Tools and Systems for Growing Organic Vegetables on 140 acres

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Hello, my name is...

Dan Fillius
Field Specialist, Commercial Vegetables and Specialty Crops
ISU Extension & Outreach
Former farm manager:
Featherstone Farm (MN)
MSU SOF

Featherstone Farm (2015-2018)

• ~250 acres, 140 in vegetables annually
• Almost all acres leased
• Certified Organic
• 50 employees in summer, 15 in winter

Featherstone Farm (2015-2018)

• SE Minnesota, 1 hour north of Decorah, IA
• Most fields in the river valleys
• 1/3 acreage on ridgetops
Perspective: Lettuce

Perspective: Kale

Perspective: Peas

Marketing the Produce (2015-18)

- 33% Traditional 18-20 week CSA with fall/winter share add-on
  - 750-1000 shares (self-distributed)
- 66% Wholesale
  - Whole Foods Distribution Center (2 semis/week to Chicago)
  - Co-op Partners Warehouse Delivery (hired semi)
  - Direct Store Delivery (self-distributed)
    - Whole Foods
    - Co-ops
    - Natural Grocers
**Perspective: Facilities**
- Machine Shop
- Lean-to sheds
- Solar power
- Office x2, Breakroom, Restroom x2
- Coolers x4
- “Cool Room”
- Warehouse/wash&pack

**Perspective: Plastic Mulch**
- 83 miles of Plastic Mulch beds!
- 84 miles without plastic

**Tools**
The following tools were essential for farming on large acreage
- Large tractors to till acres fast
- Mechanic(s) to fix machinery
- Mechanized work as much as possible
- Harvest Machines
- Water Pumps, Pipes, Hoses
- Brush Washer
- High volume well
- Modern Coolers

- Redundant machinery
- 2x High Crops
- 4x cultivating tractors
- 2x sprayers
- 2x plastic mulch layers
- 2x Hydro tractors
- 2x waterwheels
- 2x vacuum seeders
- 2x Box trucks w/ Reefer
**Tractors**

Ford 9700
- primary tillage
- 113 HP

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**Implements**

- Offset Disc
- Medium-duty incorporation
- Primary or Secondary tillage

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**Implements**

- Chisel Plow
- Heavy-duty incorporation without inverting soil layers
- Fall chisel = faster drying in spring (but bare soil over winter)
- Primary tillage

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**Implements**

- Finish Disc
- Light-duty incorporation & seedbed creation
- Secondary tillage
- Last pass before bed-shaping
**Tractors**

John Deere 4020
- 83 HP, All purpose
- 5000 transplanter
- Plastic lifting
- Mowing
- Pulling trailers
- Harvesting carrots

**Tractors**

Offset cultivating tractors
- Kubota L245H x2
- Ford 1710
- IH Super C

**Tractors**

4WD High Crop tractors
- Landini PowerFarm 105HD
- McCormick C-Max
- Have creeper gears
- Transplanted, shaped beds, high-clearance cultivation, harvested, very versatile

**Tractors**

IH 656 Hydro
- Transplanting
- Mowing
- Trailer pulling
- Hydrostatic transmission makes it able to drive slow
Tractors

IH 70 Hydro
• Transplanting
• Mowing
• Trailer pulling
• Hydrostatic transmission makes it able to drive slow

Tractors

Skid Steer
• ‘Nuff said?

Trucks

Fleet of trucks and vehicles

Forklift

• Essential for moving bins in warehouse
• Helps out with precise lifting outside
**Implements**

Drip Tape Winder
- A repurposed cable/wire winder

**Implements**

Mater Macc Vacuum Seeder
- Great for singulation
- 2x faster than old method (Planet Jr.)

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- Can seed carrots in a band (3 close rows)

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GAME CHANGER!!!
**Implements**

- Rainflo 2600 Bed Maker
- Plastic Mulch used for drip irrigated crops
- Black – warm-loving crops, spring parsley, lettuce
- White – cool-loving crops

**Implements**

- Rainflo 2600 Bed Maker
- No plastic, dirt beds when overhead irrigating or no irrigation
- Set at widest bed setting

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**Transplanting Tools**

- Waterwheel
  - With Hydro or High Crop with creeper

**Transplanting Tools**

- Mechanical Transplanter
  - Carousel type planter
**Tools**

**Organization**

- Make things easy for yourself and others!

