



# Profitable Winter Crops in High Tunnels at Pleasant Valley Farm

**February 2016**

**Paul & Sandy Arnold**



## ARGYLE, NY ZONE 4

- ❖ Land purchased in 1988-60 Acres
- ❖ Rent Neighbors 120 Acres



# 2015 PRODUCTION

- ❖ 5 Acres Mixed Diverse Vegetables
- ❖ 1/2 Acre Large Fruits
- ❖ 1/4 Acre Small Fruits
- ❖ 3-4 Acres Cover Crops
- ❖ Hay fields used by Beefalo farmer
- ❖ CNG certified



# 2015 MARKETING

- ❖ Sell at 3 local weekly farmers' markets in summer & 2 Saturday winter markets-82%
- ❖ Wholesale: Restaurants 12% Other 6%



# OUR MISSION IS TO OPERATE A FARM THAT WILL PROVIDE:

1. A healthy, challenging, financially successful, family centered lifestyle.
2. Consistent, high quality, organic fruits and vegetables that make us proud.
3. A way of life that is an example to those around us.
4. Time to be an educator of environmentally sound agriculture to our employees, customers, and the community.
5. A rural environment that teaches good moral values and work ethics to our children, while providing time for fun and interesting opportunities.

MISSION STATEMENT 12/94



# OUR 10 KEY FACTORS TO REACHING OUR GOAL OF PROFITABLE FARMING

- ***INEXPENSIVE START-UP WITH SMART EXPENDITURES***
- **GOOD BUSINESS MANAGEMENT & RECORD KEEPING**
- **LABOR EFFICIENCIES TO MAXIMIZE PROFITS**
- **EFFICIENT PRODUCTION SYSTEMS & SOIL MANAGEMENT**
- **MULCHING AND WEED CONTROL**
- **PEST AND DISEASE MANAGEMENT**
- **SEASON EXTENSION-ROWCOVERS & FIELDHOUSES**
- **YEAR-ROUND HIGH TUNNEL PRODUCTION**
- **POST-HARVEST HANDLING AND CROP STORAGE**
- **CREATIVE MARKETING**

# SEASON EXTENSION HAS INCREASED OUR PROFITS SINCE 1992

- STAY ON THE FARM
- LEVEL OUT THE INCOME
- CUSTOMER IMPACTS
- YEAR-ROUND WORKERS



# SEASON EXTENSION

- Row Covers
- Field Houses
- High Tunnels





# HIGH TUNNELS



**Always Something New to Make Us Money!**  
**January 2006**



**HAVE SITE WORK DONE EARLY  
HIRE THE PROFESSIONALS!**



- DRAIN TILE
- 2" INSULATION BOARD
- POLYCARBONATE KNEE WALL



- 2006, 2008, 2012
- Rimol
- No Wood
- 9'X9' Slider Doors

3 TUNNELS 1-30'X144' 2- 34'X144'



POWER & PROPANE & 2 WATER SOURCES



**AUTOMATIC  
ROLL-UP  
SIDES \$1200**

**PAY FOR  
THEMSELVES  
WITHIN A  
YEAR**



**SUN DRIVEN SYSTEM – NO HEAT**

# HIGH TUNNEL SOIL MANAGEMENT

- Soil Tests
- Fertilizers
- Organic Matter
- Mulching
- Compost
- Cover Crops
- Irrigation
- Greenhouse Amendments





# Soil Tests

- Take Annually to track progress
- Pick a lab and stay with them — A&L Labs has great reference book
- Take sample same time every year
- Be accurate in sampling—Soil probe is a good tool to own



# SOIL HEALTH

# Soil Tests

- Amend as needed or get custom fertilizers (2 opinions)
- Know how to calculate what is needed
- Know crop needs (Knott's Handbook)
- Soil Test as Soil Media maybe for high tunnels

Report Number: 20240101  
Account Number: 87023

**A & L Canada Laboratories East, Inc.**  
2170 Robinson Road, Oshawa, Ontario L1G 4C1  
Telephone: (905) 881-8225 Fax: (905) 881-8224

AL

Report Date: 2024-01-01

**SOIL TEST REPORT**

| Parameter | Unit  | Result | Reference Range | Notes |
|-----------|-------|--------|-----------------|-------|
| pH        |       | 6.5    | 6.0 - 7.5       |       |
| EC        | dS/m  | 0.2    | 0.0 - 0.5       |       |
| Ca        | mg/kg | 1500   | 1000 - 2000     |       |
| Mg        | mg/kg | 500    | 300 - 700       |       |
| K         | mg/kg | 10000  | 5000 - 15000    |       |
| N         | mg/kg | 200    | 100 - 300       |       |
| P         | mg/kg | 10     | 5 - 20          |       |
| S         | mg/kg | 1000   | 500 - 1500      |       |
| Zn        | mg/kg | 50     | 20 - 100        |       |
| Cu        | mg/kg | 10     | 5 - 20          |       |
| Mn        | mg/kg | 100    | 50 - 200        |       |
| B         | mg/kg | 5      | 2 - 10          |       |
| Mo        | mg/kg | 0.5    | 0.2 - 1.0       |       |
| Fe        | mg/kg | 1000   | 500 - 2000      |       |
| Cl        | mg/kg | 100    | 50 - 200        |       |
| Si        | mg/kg | 10000  | 5000 - 15000    |       |
| Al        | mg/kg | 1000   | 500 - 2000      |       |
| As        | mg/kg | 0.5    | 0.2 - 1.0       |       |
| Cd        | mg/kg | 0.1    | 0.05 - 0.2      |       |
| Pb        | mg/kg | 10     | 5 - 20          |       |
| Hg        | mg/kg | 0.1    | 0.05 - 0.2      |       |
| Cr        | mg/kg | 100    | 50 - 200        |       |
| Ni        | mg/kg | 100    | 50 - 200        |       |
| Co        | mg/kg | 10     | 5 - 20          |       |
| Mg        | mg/kg | 500    | 300 - 700       |       |
| Ca        | mg/kg | 1500   | 1000 - 2000     |       |
| K         | mg/kg | 10000  | 5000 - 15000    |       |
| N         | mg/kg | 200    | 100 - 300       |       |
| P         | mg/kg | 10     | 5 - 20          |       |
| S         | mg/kg | 1000   | 500 - 1500      |       |
| Zn        | mg/kg | 50     | 20 - 100        |       |
| Cu        | mg/kg | 10     | 5 - 20          |       |
| Mn        | mg/kg | 100    | 50 - 200        |       |
| B         | mg/kg | 5      | 2 - 10          |       |
| Mo        | mg/kg | 0.5    | 0.2 - 1.0       |       |
| Fe        | mg/kg | 1000   | 500 - 2000      |       |
| Cl        | mg/kg | 100    | 50 - 200        |       |
| Si        | mg/kg | 10000  | 5000 - 15000    |       |
| Al        | mg/kg | 1000   | 500 - 2000      |       |
| As        | mg/kg | 0.5    | 0.2 - 1.0       |       |
| Cd        | mg/kg | 0.1    | 0.05 - 0.2      |       |
| Pb        | mg/kg | 10     | 5 - 20          |       |
| Hg        | mg/kg | 0.1    | 0.05 - 0.2      |       |
| Cr        | mg/kg | 100    | 50 - 200        |       |
| Ni        | mg/kg | 100    | 50 - 200        |       |
| Co        | mg/kg | 10     | 5 - 20          |       |

