



UNIVERSITY OF DELAWARE
**COOPERATIVE
EXTENSION**



Northeast
Sustainable Agriculture
Research and Education

Gordon Johnson, PhD
University of Delaware
Bill Owens, Owens Premium
Produce, Roxana, Delaware



Converting Retired Poultry Houses Into Indoor Vegetable Growing Facilities – Growing Strawberries



Situation

- **Over 2400 empty poultry houses on Delmarva**
 - Over 1000 houses in DE
 - 2x in 20 years



Appropriate Houses for Conversions

- More modern houses that are clear span would be preferred but post houses can work. Houses should not have curtains.
- Houses should have an intact well-maintained roof with no leaks.
- Ceilings and walls in the house interior should be in good condition with no holes and should be well insulated.
- Houses should not have areas where water collects or have floors that stay wet.



Conversion process

- Determine type of production
 - Greenhouse
 - Lighted warehouse
- Test for Salmonella
- Remove litter
- Remove unnecessary equipment
- Clean and sanitize
- Make modifications
 - Floors, ceilings, walls, doors, fans, heating
- Install growing equipment
 - Lighting
 - Benches, gutters, etc.
 - Growing units
 - Water/nutrient systems
- Establish a monitoring program



Testing and Monitoring for Microbial Food Safety

- Because these facilities were used for poultry production there is some concern of the facilities harboring pathogens that are of concern for produce food safety and food borne illness.
- In most cases, the houses have been out of production for a significant period and therefore pathogen loads should be low or non-existent.
- The one pathogen group with ability to survive in the environment for a longer time are the *Salmonella* species.
 - Pre and post testing for *Salmonella* is recommended (floors and surfaces).
- Take floor samples paying attention to any wet areas and entrance areas. Swabs should be taken from ceiling and walls.
- Another issue is rodents. Rodents can also carry pathogens of concern.
 - Active rodent infestations must be controlled prior to any conversion.



Converted house



Conversion costs for base conversion

Costs

Estimates for house conversion according to University of Delaware Guidelines:
40'x550' house

- Cost for removal of current heaters and cost for removal and disposal of all old poultry equipment \$3,000
- Litter removal and cost of excavation for top 2-6" of house floor \$5,000
- Cost for alum or gypsum to apply to floor after excavation \$1,000
- Cost for 6" of replacement fill dirt, applying and packing \$8,000
- Cost for impervious Geo textile fabric and application \$4,000
- Cost for cleaning ceiling and sanitation of ceiling \$3,000
- Cost for white poly for ceiling and covering ceiling \$25,000
- Cost for cleaning walls, repairing walls, and covering with white poly \$10,000
- Cost for new doors and vents and installation \$5,000
- Cost of removal and replacement of cool cells \$3,000
- Salmonella testing \$2,000

Total \$69,000

This cost can be reduced significantly if existing family farm labor is used to excavate and replace fill, apply geotextile, clean and disinfect where needed, cover walls, cover ceilings, and replace doors and vents



Conversion cost for indoor lighted hydroponics

- 40' x 550' house Hydroponic facility costs
- Air Circulation System \$7,000
- NFT Growing System \$60,000 (tank type systems would be less expensive)
- Growing Supplies (approx. 1 year) \$14,000
- Grow Lights \$150,000
- Total \$251,000



Current conversions on Delmarva

- Spirulina
- Greens
- Medical Cannabis
- Mushrooms
- Future Strawberries?



CONTROLLED ENVIRONMENT AGRICULTURE

Open House

LET US KNOW YOU ARE COMING!

RSVP @
[HTTPS://T.LY/ECVKO](https://t.ly/ecvko)

GROWING MUSHROOMS & SPIRULINA IN A RETIRED POULTRY HOUSE

**TUESDAY
JANUARY 16TH, 2024 FROM 1PM - 3PM**

**FARM TO FORK FRESH FARM
12798 CROUSE MILL RD, RIDGELY, MD 21660**

YOU WILL SEE SPIRULINA BEING GROWN, A MUSHROOM CHAMBER THAT HAS THE ENVIRONMENT MONITORED, & A FEW OTHER SMALLER CROPS WITH HYDROPONICS, AEROPONICS & RAISED BEDS!



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Strawberry Projects – Bill Owens, Roxana Delaware SARE Partnership and USDA Specialty Crop Block Grants

- Indoor lighted production, hydroponics
- Fruit production
- Growing propagation tips
- Vision – multiple growers with converted poultry houses growing strawberries





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Providing a Research Base for Indoor Lighted Production of Strawberries in a Repurposed Poultry House.



