old crop with a wheel hoe and sweeps
Hoss sweeps
Loosening
Apply 2” compost per year
A good option for poor soils: add 6-8” of compost the first year
Leave the compost on the surface
Benefits:
• Fewer weeds
• Less work
• Slow-release fertility
• Increased water- and mineral-holding (CEC) capacity
Earth and Turf compost spreader
Historical inspiration from premodern Japan...

“Regulations of the Engi Era,” issued in 927....

1 tan (.3 acres) of spring onions required:

4 sho [3.4 liters] of seed
1,200 seedlings
1½ days for three tillings with 1 ploughman
1 ox driver and 1 ox
1 day for hand tillage
2 days to form ridges
35 days to transport 210 loads of manure
1 half-day for sowing (in the 8th month)
20 days for transplanting (in the 2nd month)
10, 9, and 7 days for three weedings

Out of 87.5 days’ work, 35 days—almost half—are devoted to composting!
A French-inspired greens harvester
4. We put in place kaizen (continuous improvement) routines
Kaizen = more precision

5S: More decluttered

Value: More precisely: what, when, how much

Muda: Eliminate more
Kaizen means respecting people

Workers are as close to *muda* as we are. Let them help us root it out!
At Toyota workers come to help us think, not build cars.

-Taiichi Ohno
In conclusion...
Be honest about who is in charge.

Farm so your farm works for you, not the other way around.
2 ways to farm: Bigger every year or Smaller and smarter ... more profitable, more clutter-free, more sustainable.
The farmer lives and works at the intersection of nature and the human economy

--Wendell Berry
Thank you!
Questions?
Bonus Tips (time permitting)
Hang these 3 pages in your workspace

Clay Bottom Farm Value Sheet

Chef Name: Jesse

Preferred communication method and time: text noon-4pm

<table>
<thead>
<tr>
<th>What do you want?</th>
<th>When? Be specific.</th>
<th>How much?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulb fluoride, tops left on, no roots</td>
<td>Tues and Fri noon-4, Sept-Jun</td>
<td>About 10 per week</td>
</tr>
<tr>
<td>Salad mix, any kind just not too much spinach</td>
<td>Tues and Fri noon-4 all year</td>
<td>96 per week</td>
</tr>
<tr>
<td>Tomatoes—mix of colors, lots of green zebra, ripe</td>
<td>Tues and Fri noon-4 May-Oct</td>
<td>50-60 per week May-June 300 per week July-Oct</td>
</tr>
</tbody>
</table>

Taichii Ohno’s Seven Wastes:

1. Overproduction
2. Waiting
3. Transportation
4. Overprocessing
5. Inventory
6. Motion
7. Making defective products
Edo Period: 1603-1868
Isolation, kubuki, bunraku puppet, samuri, origami...
...and, on farms, an “industrious” revolution

“The challenge: grow more food with less land and less technology. What would you do if you lost your tractor?”
They did it: Lifespan increased by 10 years

Yui collective work and farming guilds
Community insurance (still exists)
Rice is transplanted 15 days after seeding. Speed is of the essence.
Japan and Korea -- no waste farming: “simple, more with less” tools
By comparison: The *Industrial* Revolution

1834: The beginning of “more with more.”
The long arm of mass production agriculture

Expensive single-use machines created a “stiff”—not nimble--industry.
Tip: Grow at a steady pace
8. My favorite waste: Overburdening (*muri*)

Every year we asked, where was the *muri/hurt*? (*Muri* encourages the other *mudas*)

*Misconception: lean is just about working faster*
Every winter we choose a *muri* project—to make our work easier
9. Mura (uneven sales or production load)
Heijunka: A Level Load

Better to sell at an even pace. Grow your farm slow and steady.
10. Unused Talent: Any good idea unspoken is muda
Enter: The Lean System
A Lean Focus: No Waste—Every Seed Turns Into Cash

Seek simplicity on the other side of complexity.

Complexity is the enemy of lean.
A Simple Vision

43,000 sq. ft. per acre
1/3 acre in pathways
30,000 sq. growing area

1 head of lettuce occupies 1 sq. ft.

Wholesale price: $2/head = $60K x 2 crops = $120K/acre

Add tomatoes (3x value per square foot) = $540K/acre
Trellis crops require double value.