- Each Lab is individual
- Logan-extra micronutrients
- Extension-Resource

# SOIL HEALTH

# Soil Tests

- Micronutrients important
- Ask for full soil analysis
- Bargain at any price!
- No longer 3 major nutrients
- Spread evenly to get all nutrients up to proper levels
- Side-dressing of Nitrogen is common
- pH must be in proper range (6.5+); Adjust with lime or sulfur per recommendations

SOIL HEALTH

- Large spreaders
- Hand spreading
- Spray on field
- Small spreader
- Through irrigation



## APPLYING NUTRIENTS

# LIQUID MICRONUTRIENT APPLICATIONS

- Even distribution
- Tank Mix
- Spring or Fall



**50 GAL 3 PT HITCH HYDRAULIC  
SPRAYER W 100' HOSE**

| FIELD     | BED LENGTH | Squ Feet per Bed@5.5' wide | SULFUR on Test (ppm) | Sulfur Needed per 1000 sf | WP Sulfur per Acre | BORON on Test (#) | Actual B Needed per 1000 SF | Solubor per Acre | ZINC on Test (ppm) | Zn needed per 1000 SF | ZnSuf per Acre (#) | ZnSul Ne |      |      |      |             |      |
|-----------|------------|----------------------------|----------------------|---------------------------|--------------------|-------------------|-----------------------------|------------------|--------------------|-----------------------|--------------------|----------|------|------|------|-------------|------|
| MAIN S    | 100        | 550                        | 8.0                  | 0.63                      | 27.4               | <b>30.5</b>       | 0.39                        | 1.00             | 0.03               | 1.31                  | <b>6.5</b>         | 0.08     | 3.40 | 0.03 | 1.31 | <b>3.63</b> | 0.05 |
| MAIN N    | 100        | 550                        | 9.0                  | 0.61                      | 26.6               | <b>29.5</b>       | 0.37                        | 0.90             | 0.04               | 1.74                  | <b>8.7</b>         | 0.11     | 4.50 | 0.02 | 0.87 | <b>2.42</b> | 0.03 |
| SECOND    | 130        | 715                        | 8.0                  | 0.63                      | 27.4               | <b>30.5</b>       | 0.50                        | 0.80             | 0.04               | 1.74                  | <b>8.7</b>         | 0.14     | 2.80 | 0.04 | 1.74 | <b>4.84</b> | 0.08 |
| BLUEBERRY | 115        | 633                        | 9.0                  | 0.61                      | 26.6               | <b>29.5</b>       | 0.43                        | 0.80             | 0.04               | 1.74                  | <b>8.7</b>         | 0.13     | 2.50 | 0.04 | 1.74 | <b>4.84</b> | 0.07 |
| CENTER N  | 225        | 1238                       | ##                   | 0.58                      | 25.3               | <b>28.1</b>       | 0.80                        | 1.10             | 0.04               | 1.74                  | <b>8.7</b>         | 0.25     | 4.50 | 0.02 | 0.87 | <b>2.42</b> | 0.07 |
| NORTH     | 120        | 660                        | ##                   | 0.56                      | 24.4               | <b>27.1</b>       | 0.41                        | 0.50             | 0.05               | 2.18                  | <b>11</b>          | 0.17     | 2.40 | 0.04 | 1.74 | <b>4.84</b> | 0.07 |
| STRODE N  | 275        | 1513                       | ##                   | 0.56                      | 24.4               | <b>27.1</b>       | 0.94                        | 0.50             | 0.05               | 2.18                  | <b>11</b>          | 0.38     | 2.30 | 0.04 | 1.74 | <b>4.84</b> | 0.17 |
| STRODE E  | 100        | 550                        | ##                   | 0.48                      | 20.9               | <b>23.2</b>       | 0.29                        | 0.70             | 0.04               | 1.74                  | <b>8.7</b>         | 0.11     | 4.00 | 0.02 | 0.87 | <b>2.42</b> | 0.03 |
| STRODE W  | 300        | 1650                       | 7.0                  | 0.66                      | 28.7               | <b>31.9</b>       | 1.21                        | 0.50             | 0.05               | 2.18                  | <b>11</b>          | 0.41     | 3.20 | 0.03 | 1.31 | <b>3.63</b> | 0.14 |
| CENTER S  | 225        | 1238                       |                      |                           | 0.0                | <b>0.0</b>        | 0.00                        |                  |                    | 0.00                  | <b>0.0</b>         | 0.00     |      |      | 0.00 | <b>0.00</b> | 0    |
| ORCHARD   | 225        | 1238                       | 8.0                  | 0.63                      | 27.4               | <b>30.5</b>       | 0.87                        | 0.70             | 0.04               | 1.74                  | <b>8.7</b>         | 0.25     | 2.70 | 0.04 | 1.74 | <b>4.84</b> | 0.14 |
| HAY SE    | 600        | 3300                       | 9.0                  | 0.61                      | 26.6               | <b>29.5</b>       | 2.24                        | 0.50             | 0.03               | 1.31                  | <b>7</b>           | 0.50     | 1.70 | 0.05 | 2.18 | <b>6.05</b> | 0.46 |
| N. TUNNEL | 144        | 792                        |                      |                           | 0.0                | <b>0.0</b>        | 0.00                        |                  |                    | 0.00                  | <b>0.0</b>         | 0.00     |      |      | 0.00 | <b>0.00</b> | 0    |