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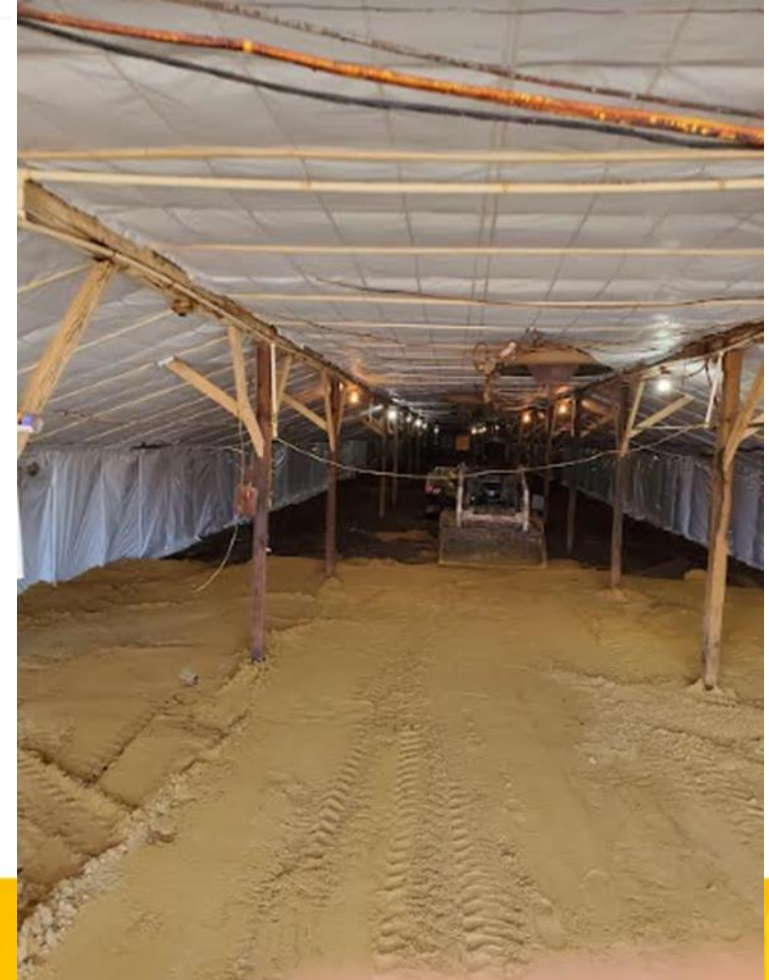
Gordon C. Johnson, PhD
Retired Extension Fruit and
Vegetable Specialist
University of Delaware
gcjohn@udel.edu



Initial House conversion

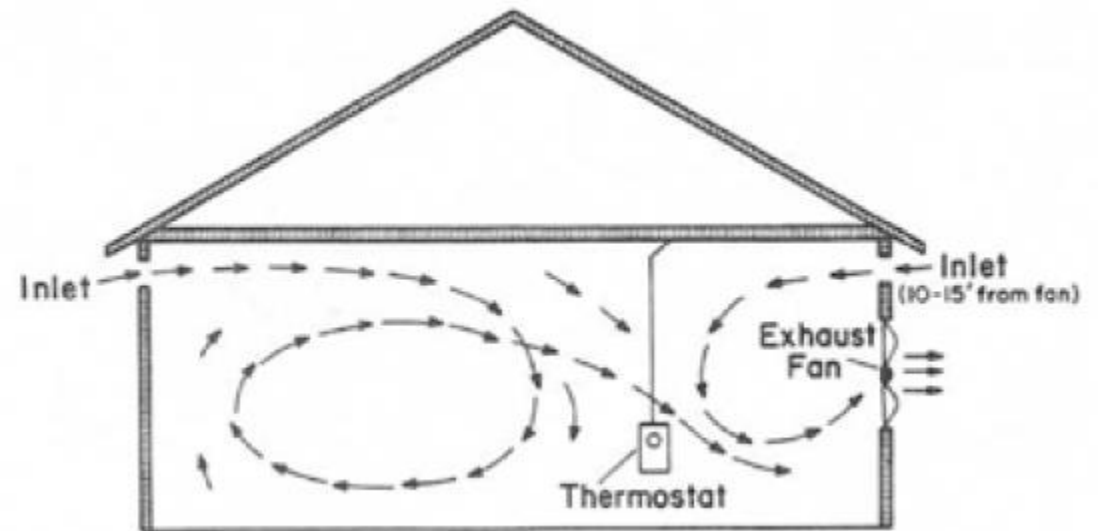
Post house 32' x 400'