Table 10.4

<table>
<thead>
<tr>
<th>Crop</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heirloom tomato</td>
<td>$19.25</td>
</tr>
<tr>
<td>Hybrid tomato</td>
<td>12.00</td>
</tr>
<tr>
<td>Ginger</td>
<td>12.00</td>
</tr>
<tr>
<td>Pea shoots</td>
<td>10.00</td>
</tr>
<tr>
<td>Salad mix</td>
<td>10.00</td>
</tr>
<tr>
<td>Spinach</td>
<td>10.00</td>
</tr>
<tr>
<td>Spring mint tips</td>
<td>7.50</td>
</tr>
<tr>
<td>Romaine</td>
<td>5.00</td>
</tr>
<tr>
<td>Carrots, bunched</td>
<td>4.50</td>
</tr>
<tr>
<td>Carrots, bagged</td>
<td>4.50</td>
</tr>
<tr>
<td>Shallots</td>
<td>4.50</td>
</tr>
<tr>
<td><strong>Microgreens</strong></td>
<td>3.75</td>
</tr>
<tr>
<td>Rhubarb</td>
<td>3.75</td>
</tr>
<tr>
<td>Turnips, bunched</td>
<td>3.30</td>
</tr>
<tr>
<td>Garlic</td>
<td>3.00</td>
</tr>
<tr>
<td>Red beets, bunched</td>
<td>2.80</td>
</tr>
<tr>
<td>Fennel</td>
<td>2.80</td>
</tr>
<tr>
<td><strong>Kohlrabi</strong></td>
<td>2.80</td>
</tr>
<tr>
<td>Head lettuce</td>
<td>2.50</td>
</tr>
<tr>
<td>Green onion</td>
<td>2.50</td>
</tr>
<tr>
<td>Pac choy</td>
<td>2.50</td>
</tr>
<tr>
<td>Potatoes, new</td>
<td>1.30</td>
</tr>
<tr>
<td>Broccoli</td>
<td>1.25</td>
</tr>
<tr>
<td>Sugar snap peas</td>
<td>1.25</td>
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<tr>
<td>Onions</td>
<td>1.00</td>
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<tr>
<td>Etc.</td>
<td></td>
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</tbody>
</table>

Table 10.3

<table>
<thead>
<tr>
<th>Crop</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Ginger</td>
<td>$360</td>
</tr>
<tr>
<td>Garlic</td>
<td>325</td>
</tr>
<tr>
<td>Shallots</td>
<td>225</td>
</tr>
<tr>
<td>Green onion</td>
<td>150</td>
</tr>
<tr>
<td><strong>Kohlrabi</strong></td>
<td>138</td>
</tr>
<tr>
<td>Radishes, bunched</td>
<td>125</td>
</tr>
<tr>
<td>Peppers, colored</td>
<td>120</td>
</tr>
<tr>
<td>Carrots, bagged</td>
<td>100</td>
</tr>
<tr>
<td>Kale/Chard</td>
<td>100</td>
</tr>
<tr>
<td>Sugar snap peas</td>
<td>90</td>
</tr>
<tr>
<td>Salad mix</td>
<td>80</td>
</tr>
<tr>
<td>Spinach</td>
<td>80</td>
</tr>
<tr>
<td>Romaine</td>
<td>75</td>
</tr>
<tr>
<td>Rhubarb</td>
<td>75</td>
</tr>
<tr>
<td>Potatoes, new</td>
<td>75</td>
</tr>
<tr>
<td><strong>Microgreens</strong></td>
<td>70</td>
</tr>
<tr>
<td>Pea shoots</td>
<td>70</td>
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<tr>
<td>Spring mint tips</td>
<td>70</td>
</tr>
<tr>
<td>Red beets, bunched</td>
<td>63</td>
</tr>
<tr>
<td>Fennel</td>
<td>63</td>
</tr>
<tr>
<td>Turnips, bunched</td>
<td>63</td>
</tr>
<tr>
<td>Carrots, bunched</td>
<td>60</td>
</tr>
<tr>
<td>Peppers, green</td>
<td>60</td>
</tr>
<tr>
<td>Potatoes, storage</td>
<td>40</td>
</tr>
<tr>
<td>Squash, butternut</td>
<td>40</td>
</tr>
<tr>
<td>Head lettuce</td>
<td>38</td>
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<tr>
<td>Pac Choi</td>
<td>38</td>
</tr>
<tr>
<td>Onions</td>
<td>30</td>
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<tr>
<td>Watermelon</td>
<td>20</td>
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<td>Etc.</td>
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</table>
The result: a compact, high-flow farm, with strong pull.
Factory system on a farm?
In the end, we said yes.

A powerful formula:

ELIMINATED WASTE= CAPACITY
4 hours per week = 1 year off every 10 years
$100 per week, over 20 years = $100,000

A way to grow profits without large investments

The secret weapon: process
Fastest-growing types of farms:

Gigantic farms

And...

• Female-led farms (twice as many as 20 years ago)
  • Farmers under age 35 (millennial farmers)
• “Exurban micro-farms” (usually 1-2 acres, USDA)
2019 farm debt: $416 billion (all-time high)

More than half of all farmers have lost money every since 2013.

2019 farm bankruptcies: up 24% from 2018

American Farm Bureau