# MICRONUTRIENT SPREADSHEET AUTO CALCULATIONS

No ALFALFA MEAL (Organic) 2.50 0.50 2.20  
 No ARAGONITE 0.00 0.00 0.00 33% Ca  
 Yes AZOMITE 0.00 0.00 0.00  
 No BLOOD MEAL 13.00 0.00 0.00  
 Yes BONE CHAR 1.00 20.00 0.00  
 No BONE MEAL 6.00 9.00 0.00  
 Yes BORON (SOLUBOR 20%) 0.00 0.00 0.00  
 Yes CHEEP CHEEP 4.00 3.00 3.00  
 Yes CHILEAN NITRATE 16.00 0.00 0.00  
 No COBALT (33%) 0.00 0.00 0.00  
 No COPPER (25%) 0.00 0.00 0.00  
 No CORN GLUTEN 10.00 0.00 0.00  
 No COTTON SEED MEAL 6.00 2.00 1.00  
 No EPSOM SALT 0.00 0.00 0.00 10% Mg, 13% S  
 No FEATHER MEAL 13.00 0.00 0.00  
 Yes GREENSAND 0.00 0.00 1.00  
 Yes GYPSUM 0.00 0.00 0.00 23% Ca, 19% S  
 Yes HUMATE 0.00 0.00 0.00  
 No KELP MEAL 0.00 0.00 4.80  
 No Manganese (27%) 0.00 0.00 0.00  
 No MOLYBDENUM (39.5%) 0.00 0.00 0.00  
 No PEANUT MEAL 8.00 1.50 1.80  
 No Pelletized Ca Lime 7.00 1.00 2.00  
 Yes PHOSPHATE ROCK 0.00 5.00 0.00 22% Total P2O5  
 Yes SULFT/PTSH 0.00 0.00 51.00  
 Yes ELEMENTAL SULFUR 0.00 0.00 0.00  
 No SULPOMAG 0.00 0.00 22.00  
 No ZnSO4 (35.5%) 0.00 0.00 0.00  
 Yes PRO-GRO 5.00 3.00 4.00  
 Yes PRO-START 2.00 3.00 3.00  
 No PRO-BOOSTER 10.00 0.00 0.00

# LOTS OF ORGANIC FERTILIZERS OUT THERE

- Know the numbers
- OMRI-approved & listed
- Multiple nutrients
- What's needed in your soil

# CUSTOM BLEND FERTILIZERS

- 20# Solubor (20% B)
- 16# Copper Sulfate (25% Copper)
- 400# Feather Meal
- 200# Humates
- 1214# Peanut Meal
- 100# Elemental Sulfur (90% S)
- 50# Zinc Sulfate (20% ZN)

**GIVE SPECIFICS-POUNDS/ACRE & CUSTOM MADE  
BASED ON SOIL TEST**



# CUSTOM BLEND FERTILIZERS

- Consider cost at \$800 per ton
- Spread at rate of 500# per acre to add 60# of N per acre
- Covers 4 acres and cost is \$200 per acre
- One acre on our farm grosses approximately \$30-35,000 per acre
- **GREAT VALUE & Deals with all Nutrients**

# OUR FERTILIZER

- Spray on micronutrients
- Pre-dress with BioTelo
- Often spread by hand
- Sidedress Nitrogen: Peanut Meal, Soybean Meal, Cottonseed Meal



# COMPOST

- Can be good
- Can be bad
- Critical to be weed-free
- Good if need nutrients and organic matter
- Can be expensive
- Must be properly finished



- **Use caution for soil mixes**
- **1 to 2 year old compost best**

# SOIL HEALTH

# COMPOST

- Know your rates
- Use manure spreader designed for compost, like H&S
- Adding other types of organic matter are an option, like peat moss



# SOIL HEALTH



PEAT MOSS VS COMPOST

# BENEFITS

- Smother Weeds
- Hold Nutrients
- Maintain Organic Matter
- Source of Pollen for Bees
- Food for Beneficials
- Break up hardpan



COVER CROPS & ROTATIONS

- 90#/ACRE RATE
- BROADCAST
- DROUGHT & HEAT TOLERANT
- 100-150# N/ACRE



## COVER CROP -COW PEAS

- 90-100#/ACRE RATE
- BROADCAST
- SMOTHERS WEEDS
- ATTRACTS BENEFICIALS
- ATTRACTS POLLINATORS
- FAST: 70-90 DAYS
- PHOSPHORUS SCAVENGER
- CAN MOW



# COVER CROP-BUCKWHEAT





- Kills soil disease causing organisms and nematodes
- Biofumigant
- Kodiak or Caliente
- 15#/acre

## MUSTARDS AS COVER CROPS



- Flowering
- Chop, turn under & irrigate
- Glucosynolates
- Add compost
- Wait 2 weeks

**MUSTARDS AS COVER CROPS**



**PLASTIC OFF**

# SUMMARY

- **USE SOIL TESTS AS A GUIDANCE TOOL REGULARLY**
- **KEEP ALL NUTRIENTS BALANCED**
- **ORGANIC MATTER IS KING**
- **HEALTHY SOILS ARE KEY FOR HEALTHY PLANTS**
- **ASK THE PROFESSIONALS AND CHOOSE WISELY!**
- **WATCH NEW RESEARCH – NUTRIENT SUPPLEMENTS, SOIL BIOLOGICALS +**