- 2.5x faster than hand seeding
- Use when whole trays of one type are being seeded
- Pelleted seed is useful for lettuce, most irregular seeds (brassicas are fine)

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**Propagation Tools 1.0**

**Vacuum Seeding**

- 2.5x faster than hand seeding
- Use when whole trays of one type are being seeded
- Pelleted seed is useful for lettuce, most irregular seeds (brassicas are fine)

**Propagation Tools 2.0**

**Seederman GS3 Needle Seeder**

- Purchased used in 2021 from Vermont Valley
- Dibbles, seeds, covers with vermiculite
- Set up for 192 Plantel Trays
- Major savings on labor, and improved consistency of transplants, more comfortable seeding env.
Irrigation Tools
Water pumps
- Godwin
- Rainflo
- Small pumps for storage tanks and pressurizing Water Reel

Irrigation Tools
- Traveling Gun/WaterReel
- Auto retract
- Auto shutoff
- 1 acre watered
- Needs high pressure, moderate volume

Pest Control Tools
Boom Sprayer
- Sprays 4 beds at a time
- Needs a drive lane for tall crops

Harvest Tools
Harvest Conveyors
- Nolts Harvest Conveyor
  - Zucchini, melons, cucumbers, peppers
- VegVeyor
  - Cabbage, sweet corn
- Broccoli Belt
Harvest Tools
Scott Viner

Warehouse Tools

Brush-washer
Bin Dumper & Sorting Table

Warehouse Tools

Electric Pallet Jacks
Thermal Label Printer

Tools
RIP Roeters
- Roeter’s Farm
  Equipment from MI closed in fall, 2021
- Used to come out once or twice to deliver tractors, implements and machinery
Systems

These systems were essential for farming on large acreage

- H2A Visa labor & Labor Continuity
- Uniform beds
- Stale seed bed
- Kanban + map
- Decrease variables
- Support and Supply tasks

H2A Visa Labor
Advantages
- Returning workers
- High-skill level

Challenges
- Bilingual leadership?
- Housing and cars?
- More paperwork, hoops and red tape

Uniform Beds
- Chisel > Disc > Make Beds (field work same direction as beds)
Uniform Beds

• A shovel at each end to hold the drip tape
• Leave dirt at each end
• Then rototill a headland to even it out

Uniform Beds

• Beds too wide – problem for cultivation
• Also, Chisel>finish discing made better tilth for covering edges…no need for human weight

Stale Bedding

Baskets and Tines for stale bed passes
Stale Bedding • Tine weeders are good at removing the plastic scraps…
• But too many scraps damage plants
Stale seedbed cultivation makes a huge difference in weed population (and labor costs!)

One bed was missed during stale seedbed cultivation

University of Kentucky Stale Bed System

University of Kentucky Stale Bed System
University of Kentucky Stale Bed System

Stale seedbed cultivation makes a huge difference in weed population (and labor costs!)
• We still handweeded every row-foot of carrots
  • And we grew 38 row-miles of carrots!

Support and Supply tasks
• Work Sunday to plan for the week
• Make the work board early
• Stage equipment, trailers
Support and Supply Tasks

Friday Tidy!
- First 15 minutes of every Friday
- If you expect somebody to do something, give them the time and tools to do it.

Decrease Variables

Case Study – W. Squash
- Fewer options for field layout
  - Less confusion
  - Less weeds
  - Higher yield/acre

Decrease Variables, Support & Supply

- Hodgepodge of pipe...Too many variables
- Not enough supplies...Irrigation not supported & supplied

Kanban Board

- Labor hours tracked on all tasks
  - First pen and paper
  - Moved to iPad + Google Forms
  - Next step = only track labor on certain tasks/crops
**Kanban Board**

- Magnetic nametags
- Color-coded “Skinnies” posted with scotch tape

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**People Management**
Kanban Board – Behind the Scenes

Work Board Task Generation
- Crop Managers create labor request forms weekly
- Field Production Coordinator prioritizes the work and makes the overall plan
- Operations Supervisor allocates labor hours to Field Production

Kanban Board – Behind the Scenes

Tractor Use & Allocation
- Plan to have as many tractors running as possible each day
- Allocate tractors between Production & Harvest

Maps

Limitation of “Skinnies”
- Some jobs need more info
- Some people need more info
Maps

Maps

Maps

Maps
Propagation

- Hot Water Seed Treatment
- Window screen pouches
- Seeds dried in a dehydrator on very low
Propagation
- Wash and sanitize all reused trays annually
- Stagger stack to dry on pallets

Propagation
- First month of propagation happens in the warehouse
- Stagger stack seeded trays on heated concrete for germination

Propagation
- Later, germinate peppers, tomatoes on heat mats
- Pot up once into the final cell size
- Cooler air temps saves gas $$ on heating
**Propagation**

- Pot up peppers into 72 cell 1020 trays
- Printed tray tags with Tharo thermal printer

**Propagation**

- 2 greenhouses for benchtop growing
  - Moveable benches
- 1 greenhouse for trailers (hardening off, cold/hail protection)

**Propagation**

- Harden off trays on trailers (80 trays per)
- Handle trays less!

