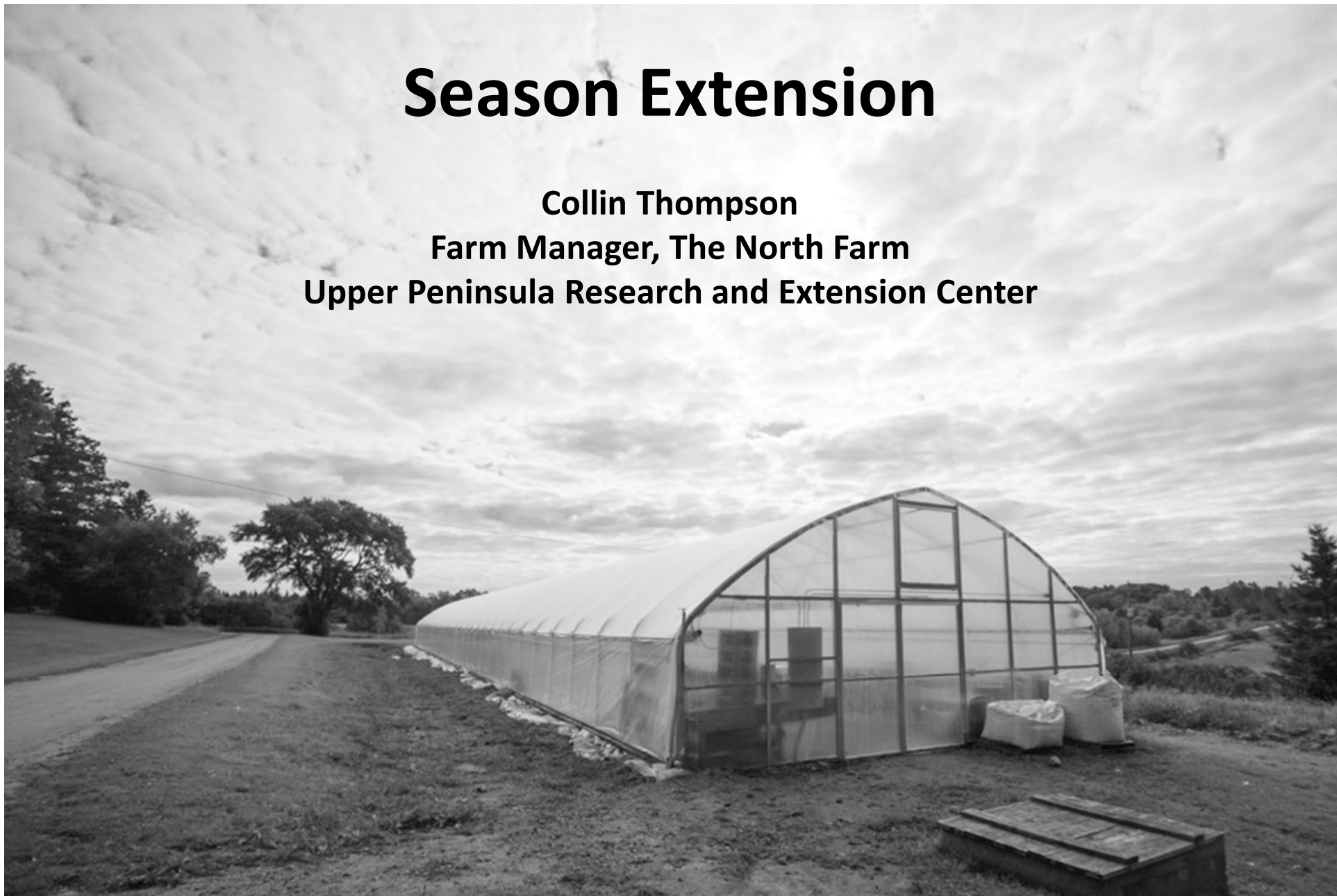


Season Extension

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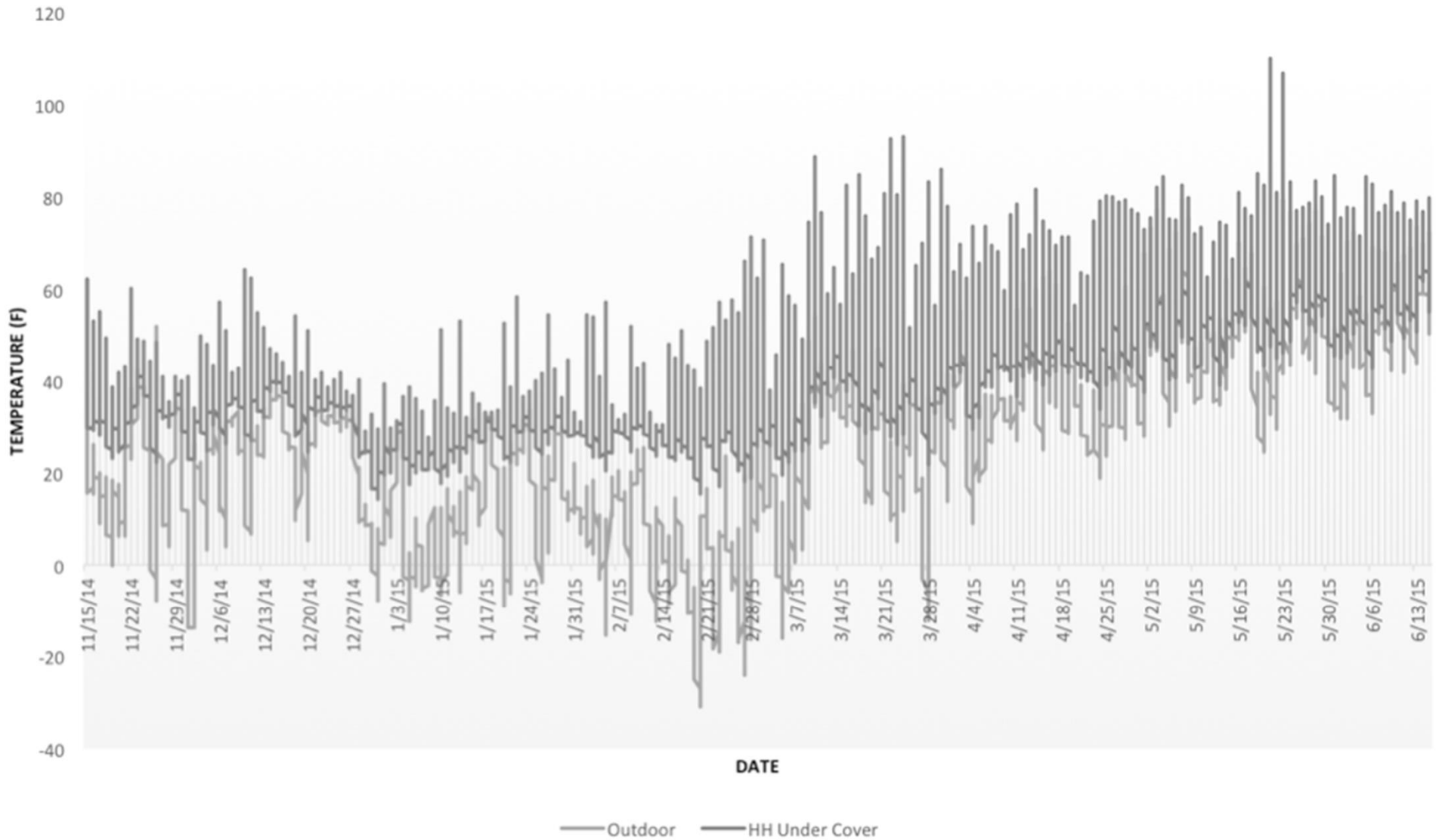


Why Consider Season Extension?

- “ Extend the growing season
- “ Increase marketing/cropping opportunities
- “ Increase revenue per square foot
- “ Increase crop quality & yield
- “ Enhanced environmental control
- “ Reduce incidence of plant disease
- “ Protection from weather (i.e. frost & hail)
- “ Labor efficiency (work regardless of weather)



Temperature (F) Hoophouse (covered) vs. Outdoor



Terminology

- “ Hoophouse – Structure glazed with polyethylene (greenhouse plastic) that is used to extend the growing season
- “ High Tunnel – Same as hoophouse. Term used to emphasize importance of low tunnel use inside high tunnel
- “ Greenhouse – Typically a more permanent structure, often with supplemental heat



Considerations

How do season extension technologies fit into my overall farm goals?