# WINTER PRODUCTION



**IN HIGH TUNNELS**

# CROPS WE GROW



- Kale
- Swiss chard
- Spinach
- Asian Greens
- Lettuce Mix
- Arugula

- Broccoli



DECEMBER TO MAY

# VARIETIES

- Kale:

- Swiss chard

- Spinach

- Lettuce

- Arugula



interbor

Mustards

Asian Greens: Tokyo Bekana,  
Yukina Savoy, Vitamin Green,  
Tatsoi, Red Choi, Black Summer,  
Mei Qing Choi, Joi Choi

DECEMBER TO MAY

# GREENHOUSE SEEDINGS





## Organic Soil Mix:

4 buckets (5gal) compost

4 buckets (5 gal) horticultural grade peat moss

1 ½ buckets of perlite

4# organic fertilizer 5-3-4



\*Test soil mix for pH and salts and nutrients

\*Test greenhouse water for pH

\*Work with professionals if issues



# GREENHOUSE

# SEEDS

GOOD SEEDS ARE CRITICAL TO SUCCESS

QUALITY SEEDS

DISEASE FREE

CONSIDER HOT WATER TREATING



# GREENHOUSE

# SEED STRIPS, SPEEDLING, WINSTRIPS



Must be on special list to get imported Winstrips from Korea-ask!

# SEEDING TRAYS

- Diseases-Root Shield and Root Shield Plus
- Actinovate-Fusarium
- Biological Stimulants
- Humic Acids



TRANSPLANT  
SOLUTIONS

Water in

GREENHOUSE CARE

# PREPARE SOILS

## Subsoiler

- Deep
- Hard Pan
- Results of Growth



# PRIMARY TILLAGE

# Chisel Plows

- Fast
- Better for soil
- 2 foot
- Every year
- Different points



PRIMARY TILLAGE

# Kuhn 5 ft Rototiller

- One pass-fine seed bed
- Quality brand
- Commercial



SECONDARY TILLAGE

# DIRECT SEEDING DATES

OCTOBER 1st  
OPTIMUM FOR US  
(some years!)  
SUCCESSIVE

- Salad Mix LETTUCE
- MUSTARDS-Reds,  
Greens
- SPINACH
- ASIAN GREENS-  
Mizuna, Tatsoi, etc