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- Handle trays less!
- Trailers go to fields
- Enough trailers to hold all plants
Propagation

- 1 greenhouse for trailers (hardening off, cold/hail protection)
- Nightly trailer pushing in spring, or thunderstorms

Fails!

- Frosted TPs
  - Solved by getting more trailers

Moving TPs multiple times
  - Solved by getting more trailers

Field Prep
**Field Prep**

- MBA augers into tote bags
- Borrowed spreader from MBA

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**Field Prep**

- Rainflo 2600 Bed Maker
- Plastic Mulch used for drip irrigated crops
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**Field Prep**

- Pallets and pallets of plastic
- Volume discount!
- Important to use both rollers on implement to splice ends

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**Field Prep**

- Rainflo 2600 Bed Maker
- No plastic, dirt beds when overhead irrigating or no irrigation
- Set at widest bed setting
Field Prep

- No plastic with 2600
- Then rototill to widen, get better texture.

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Field Prep

Making beds on the contour when slope is steeper

Field Prep

Making beds on the contour when slope is steeper
Field Prep

- Would be better for carrot cultivation if bed had been firmer at seeding to avoid troughing
- Notice uncultivated space in pathway

Direct Seeding

Seeding – Gen 1.0

- Planet Jr. x3
- Pelleted carrot seeds

Seeding – Gen 1.0

- Planet Jr. x3
- Pelleted carrot seeds
- 2 rows of carrots for easier cultivation, harvest
Seeding – Gen 1.0

Mater Macc Vacuum Seeder
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Seeding – Gen 2.0

Mater Macc Vacuum Seeder
- Great for singulation
- Can seed carrots in a band
- Mostly 2 row still (3-row in pic)
Transplanting

- Waterwheel
- Mechanical Transplanter 5000

Transplanting

- Water trays to saturation
- Tow trailers out to the field
- Picture is of our 2nd of 3 successions of kale!

Transplanting

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All aboard the transplant train!
Transplanting
• Up to 3-rows per bed
• Trailer for transplants
• “Hot Dog” water tank
• No beds so harvest trucks can access beds easily
Transplanting

- Mechanical Transplanter 5000 - carousel type planter

Sweet Corn Transplanting

- First 2 successions transplanted for earlier yield
- Sh2 corn
Sweet Corn Transplanting

5000 Mechanical Transplanter

Transplanting

- Waterwheels sometimes used in bare dirt (winter squash)

Transplanting

- "Hot Dog" and "Hamburger" water tanks
- Refill transplanters MUCH faster
- Hot Dog had fish solution mixed in
- Hamburger was just water

Fails!

- "Hamburger" Tank
- Take the cap off when you’re filling with high pressure, high volume

- $1,200 mistake

photo by Abby Benson
Fails!

Leggy TPs
- Too many days in the greenhouse
- Can avoid by
  - getting 2 crews to transplant
  - increasing # of successions
  - Direct Seeding some squash

Cultivation

As many tractors in the field as possible!

Cultivation

- Kubota L245H
- Ford 1710
- Super C

Other cultivating tractors on the market:
- Allis Chalmers G
- Case 265
- JD 900HC
- Tilmor, Oggun, Euro models
**Cultivation**

Cutaway discs + 'L' Blades
- "Alloways"
- Kult Kress Duo
- Steketee Ridge Cultivator
- Tilmor hiller disc + tender plant hoes

**Cultivation**

"One pass to rule them all" – Cover every inch each time you drive over a bed

**Cultivation**

Crops grow too tall for cultivating tractors

The "Horseshoe" on a high crop tractor

**Cultivation**

- Clean aisles
- Weedy roadways
  - Mowing was almost a full-time job
  - Area over irrigation was not possible to mow
Cultivation

• Plastic Bed edges are tricky!
  • Harder to keep clean than dirt beds
  • Some people are blowing straw mulch in between @sognvalleyfarm
  • Some are putting landscape fabric in between

Cultivation

• One crude way to cultivate plastic bed edges

Cultivation

• Another way to cultivate plastic bed edges
  • Other farms using finger weeder and spyders (@doctorfarmerbrother)

Cultivation

• Flame weeding
  • Would be better with a hood
  • Ground speed must be slow
Cultivation

• Kubota L245H modification for slightly more clearance

Hand Work Still Used For:

• Handweeding 38 row-miles of carrots
• Removing 84 bed-miles of Plastic Mulch
• Clipping and collecting 12 acres of winter squash
• Trellising tomatoes
• Rogue Weeding
• Most harvest (sometimes with a harvest conveyor)