- “ What is your ideal ratio of covered to uncovered space?
- “ How about movable structures vs. stationary structures?
- “ Any thoughts on heated vs. unheated structures?
- “ What percentage of your revenue should come from covered growing spaces?
- “ What will be the primary type of usage of covered spaces?



Let's Discuss

- “ 1st Phase: low tunnels and field tunnels
- “ 2nd Phase: High Tunnels/Hoophouses
- “ Movable Structures
- “ Systems management
- “ Crop selection and timing
- “ Storage Crops/Root Cellaring



Low Tunnels



Low Tunnels

- “ Low supports made of wire, conduit, or PVC for fabric or plastic covers
- “ Offers frost protection in the field or hoophouse
- “ Serves as a physical pest barrier and offers wind protection
- “ Maximizes effect of hoophouse for season extension
- “ Different types of row cover
- “ Relatively small investment
 - “ \$0.136 / Square Foot Cost



Low Tunnels

- ” Cost of materials:
 - ” \$69.00 – Quick Hoop bender
 - ” \$229.00 – 10’ W x 1000’ L AG-19 row cover
 - ” \$415.00 - 1000’ of hoops at 5’ spacing
 - ” \$108.00 - Sandbags to secure hoops (not necessary in hoophouse)
-
- ” \$821.00 – Estimated material cost for 6,000 square feet of low tunnels
 - ” **\$0.136 per ft² cost**



Low Tunnels

Row Cover Impact on Greens Production (28 Days of Growth)

Inner Cover	Mizuna		Tatsoi		Salad Mix	
	Height (inches)	Weight (oz)	Height (inches)	Weight (oz)	Height (inches)	Weight (oz)
Plastic	7	5.9	5.5	6.9	4	2.8
Typar	4.75	3.7	4	0	2.5	0
None	2.75	0	4	0	1.75	0



Effects of row covers on plant



6 mil plastic



Typar (nonwoven
polypropylene fabric)



No cover



Low Tunnels

Frost protection versus light transmission		
Product name	Frost protection	Light transmission
Covertan CP-17	4°	90%
Agribon AG-19 Agrofabric Pro 17	4°	85%
Covertan CP-30	6°	80%
Agribon AG-30 Agrofabric Pro 30 Tyvar T-518	6°	70%
Agribon AG-50 Agrofabric Pro 50	8°	50%
Tufbell	10°	95%

















Field Tunnels



Field Tunnels

- “ Greater thermal gain and working environment
- “ Typically uses very basic plastic attachment technology and ventilation
- “ Often viewed as 3-season structures in area with snow
- “ Can be bought as kits or bent on-farm
- “ Slightly larger investment
 - “ \$1.75 per ft² cost



Field Tunnels

- “ Cost of materials (12' x 96'):
 - “ \$59.00 – Quick Hoop bender
 - “ \$379.00 – Tufflite greenhouse film (24' x 125')
 - “ \$1078.00 – 1-3/8" fence post for hoops and purlins
 - “ \$494.00 – Hardware and accessories
-
- “ *\$2,010* – Estimated material cost for 1,152 square feet of field tunnel
 - “ **\$1.75 per ft² cost**













High Tunnels/Hoophouses



High Tunnels/Hoophouses

- “ Large structures designed for 3-4 season production
- “ Maximum thermal gain and pleasant working environment
- “ Varying materials, but generally galvanized steel frame
- “ Pre-bent kits or bend-your-own
- “ Varying levels of automation
- “ Larger investment
 - “ \$2.84+ / Square Foot Cost



Roof Geometry



Quonset



Cathedral



Gable



Gothic

High Tunnels/Hoophouses

- ” Cost of materials (12' x 96'):
 - ” \$89.00 – Tools
 - ” \$1560.00 – Frame components
 - ” \$757.00 - Greenhouse film and plastic attachment hardware
 - ” \$400.00 - Doors & endwalls
 - ” \$470.00 – Sidewall ventilation
-
- ” \$3276.00 – Estimated material cost for 1,152 square feet of covered space
 - ” **\$2.84 per ft² cost**



High Tunnels/Hoophouses

- ” Pipe Gauge
 - ” Lower the gauge, thicker the pipe
 - ” 14ga is 43% more material than 17ga
- ” Pipe Diameter (14ga example):
 - ” 2.375in OD is 86% more material than 1.315in OD
 - ” 2.375in OD is 26% more material than 1.9in OD
- ” Weight in documentation



Management!