WINDOW OF OPPORTUNITY  
SEPTEMBER 20<sup>TH</sup> TO OCT 5<sup>TH</sup>

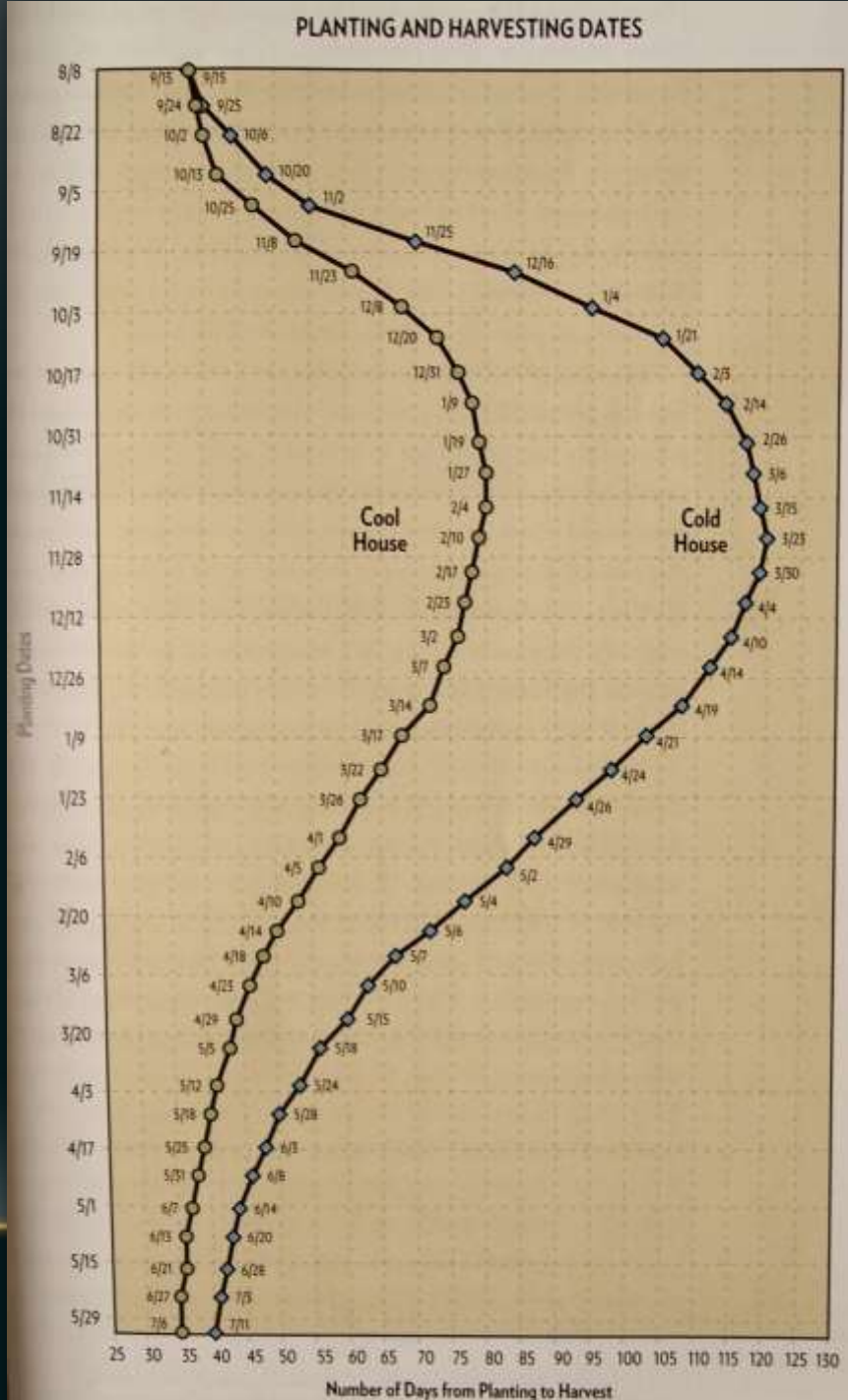


# FIND YOUR DATE!

THE WINTER HARVEST HANDBOOK BY ELIOT COLEMAN

Time of seedings are critical...Successive seedings gives consistency

Weather is a changing factor



# PREPARE TUNNEL MID-LATE SEPTEMBER



- 7 BEDS IN 30' WIDE TUNNEL
- 8 BEDS IN 34' WIDE TUNNEL
- ROTOTILL AND FORM BEDS BY HAND WITH A SHOVEL...TAKES APPROX 5 HOURS
- BEDS ABOUT 3 FT WIDE
- LAY BIOTELLO BY HAND TO SAVE SPACE

**ROCK DOWN BIOTELLO---ADD STRAW TO PATHS**



**Waterwheel axel for marking**

# PLANT TRANSPLANTS



- 5 Rows per bed
- 3 Rows of Kale or Swiss Chard with 2 rows of Asian Greens in-between

**MUST PLANT BY NOVEMBER 1ST**



**Neighbors' Rented Land Good for Hay Production  
Custom Bales processed for us**

# Mulching Benefits

- Organic Matter
- Weed Control
- Moisture Retention
- Prevents Soil Erosion
- Clean Crops
- Disease Suppression
- Workers and crates clean

Teagle Tomahawk  
Round Bale  
Bale Chopper



# CROPS ARE PACKED IN AND NEED EXTRA FERTILITY



# FRENCH INTENSIVE METHOD



## Asian Greens for Braising Mix

- Tokyo Bekana
- Yukina Savoy
- Vitamin Green

Swiss Chard and Asian Greens



# FRENCH INTENSIVE METHOD



- Asian Greens also named “Large leaf mesclun mix”!
- Start harvesting December/January...love cold
- Kale & Swiss Chard dormant till late Feb unless warm!

Kale and Asian Greens

# GO PLAY TILL HARVEST! Well..



- Rowcovers left off as much as possible to get sunlight
- Keep humidity down
- Scout often for diseases
- Monitor and set traps for rodents
- Sluggo for slugs
- Water



**LETTUCE ALL WINTER**  
❖ **DISEASE RESISTANCE**  
❖ **NOW SEED SEPARATELY**  
❖ **HAPPY CUSTOMERS**

- **New 2012**
- **Trialed Winter 2012-13**
- **Seeded 9/30**
- **Not ready until March**
- **Small plants cold tolerant**
- **No disease issues**



**SALANOVA LETTUCE**

- **Fantastic efficiency for harvest**
- **Cut 8 pounds in 5 minutes**



**SALANOVA LETTUCE**

- **Makes a great quality mix**
- **Same length leaves**
- **Can recut**
- **Slower to grow**



**SALANOVA LETTUCE**

# PERCENT USE & VALUE

Map for  
efficiency

Value per  
square foot  
high:

Usually about  
\$4-\$5



# Winter Weeding



WINTER MAINTENANCE





## WEEDING

Our Favorite: Dutch  
Push Hoe

Walking pace

Incorporate fertilizer



# WINTER MAINTENANCE



**TWO BAD CATS CO.  
TINEWEEDERS, POPPERS, ETC**

# WATERING OVERHEAD

- Good for seed starting
- Use nozzles that empty water out so don't freeze
- Out of way



WINTER MAINTENANCE

# DRIP TAPE WATERING

- Great for BioTelo beds
- Can use on all beds year-round
- Don't get row covers wet



WINTER MAINTENANCE

# HAND WATERING

- In winter—only about once per month
- Even watering
- Seed starting & Transplant watering in
- Row covers can be left in place



WINTER MAINTENANCE

- Buckhorn crates
- Window of opportunity for harvest



WINTER HARVESTING

- Keep area clean and neat—no debris
- Clean up bed after cutting
- Many re-cuts



# WINTER HARVESTING

- Weigh as we go
- Keep records!



WINTER HARVESTING



# RECORD-KEEPING

Simple spreadsheets  
or notebook:

- Seeding Records – Field space/rows
- Harvest Records – Total Crops Sold
- Timing Records for Preparation

# Aphids

Ladybugs:

- Buy Early
- Spread weekly



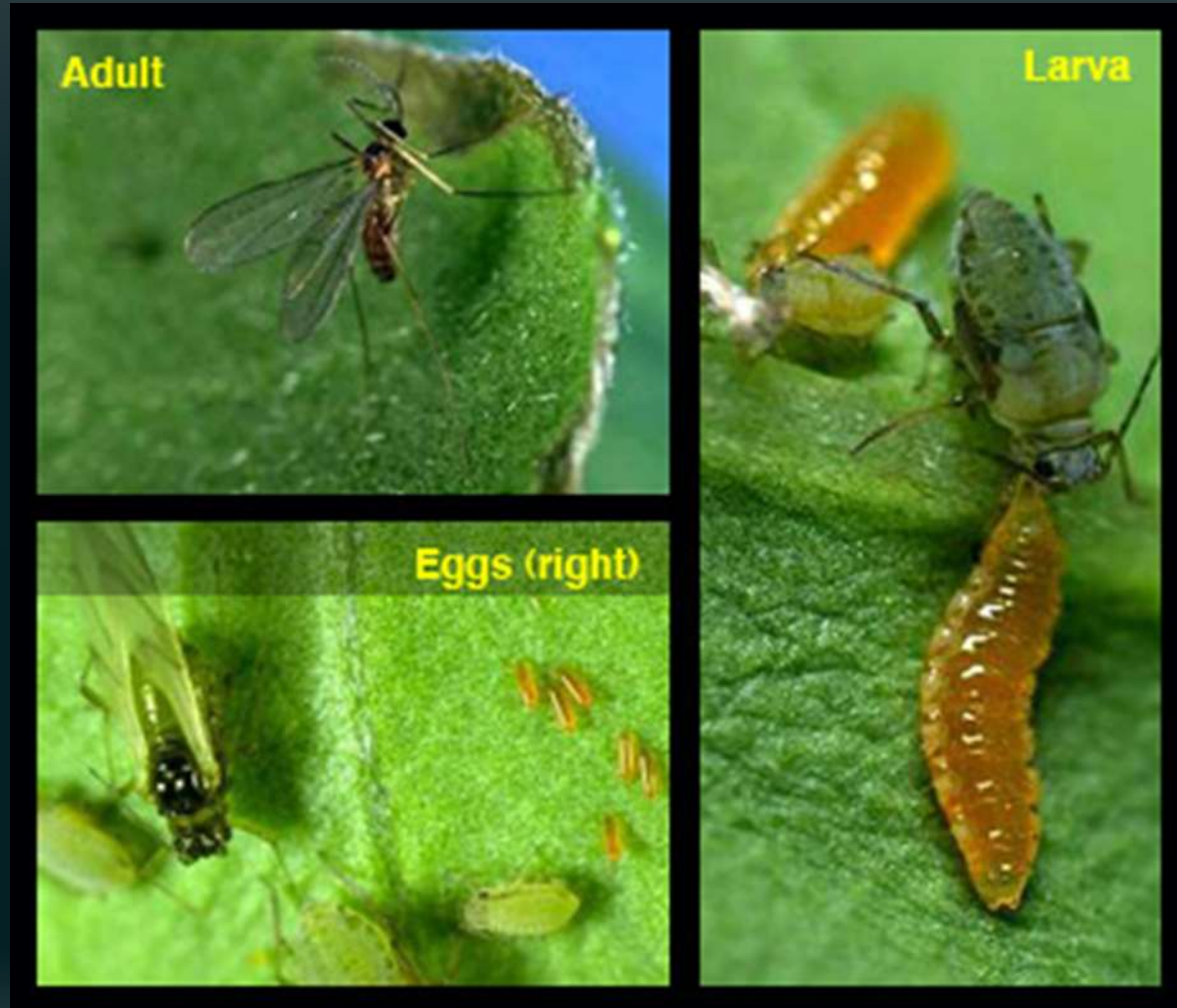
WINTER INSECTS

# Aphids

## Aphidoletes

- Predaceous mite

## Safer Soap



WINTER INSECTS

# Mites

- Ragged edges on leaves/ Irregular leaves
- Microscopic
- Predatory Mites- IPM Labs
- Aza-direct



WINTER INSECTS



**Monitor to  
catch early!**

**SPINACH CROWN MITE**



MANAGE FOR DISEASES..  
OR IT IS DISEASE?

- Venting critical-  
no moisture!
- Fans help
- Keep row cover  
dry
- Actinovate
- Regalia
- Cease
- Double Nickel
- LOTS OF TRIALS!



Downy Mildew in  
Lettuce and Greens

# WINTER DISEASES

# Fusarium & Mildews

- Root Shield Plus
- Actinovate
- Soil Serenade



WINTER DISEASES



- Venting most important!
- Temperature fluctuations
- +/- 20 degrees
- HAF fans helpful-6 per tunnel



Cladosporium leaf spot

# WINTER DISEASES



VENTS OPEN 24/7 TO KEEP HUMIDITY DOWN

# WEATHER STATION



SOLAR TEMP HUMIDITY WIND RAIN

# WEATHER STATION



Wireless 3 Stations Computer  
Davis Vantage Pro II

# WEATHER STATION



**Scientific Sales, Inc.— Repeater—Harvest time**

# DATA LOGGERS



**44 temperature data loggers with multiple parameters: Soil temp 1" down, outside temp, rafter temp, plant height, 1' up, 6' up**



- 2 Unheated High Tunnels
- 2 Ground-Heated High Tunnels
- 1 Heated Low Tunnel & 1 Unheated Low Tunnel