- Equipment removed
- Washed, Sanitized
- Old soil removed top 6"
- New fill put in
- New Tri-ply on ceilings and walls



Heating and Ventilation – Use Poultry system

- Use existing heaters
 - Unvented!
- Existing vent boxes
 - Fresh air
- Existing tunnel fans
- Need to add circulation
 - HAV fans
 - Humidity control



Basic Setup for growing established

- Simple hydroponic system
 - Plastic drums
 - Submersible sump
 - Mixing pump
 - Standard drip lines
 - Strawberry hydroponic nutrients
- Standard gutters on posts
- LED Light fixtures
 - 2 types



Basic hydroponic system



Gutters and posts. Initially lined gutters Filled with standard greenhouse media



Lights – High PAR but white added for working. Plug-in fixtures, 2 rows adjustable for intensity 650 PAR target. 14 hours lighted.



Initial trial – 2023 Variety Trial 12 weeks February – April
(4 plants per replication, 5 replications, plug plants used.
6” spacing. First 4 weeks flowers removed

- Day neutral – Albion, San Andreas, Cabrillo, Sweet Ann, Royal Royce, Monterey
- June Bearer – Keepsake, Camarosa, Fronteras, Ruby June, Camino Real, Flavorfest



Results 4 weeks of production, 4 plants

- June Bearing varieties berry number per 4 plants Keepsake 14, Camarosa 10, Camino Real 6, Ruby June 4, Fronteras 3, Flavorfest 0
- Day Neutral Varieties Fruit production was in this order Cabrillo 30 > Monterrey 20 > Royal Royce 16 > San Andreas 11 > Sweet Ann 9 > Albion 6
- Plant health and vigor was variable across the trial with no specific trends.



Lighting trial – not possible due to house wiring but did look at light levels with variable power lights.

- The lighting trial was monitored for light levels. At 100 % power, PPFD was 930, at 75% power, 725, and at 50% 530.
- Lights could be run at 50% and still get good production



Lessons learned

- June Bearer types need different lighting
 - Short days to set
- Day neutral varieties better suited
- Lined gutters held too much water, no drainage.
 - EC tended to drift upward without drainage
 - Roots stayed too wet.
- Initial temperatures used in the 70's too high
 - Need 60's for best fruit set part of the time



Changes made

- Focus on day neutral varieties
 - Only 2 rows of June bearer kept for tips
- Plastic liner removed
- Drainage holes drilled
 - Plastic buckets to collect drainage
 - Drainage monitored for EC
- Media changed
 - Coir, perlite, peat
- Decreased low temperature to 65 F



Production trial

- Day neutrals – Albion, San Andreas, Cabrillo, Sweet Ann, Royal Royce, Monterey
- Replanted original trial with new media and drainage in April
- Fruited from June through early August
- Production declined with heat
- Runnering increased
- Pests/diseases increased
- Lighted during night to decrease heat load
- Cut back in August



Day Neutral Production Trial



Production trial results - one month

2 rows, 48 plants total

- Royal Royce = 7567 g total, 618 berries, 12.2 g/berry
- Cabrillo = 7465 g total, 700 berries, 10.7 g/berry
- Monterrey = 5301 g total, 433 berries, 12.2 g/berry
- San Andreas = 3195 g total, 307 berries, 10.4 g/berry
- Sweet Ann = 3024 g total, 206 berries, 11.8 g/berry
- Albion = 2518 g total, 204 berries, 12.3 g/berry
- Quality was evaluated by tasting and scored as follows: Cabrillo > Royal Royce > Monterrey > San Andreas > Albion > Sweet Ann





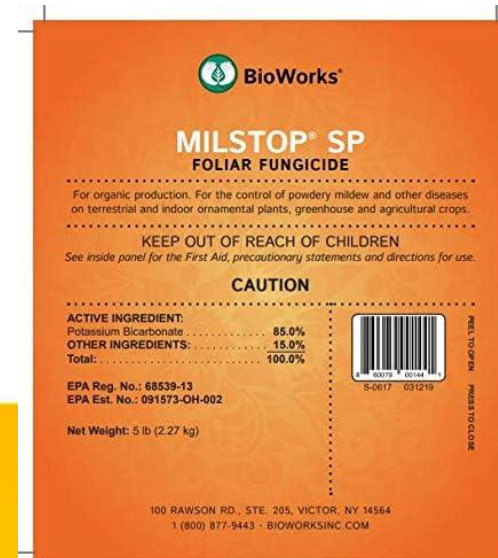
Pest issues

- Mites
- Slugs
- Aphids
- Powdery Mildew
- Botrytis



Pest Management

- Mites – predator release
- Slugs – slug pellets
- Aphids – predator release
- Powdery Mildew – MilStop, Potassium bicarbonate
 - Air circulation
- Botrytis – sanitation and timely harvest
 - Air circulation