Movable Structures



Movable Structures

- “ Movable
 - “ Allows multiple plots to be covered per year
 - “ Allows for natural rotations
 - “ Plant-positive
 - “ Expensive
- “ Fixed
 - “ Permanent and simple
 - “ Minimizes weed pressure
 - “ Easier access to utilities
 - “ Limits rotations



Movable Structures

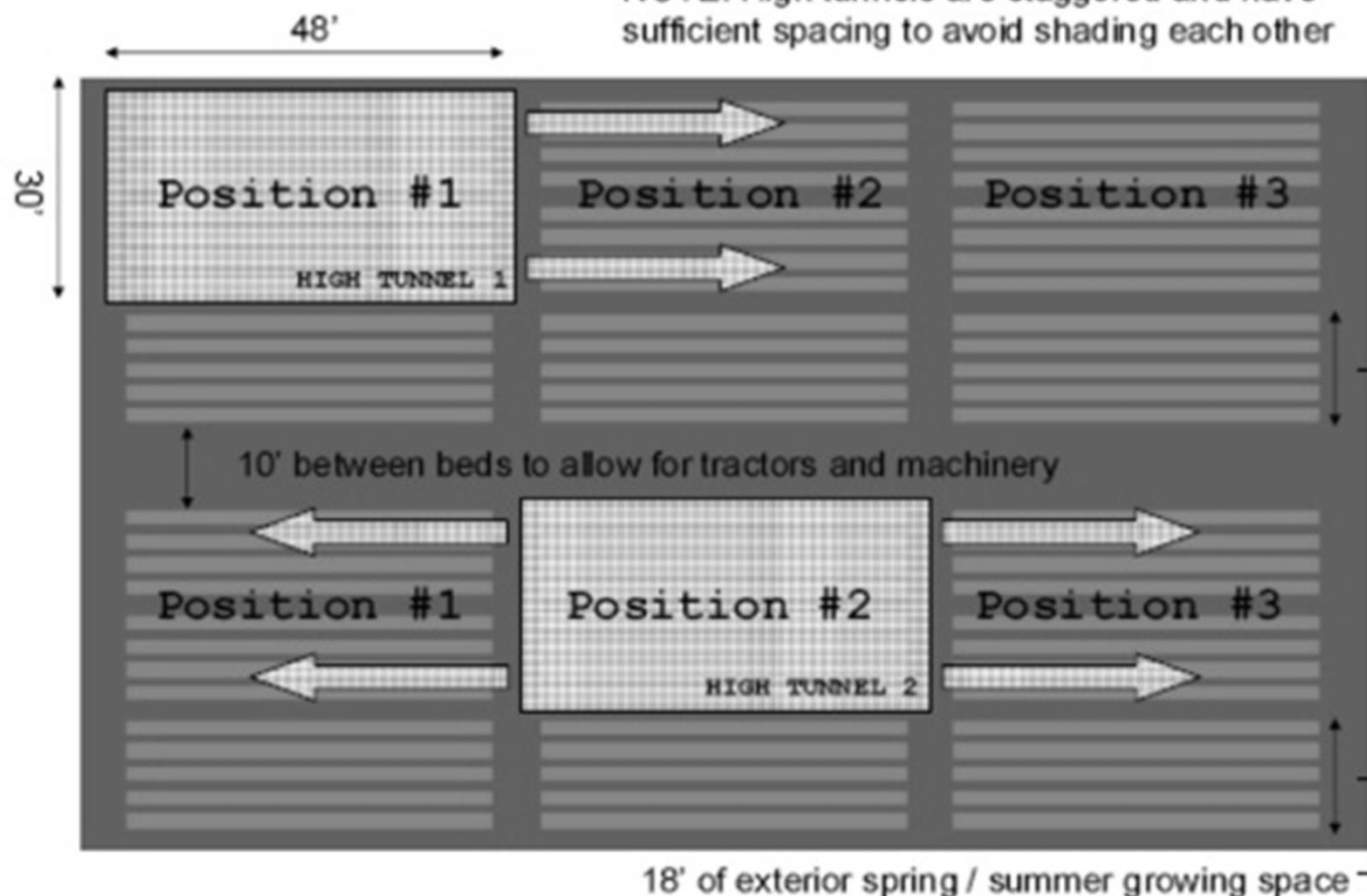
Benefits of Movable:

- “ Multiple “season extensions”
- “ Enhanced soil management practices
- “ Diversified and simple crop rotations
- “ Minimize insect and disease pressure
- “ Eliminate high tunnel cooling needs
- “ Extend market availability
- “ “Plant positive” approach



THREE POSITION MOVABLE HIGH TUNNEL LAYOUT

NOTE: High tunnels are staggered and have sufficient spacing to avoid shading each other



<i>Position 1</i>	<i>Position 2</i>	<i>Position 3</i>
Feb. 1 st – Plant and Cover Direct Seeded Carrots	Apr. 15 th – Cover Transplanted Tomatoes (moved from “warm house” to ground)	Nov. 1 st – Cover Fall Spinach Planted in Sept.
Dec. 1 st – Cover Winter Leeks Planted Late Spring		

Crop Selection

- “ Any crop can be grown in a hoophouse. But should it?
- “ Select crops based on market value – high value growing space.
- “ Compare apples to apples:
 - . \$/ft²/week
- “ Look for cold-hardy varieties
- “ Cool season crops
 - . Spinach, kale, chard, arugula, lettuces, radish, carrots, beets, Asian greens
- “ Warm season crops
 - . Tomatoes, peppers, eggplant, cucumbers, ginger, flowers



Crop Selection

- “ Work backwards from transplant, harvest, etc.
- “ Successions – make use of the valuable space!
- “ Rotations within a structure
- “ Rotations with movable structures
- “ Transplants for outdoor production
- “ Plant for the season



Crops and Crop Schedules

” Spring

- . First Direct Seeding Date: March 1
- . Carrots, Spinach, Baby Greens
- . 1-3 layers AG-19



Spring Varieties

” Lettuce

- . Red – Skyphos, Refugio, Garrison, Salanovas, Red Tide
- . Green – Lettony, Winter Density, Salanovas

” Greens

- . Kales – Winterbor, Toscano, Dwarf Green Curled, Red Russian
- . Chard – Bright Lights, Ruby Red
- . Komatsuna (Carlton), Yukina Savoy, Mizunas, Mustards, Arugula
- . Spinach – Space, Corvair, Tye

” Roots

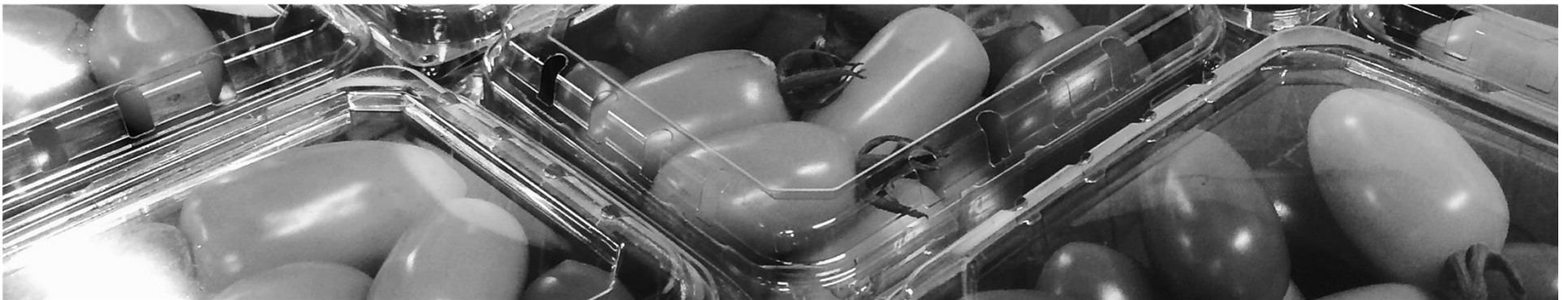
- . Carrots – Mokum, Nelson
- . Turnips – Hakurei
- . Beets – Early Wonder Tall Top
- . Radish – Celesta, Rover, D’Avignon