Irrigation

• Most water pumped from Root River
  ▪ Cheap permit from DNR
  ▪ ~$250 for 2 million+ gallons/yr
  ▪ What’s in the water?
Irrigation

- Most water pumped from Root River
  - Godwin pump
  - 6" high-pressure layflat
  - 6"x30' solid-set aluminum pipe x 100+

Irrigation

Big Aluminum pipe from River Pump to field

Irrigation

- Some water pumped from neighbor’s pond to nearby field
  - 6" high-pressure layflat
  - 6"x30' solid-set aluminum pipe
• Some water pumped from pond to nearby field
  - 6” high-pressure layflat
  - 6”x30’ solid-set aluminum pipe

• Pressure regulators
• Banjo Fittings

• Permanent Irrigation beds in carrots, cilantro
• Rotated sprinkler lines in other crops
Irrigation
• Supplied 3" pipe using 3" layflat

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Irrigation

Flame weeding maintenance of sprinkler beds
Irrigation

- Loosened and sliced plastic mulch with Rainflo 1800 lifter

Irrigation

- Loosened and sliced plastic mulch with Rainflo 1800 lifter
- Removed drip tape and mulch by hand for many years

Irrigation

- Drip Tape was recycled
- Common in areas with lots of silage plastic use (dairy)
- Cut trash by ~30%

Pest Control
**Pest Control**

- Dipel/Deliver (Bt)
- Cabbage loopers
- Imported Cab Worms
- Entrust
- Flea beetles
- CPB

*photo by Abby Benson*

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**Pest Control**

- Colorado Potato Beetle
- Hand removal
- Entrust

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**Pest Control**

- Deer control
- Melons
- Lettuce
- Not on corn!

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**Pest Control**

- Black Rot in cabbage 😊
**Pest Control**

- European Corn Borer parasitoid
  Trichogramma wasps
- Subscription from IPM Labs
- Followed VegEdge Model from UofM

[https://vegedge.umn.edu/weekly-moth-flights/european-corn-borer](https://vegedge.umn.edu/weekly-moth-flights/european-corn-borer)

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**Pest Control**

- European Corn Borer parasitoid
  Trichogramma wasps

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**Pest Control**

- 13-lined Ground Squirrel
  - AKA Striped Gopher
  - AKA Grinny

Rat traps were semi-effective

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**Pest Control**

- Tissue testing
Harvest

Nolts Harvest Conveyor
- Zucchini, melons, cucumbers, peppers

Harvest

Clip and place squash on top of every other bed.

Drive between rows of squash and toss up to a trailer.

Harvest

Harvest

photo by Abby Benson
Harvest

Metal posts stretch open the rubber band

Put broccoli in, the ends are sliced off and the band closes.

Pneumatic bunching machines

Broccoli is field packed

Whoops!

Iowa State University
Extensions and Outreach

photo by Abby Benson

189

190

191

192
In the warehouse, broccoli gets a scoop of ice in the boxes for better shelf life.

Scott Viner Root Harvester

- Hydraulic steering
- Digging plow is set manually at start of row
- “snouts” get under leaves

Scott Viner –
- Knives scissor off the tops
- Carrots fall onto chain conveyor
- Tops are sent off to the side
**Harvest**

Scott Viner –
- knives scissor off the tops
- carrots fall onto chain conveyor
- tops are sent off to the side

**Warehouse & Wash/Pack**
Warehouse & Wash/Pack

Zero Threshold Cooler Doors

Warehouse & Wash/Pack

Zero Threshold Cooler Doors
A wet harvest adds a lot more labor in winter:
- Cleaning mud off carrots
- Scooping mud out of trench drains 2x/day

Scoop carrots into brush-washer
Pack #1 carrots into boxes, put everything else into bulk bins for bagging

Carrots dry in cooler overnight

Scoop carrots into brush-washer
Pack #1 carrots into boxes, put everything else into bulk bins for bagging
**Crop Storage**

- ~750 bulk bins

**Warehouse & Wash/Pack**

LOTS of waxed boxes purchased each year

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**Coolers**

Stacking for long-term storage

**Coolers**

Taking Inventory
No solid indoor option for curing onions

Tips & Tricks

Tips and Tricks
• Welded-on tool basket

Tips and Tricks
• Cultivate wheel tracks while seeding
Tips and Tricks

• Easier to separate trays when stagger-stacked

Tips and Tricks

• Backpack straps on a propane tank

Tips and Tricks

• Backpack straps on a propane tank

Tips and Tricks

• Cheap dibbler
Tips and Tricks

• Work on Relationships!

Strawberry Social

• Creates connection to the farm for CSA members
• Typically around Summer solstice

Fails!

Fish bucket challenge, lol

Thank you!

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