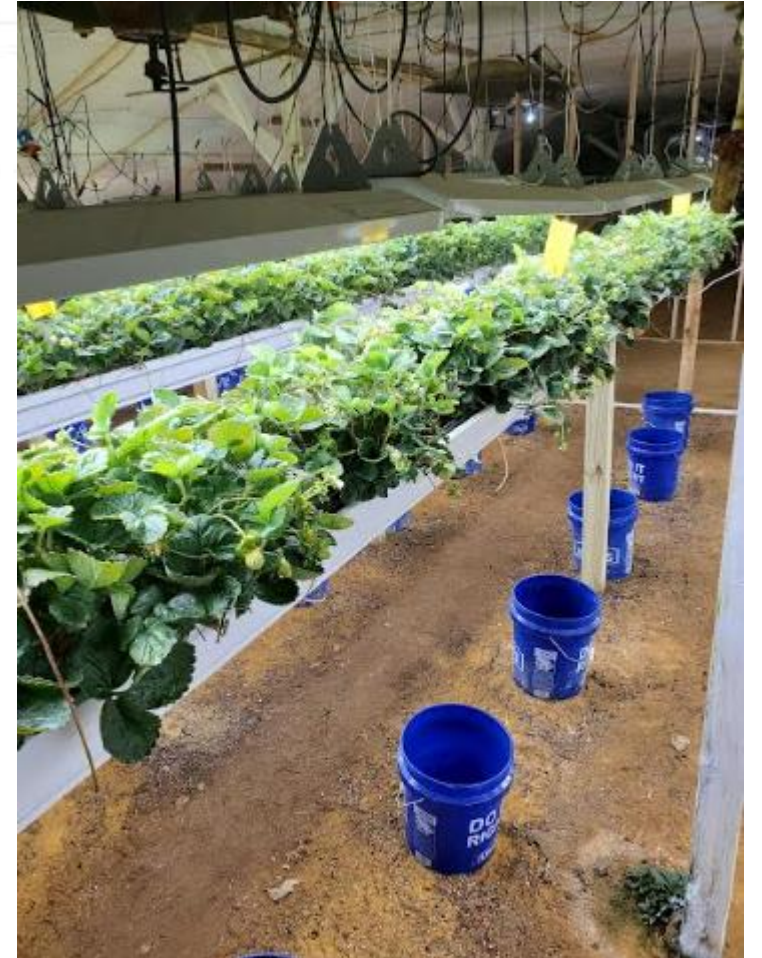
Managing temperature

- Switched to lights at night
 - Lower daytime temps
- 75° day, 65° night targets
- Future use of tunnel fans
- Air circulating fans
- Mid-July heat wave got into the 90's
 - Slows fruiting, increases runner production
- Should not be a problem Fall-Spring



Renovations

- Initially just cut back August
- Re-fruited in September
- Berry size small
- Too many crowns
- Crowned thinned in September
- Berry Size improved
- Runners a problem until November
 - Weekly runner removal
- Removed ½ the plants in January 2024.



Berry shape and size issues



Continued R&D

- More space per plant
- Allow fruit to hang more
- Concentrate on fewer varieties
- Ventilation
- Lighting



Economics best case

- Production trial showed 4 lbs/plant/10 months possible
- For a 40' x 550' house
 - 60,000 lbs. of fruit
 - \$240,000 retail
 - \$125,000 wholesale

Amortized conversion cost for 5 years

$150,000/5 = \$30,000$ assumes lower light costs.

Production costs (lighting, heat, fertilizer) \$25,000 per year

Return to labor \$70,000 to \$185,000 per house



Poultry House Retrofit Opportunities for Growing and Marketing Fruits and Vegetables – Specialty crop block grant



Objectives

Objective 1: To demonstrate how to convert a poultry house to address food safety concerns for produce production.

Objective 2: To demonstrate how to retrofit a poultry house for growing fruits and vegetables under lighted hydroponic production using strawberries, mini-peppers, and dwarf cherry peppers as test crops.