**3 Farms**

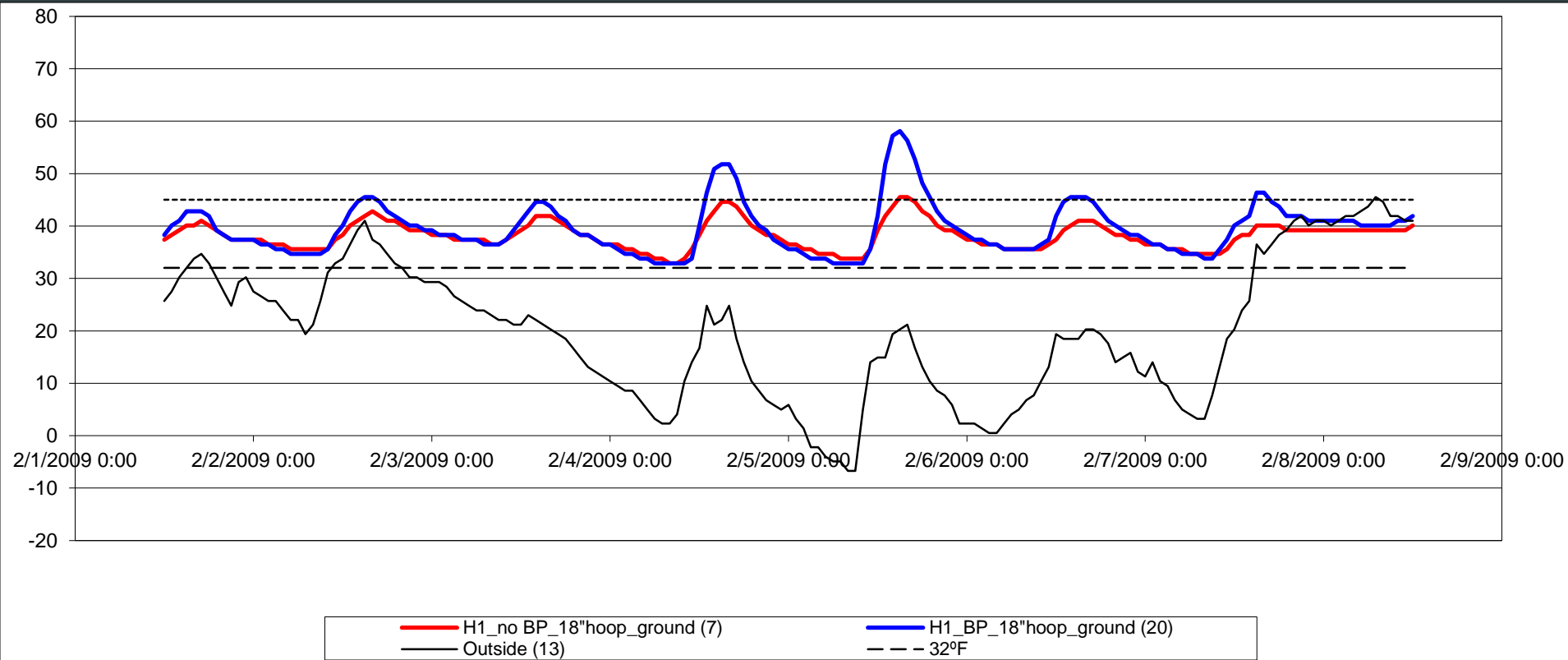




**LOTS OF DATA!!**

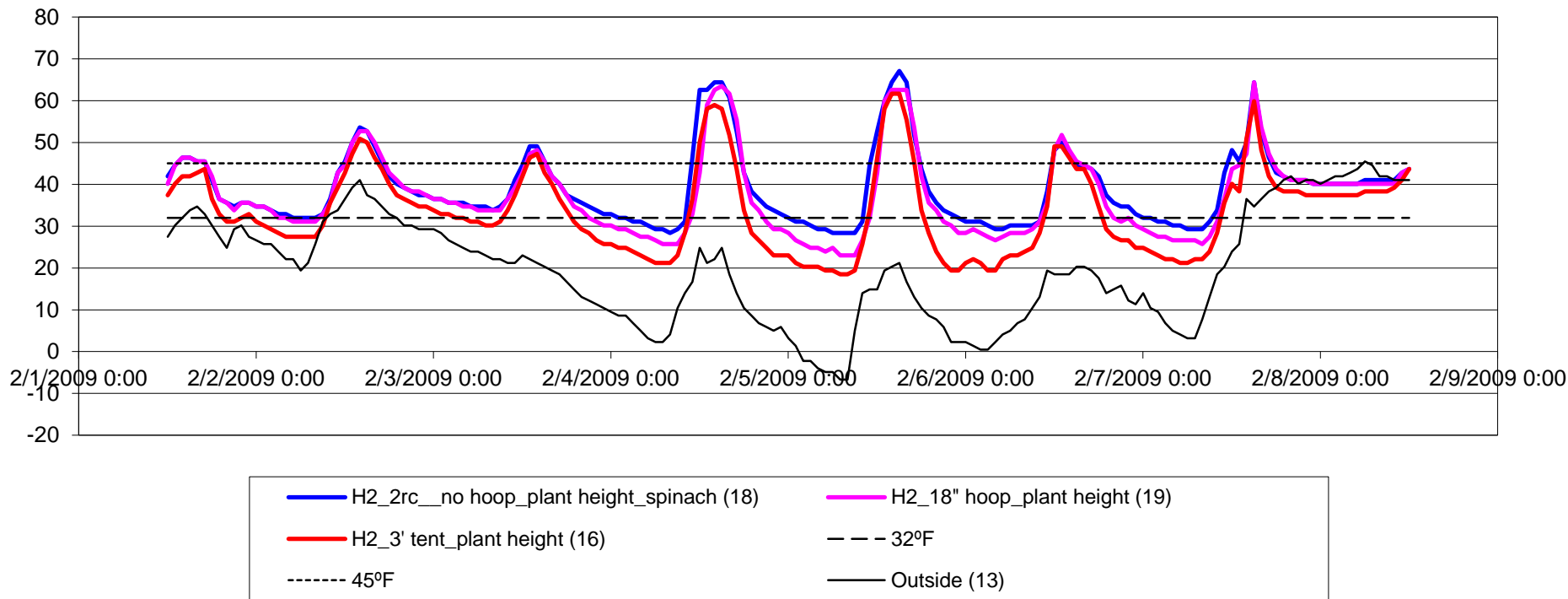
**Rowcovers varied; Tent heights varied (0, 18", 2' to 3')**





**Soil temps: Biotello plastic and No Biotello plastic under 18" hooped Swiss Chard; Outside temp**  
**Not much difference at night, but daytime advantage to warm the soil...more growth**