Crops and Crop Schedules

” Summer

- . Transplanted May 1
- . Tomatoes, Peppers, Eggplants, Cucumbers, Ginger, Turmeric
- . AG-19 as needed











Summer Varieties

” Tomatoes

- . Cherries – Sun Gold, Black Cherry, Indigo Cherry Drop
- . Grape – Nova, Five Star
- . Red Slicer – Geronimo, Arbason
- . Heirloom – Red Zebra, Green Zebra, Cherokee Purple, Brandywine, Amish Paste

” Peppers

- . Islander, Red Knight, Ace, Gourmet, Canary Bell Carmen, Escamillo

” Eggplant

- . Jaylo, Angela

” Cucumber

- . Corinto, Socrates, Diva, Tasty Jade



Crops and Crop Schedules

” Fall Baby Greens

- . Overwintered

 - ” Final Transplant Date: 11/15

 - ” Final Direct Seeding Date: 10/21

- . Winter Harvest

 - ” Final Transplant Date: 9/30

 - ” Final Direct Seeding Date: 9/7



Winter Varieties

” Lettuce

- . Red – Refugio, Garrison, Salanovas, Dark Red Lollo Rossa, Rouge D’Hiver
- . Green – Lettony, Winter Density, Salanovas, Sparx
- . Blends – Yankee Hardy, DMR Blend

” Greens

- . Kales – Winterbor, Toscano, Dwarf Green Curled, Red Russian
- . Chard – Bright Lights, Ruby Red
- . Komatsuna (Carlton), Yukina Savoy, Mizunas, Mustards
- . Spinach – Space, Corvair, Tyee

” Roots

- . Carrots – Napoli



Field Overwintered Crops

- ” Onions
 - . **Bridger**
 - . Keepsake
 - . Top Keeper
- ” Quick hoops
 - . AG-19
 - . 4mil poly
 - . \$0.38/sq.ft.
- ” Seeded – 8/15
- ” Transplanted – 9/30
- ” Harvested – 7/3



Field Overwintered Crops



Field Overwintered Crops



Storage Crops

- “ Bring in valuable revenue in winter months
- “ Potential low cost for storage (cellaring)
- “ Maintain customer relationships throughout winter
- “ Wide range of crops



Crop Types

” Potatoes

” Carrots

” Other Roots

” Beets

” Parsnips

” Radish

” Rutabaga

” Turnip

” Brassicas

” Cabbage

” Brussels Sprouts

” Alliums

” Garlic

” Onions

” Leeks

” Cucurbits

” Winter Squash

” Pumpkins



Crop Types

Cold and Very Wet (32-40F/0-4C; 90-95% RH)

- " Roots – Beets, Parsnips, Radish, Rutabaga
- " Leeks
- " Cabbage
- " Brussels Sprouts
- " Kohlrabi
- " Celeriac

Cold and Dry (32-35F/0-3C; 60-70% RH)

- " Onions
- " Garlic
- " Popcorn

Cool and Wet (38-42F/3-5C; 90-95% RH)

- " Potatoes
- " Apples

Warm and Dry (50-55F/10-13C; 60-75% RH)

- " Winter Squash
- " Pumpkins



Cold Cellar

- ” 20’ x 40’ buried concrete cellar
- ” Built in 1913
- ” Maintains summer temp – 50F/10C
- ” Coldest winter temp – 34F/1C
- ” Fall cooling – use two CoolBot systems (minimal effect)
 - . Limited ability to cool in fall



Our Method

- “ Depending on labor, items can be stored washed or dirty
- “ If dirty – stored in clean bins, wrapped with plastic as necessary
- “ If clean – stored in lined bins with peat/burlap or in clean, wrapped bins



Storage Crop Varieties

- ” **Onions** – Pontiac, Patterson, Redwing, Zebrune(s), Camelot(s)
- ” **Carrots** – Bolero, Purple Haze, Yellow Sun
- ” **Beets** – Red Ace, Chioggia, Touchstone Gold
- ” **Cabbage** – Storage No. 4, Ruby Perfection, Mammoth Red Rock
- ” **Parsnips** - Albion
- ” **Rutabaga** – Helenor, Laurentien
- ” **Potatoes** – Reba, Strawberry Paw, Canela, Yukon Gem, Peter Wilcox, Red Gold, Banana (f), Magic Molly (f), French Fingerling (f)



Questions?

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