TILAPIA

- No tilapia for sale in the USA in 1970's
- You can raise tilapia with NO fish meal (less than 5%). One wild fish was used for feeding food fish
- Tilapia lives low on the food chain – doesn't rely on fish meal protein
- Easier to certify an organic contained system
- Fewer antibiotics
- China leads tilapia production
- Asia – S. America – Egypt – Middle east
- US has bad climate for outdoor tilapia
- Carp is #1 in China. Tilapia is #2 and surpassed farm raised salmon production
- Fish consumption of seafood in the US: 1 – Shrimp; 2 – Tuna; 3-Salmon; 4-Pollock; 5-Tilapia
- Americans eat 1.19 pounds of tilapia per person per year
- Omega 3 is good for brain and neuro development
- US imports a large majority of tilapia because of the increased demand but domestic production remains at a constant figure since the 1990's
- We produce 20M pounds and 450M pounds are imported
- One billion pounds are consumed per year.
- Tilapia: grapes, wheat, olives, barley, sorghum, melon
- Oxidation from bad packaging. Needs to be vacuum sealed
- Lots of Value Added products – packaged meals
- Prices/kg remain constant. From 1992-2008 prices rose from $5-$7
- Here 2/3 of the profit is on plants; tilapia is more of a nutrient source
- There has been improved farming, processing, packaging, and safety with minimal increase in price.
- Local marketing: YES. Fresh tilapia in Chicago sells for $14 pound.

CULTURAL PRACTICES FOR RAISING TILAPIA AROUND THE WORLD

- For the pure species the Nile Tilapia is desirable although it doesn't do well in California
- GIF: genetically improved fish grow faster
- The pure species in Mozambique is a darker color not as appealing as the Caribbean variety. It grows in salt ponds with twice the intensity of sea water
- Red Tilapia: from 1969 is a Taiwan strain
- Florida Red is not as hardy as the pure original species. They die at low oxygen levels
- Pond raised tilapia have high parental care and high survival. High breeding lessens the size. The stocking rate is important
- Pond culture equals dirty harvest
- Israel automates all the way to fried fingers without any human touch. Chicken coops are built over ponds so the fish eat the chicken feed and feces fertilize the pond and algae.
- Blue/green algae can give inconsistent flavors.

- The Aquaponic System purges flavor inconsistencies. Purge for 4 days with clean water. Easier on tanks
- Bioflac system doesn't result in off flavor
- Ponds are covered with mesh to discourage birds
- Chicken and pig manure supplies the pond but the production rate is not that high
- Polyculture: manure pond – multiple fish species. Silver carp filters algae
- With cage culture you may need more aeration – rainstorm – flush pond and algae – grass dies, oxygen depleted
- 30 cages = 10K fish. 300 fish/4 m^3 cage to 300/m^3
- Salt water can bring parasites. Parasites die at half strength fresh water with 18 ppt salinity
- Grain meal and grass bits are poor quality food
- Cage culture can harm the environment due to the waste falling out
- Multiple cohort systems can be difficult as there are inventory issues
- Difficult to remove solids in rectangular tanks
- One pump

TILPIA BIOLOGY

- 1.5 pounds of feed required for a 1 pound fish – UVI is an OK rate but produce adds money
- Feed ratio under 1.0
- There is no organic feed standard
- Yy + XX = xy = mostly male birth population
- Yy is super male and $10K
- Some customers do not like male hormone treatment.
- Tiltech: Steve Abernathy

WATER QUALITY

- Plants are used to clean fish water
- Fish minded vs. plant minded
- Balance – no bells and whistles. Simple=good
- Analyze water
- We do not want algae in Aquaponics, just fish. Promote photosynthesis with algae & algae removes oxygen from water.
- Fish go to the surface to get air/oxygen
- Watch your animals and use less automation
- Aquatic Eco makes meters and supplies
- Refractometer – Brix readings measure the sugar content in an aqueous solution
- ppm=mg/L hydro vs. fish
- ppt=salinity
- For pH: plant 6.0; fish 8.0; so compromise at 7.0

- Toxic anemia: nitrofying bacteria converts nitrites to nitrates
- pH is important in regulating bacteria
- If the pH is low, then ammonia will be at a safe level
- High pH means ammonia is at a dangerous level
- For fish, if the pH is low you can use sodium bicarbonate (baking soda) to raise pH
- Aquaponics (plants) do not use sodium
- Calcium, potassium, and iron are hard to get with only fish food. Base additions are Ca and K