Objective 3: To demonstrate how to repurpose heating and ventilation systems in poultry houses for indoor product.

Objective 4: To produce disease indexed, disease-free clean strawberry starter plant material (runner tips) for regional nurseries producing “plug plants” for Mid-Atlantic strawberry farmers.

Objective 5: To initiate the formation of a grower’s cooperative to market produce from converted houses with potential buyers..



Why tips

- Tips are in short supply
 - Almost all tips come from Canada
 - No more NC production
 - Greenhouse is too expensive
- Shortages
- Late shipments
- Poor results
- Local supply would benefit industry



G. Johnson, University of Delaware

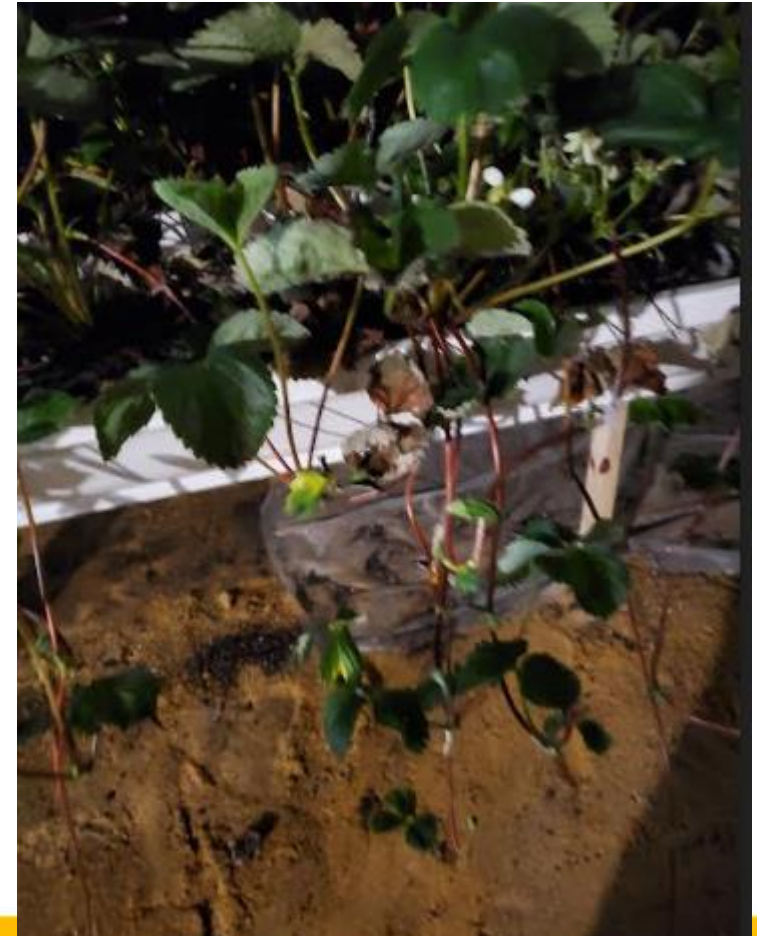


G. Johnson, University of Delaware



Tip production house conversion

- Similar base conversion
- Gutters
- Lights
- Simple hydroponic system
- Lower lighting costs
- Only need for 4-6 months



Tip production initial lessons 2023

- Late start
- Only 1/4 of house converted
- Gutters too close for runners/tips to hang
- Mite, powdery mildew a problem
- Tip vigor low
- Gutters stayed wet



What whole house will look like in 2024



Tip production changes 2024

- Multi-level gutters for tips to hang better
- Better drainage
- Better PM and mite control
- Better tip vigor
- More of the house converted



Tip production economics – house conversion from Bill Owens

- House conversion basic costs \$70,000
- Lights \$85,000
- Gutters \$16,000
- Total \$171,000
- Amortized over 5 years = \$34,200



Tip production pricing

- Electric for Jan to end of July \$25,000
- Fuel for winter \$3,000
- Nutrients, supplies, beneficials, sprays, etc. \$4,000
- help at harvest and delivery cost estimated at \$10,000
- Misc. \$6,000
- 218,000 daughter tips at an agreed sale price of **\$.22 each**
- \$48,000 for $\frac{3}{4}$ of the 30' x 400' house to break even
- Current tip cost from Canada are .17 per tip so a premium will be necessary for disease free, on time, and local



Questions?

Gordon C. Johnson, PhD
Retired Extension Fruit and Vegetable Specialist
Adjunct Instructor
University of Delaware and Del Tech
gcjohn@udel.edu
Cell: (302) 545-2397

