

Developing new, space efficient, growing techniques,
with water conservation, native fish preservation, and
increased crop yields for small farmers



Rylan Morton-Starner: Forestdale Farm

About our Farm

Provide community with high quality produce that is organically, ecologically and sustainably grown

Value water conservation, biodiversity, and healthy soil (and people!).

Vegetables and herbs, chickens and turkeys

Farmstand, CSA farm shares, and sell at the Flagstaff Community Markets and to local restaurants.



Project Overview

- Develop Sustainable systems
- Space efficiency
- Water conservation
- Increased crop yields
- Conservation of rare native fishes.



Benefits for Northern Arizona Growers

- Farms and producers in the region remain scarce.
 - limited and expensive farmland
 - Often poor soil
 - Extreme weather
- Growers need to be creative with small plots.
 - Space efficiency. High yields, intensive production, frequent plantings, intensive rotation, stacking
 - High tunnel production



Experiment design

- Tank and grow tables
- Six independent, identical, artificial stream systems
- Half with fish, half without.



- In-ground growing.
- Using our farm's standard techniques

All in a high tunnel

Tank treatments

- Recirculating, artificial stream systems, mimicking natural streams
- 200 gallon tanks
- Pump and bead filter for biological filtration
- Oxygen diffuser
- Two-tiered grow tables
- Y-valve and filter for watering



Grow Table planting

- Standardized potting mix
- Standardized seeding
- Planting every week on tables, until full production
- Utilize space under tables for germination
- Harvest once at maturity, and succession plant
- 6in pots versus 4in pots.
- Water usage



Native Fish Preservation: Roundtail chub (*Gila robusta*)

- Help protect an important native species in our region
- Help achieve local and state conservation goals
- Approximately 600 juvenile chub/tank
- Fed standard hatchery rations
- Monitored water quality
- Pit tag fish to record growth



In-ground Growing

- Intensive leafy greens production
- Direct seeding. Standardized seeding
- Application of aged compost prior to planting.
- Harvests throughout season at maturity
- Monitor water usage



Results. Kale



Kale pounds per square feet over 35 days (preliminary numbers, rough draft)

	#/sqft
in ground	0.24
4in control	0.13
4in with fish	0.34
6in control	0.15
6in with fish	0.39

Results: Salad Mix



Salad pounds per square feet over 45 days. (preliminary results, rough draft)

	#/sqft	
in ground	0.47	
4in control	0.05	
4in with fish	0.36	
6in control	0.08	
6in with fish	0.53	

Results: Arugula



Arugula pounds per square feet over 35 days (preliminary results, rough draft)

	#/sqft	
in ground	0.38	
4in control	0.04	
4in with fish	0.24	
6in control	0.06	
6in with fish	0.32	

Results Water Usage

Water Usage. Averages for June-Aug in gallons per square ft per day. (Preliminary data, rough draft)

in ground growing	.11 gallons
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4in full grow table	.12 gallons
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6in full grow table	.10 gallons
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Benefits for sustainable farming

- Increased diversification and productivity for small farms.
 - Fish and crops. Intensive growing
- Water conservation. Water is recirculated and reused
- Reduced fertilizer use
 - Fish waste is utilized as fertilizer





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