## Down right cold night

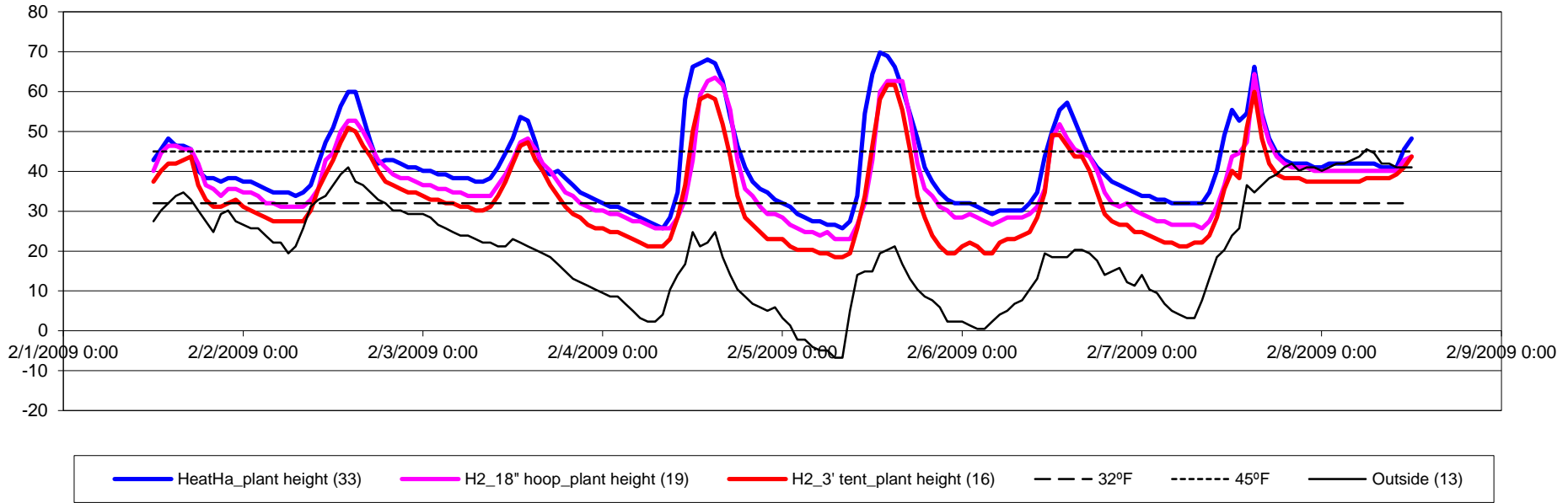


**COLD NIGHT: Plant Height (2"):**

**No hoops; 18" Hoops; 2-3' Hooped area; Outside**

**5-10 degree increase in temp the closer rowcover is to the ground; laying right on crop best for night; Daytime peak temp all about the same**

## Down right cold night



Plant Height (2") and outside temp

Heated tunnel; 18" hoops; 2-3' tent

COLD NIGHT: 5 to 7 degree benefit from heat at night and 2 to 5 degrees in the daytime.

WORTH THE COST OF PROPANE or OIL?  
Stockpile? Production yields????

**HEIGHT OF  
ROWCOVERS  
CRITICAL TO  
TEMP**

**LOWER TO  
GROUND,  
WARMER AT  
PLANT HEIGHT  
& SOIL TEMP**



# PROTECTION

## ROWCOVER

- 1, 2, 3
- Height
- Hoops
- Fold into center





**SPRING PRODUCTION**

# JANUARY SEEDINGS



- Broccoli Raab
- Happy Rich
- Beira Kale
- Asian Greens
- Salad Mix Greens

**IN THE GREENHOUSE**

# JANUARY SEEDINGS



- Broccoli Raab
- Happy Rich
- Beira Kale
- Asian Greens
- Salad Mix Greens

**IN THE GREENHOUSE**



# NEW SYSTEM



- STRIP TRAYS
- DIRECT PLANT

**IN THE GREENHOUSE**



## LETTUCE

- GH SEEDED FEB 15+
- SPEEDLING VS WINSTRIP
- TRANSPLANT IN MARCH into TUNNEL



## LETTUCE

- FULL SIZE HEADS  
New Red Fire, Green Star, Carmona, Nancy and Romaine
- MINI HEADS-Many from Johnnys
- HARVEST IN MAY
- Mini Heads make the salad mix or are \$1



**YIELD DATA**



**DECEMBER  
TO APRIL**

- Kale
- Swiss chard
- Spinach
- Asian Greens
- Lettuce Mix
- Arugula
- Turnips
- Herbs

**Increased weekly  
sales by \$450 in  
08-09**

# SPINACH



FIRST WINTER 2007  
Plastic on in January  
11 Rows of Spinach  
Gross over \$10,000  
Just one crop!



2009-10 Gross  
\$16,000 and  
\$150,000 per acre  
2010-11 Winter  
9 Variety Trial

**Winter Tunnels  
increased Sales  
\$1200 per week  
'09-10**





**SWISS CHARD: 800 square feet yielded \$4998 for one winter season**



- Perfecting the systems
- More per square foot
- Yielded \$1630 per week
- Markets building every year



2010-11

- Every year different
- Weather variables
- Diversity Important



**2011-12**

- Asian Greens 11/12 to 5/19 \$4,116
- Arugula 11/19 to 4/28 \$4,039
- Spinach 11/25 to 4/3 \$12,858
- Swiss Chard 12/17 to 6/20 \$7,440
- Salad Mix 1/1 to 6/1 \$18,484
- Kale 1/28 to 5/12 \$3,291

**TOTAL: \$50,228 Gross**  
**2 Tunnels-6 Crops!**



**TOTALS 2011-12**

Averaged approximately 120 pounds of greens weekly out of the three tunnels



**TOTALS 2012-13**

# Timing critical...Cloudiness Eliot Coleman-Frozen Ground



**Lower Yields but  
still profitable**



# 2013-14 CHALLENGES

More sun....Warm fall & early winter  
Changeable weather



January 5<sup>th</sup>  
Network-FB



**2015-16 NEW CHALLENGES**

Every year—Something new to learn to increase profits



**10 DEGREE TEMP DIFFERENCE DURING 15 DEGREE NIGHT-HOOPS VS NO HOOPS**

**Last week harvested 272# of greens**

**Total value: \$2088**

**3 Tunnels-7 Crops**



**RECORD HARVESTS**





**WINTER BOUNTY OF THE WORK!!**

# SUMMARY OF WINTER TUNNEL PRODUCTION

- **LARGE INVESTMENT**
- **FAST PAYBACK**
- **PRODUCTION HIGH—LABOR LOW**
- **MUST BE GOOD SOIL MANAGER**
- **MUST BE GOOD MARKETER**
- **MUST BE DETAIL ORIENTED**
- **IMPROVING EVERY YEAR**

# HOW WE GET OUR ELECTRICITY FOR OUR WHOLE FARM....

**SOLAR, SOLAR  
& MORE SOLAR!**

**2007-10kW**

**2012-19kW**

**NETMETERED**



# QUESTIONS ON WINTER HIGH TUNNEL PRODUCTION??