TOUR

- Three pounds of feed per day
- 2 20′ x 5′ pads with 3000 gal@UVI. 500 would be more appropriate
- Square tank with a clarifier; must build by hand with a 60 degree slope at the bottom
- Swirl separator must have a high flow
- Male tilapia help clean solids separator
- UVI grows Chinese water spinach in a raft system – 1 acre yields 50K lbs.
- Bead filter clogs with organic matter
- 20 gal/min flow
- Nursery vs filter. Rotating drum gets sprayed to unclog the float valve; biofilter nitrite to nitrate – KMT media; houses nitrifying bacteria as it lives in the media caldus
- Biofloc: quick tank; mesh metal with liner $2,200 for 1800 gallon tank; rotating water; bacteria live in water; regulates food; pH 7.5. Calcium chloride increases H; feed twice per day.
- Ammonia to nitrite to nitrate is an acid process
- 600 mg/L of TSS (total soluble solids)
- Not for greenhouse, for outside.

AQUAPONICS

- *Pythium* slows plant growth by 40%
- Use Lowes blue foam for rafts and paint the top white (inexpensive)
- Misting helps lower the temperature; in the greenhouse that can encourage fungus
- Go dirty: there are beneficial bacteria; sterile conditions can be bad
- Spray with BT (*Bacillus thuringiensis*) for caterpillars and moths
- Pesticides kills bacteria
- Media: vermiculite and coir; no peat as it is not sterile and has spores
- UVI system: 100 gal/min split 3 ways; 6″ pipes underground
- 3 hours will then cycle water which will help purify before returning to plants. Similar work of Biofloc; $40-90K for system and a $20 case of lettuce
- NFT requires more clarifiers
- Cucumbers, okra, cantaloupe; no pith

- Herbs = ten times the money of fruiting plants
- No value in algae
- 1.37 hours of water retention in fish tank
- 2,000 gal for 600 male tilapia; in 24 weeks they can grow to 1.8-2 pounds
- 7 fish per cubic meter
- No rotation with flow needed here
- 500 mg/L TSS is good. 375 is better

DEVELOPMENT OF THE UVI AQUAPONIC SYSTEM

- Too much organic matter in media is secondary ammonia
- No calcium in Styrofoam vs. gravel
- Supplement iron. Not in fish food. Ca, K, and Fe are crucial
- 10 Kg/m of feed=2000 mg/L
- 30% shade cloth is too much; need more light.
- BT
- 6" of water live return pipe to system. No 2" pipes! 2" pipes clog easily
- No mercury float switches
- Raft system – doesn't need biofilter most of the time
- Orchard netting or clarifier to remove solids
- No protein foam for Aquaponics
- Tea colored water is good; from feed to tanic acid – a good insect barrier
- Crystal clear water is not the best
- Harvest produce every 6 weeks @ UVI @ harvest lower feed rate
- Level nutrient uptake as it is necessary for plant and fish health
- Microscreen drum filter to remove solids
- Does not remove dissolved solids – bacterial food
- Don't want to remove solids too quickly or else they will not break down and can result in nutrient deficiency
- Lettuce (not head lettuce) at 4 weeks - $20 case; $6 case wholesale=no profit
- Raft – 2' spacing for air stones
- Zooplantkton and snails are possible threats; use tetras and red ear sunfish to control
- Slow reproduction rate is good
- 2' walkway; 4' wide bed
- Ca(HO) and KHO change pH and supplement calcium and potassium
- Staggering growth can reduce stresses of nutrient deficiency

TILAPIA BROODSTOCK MANAGEMENT, BREEDING AND FRY MASCULINATION

- 75 grams is a breedable size
- 50 grams – difficult to sex but ready to move to production
- Oviduct is slit across genital apilla
- Good eggs sink; dead float
- Tilapia fingerling production in recirculating systems and Biofloc tanks
- Aquaponics: 4 tanks; 2 nursery tanks
- Fixed feeding schedule can lead to waste feed but can save on labor (1 min. fixed or 30 min. ad lib)

WATER QUALITY

- Systems are naturally moving down – acid
- Only need pH to go up
- Nitrification releases H = acid; naturally down
- Hydro is opposite
- Alkalinity: if you maintain 100 mg/L as $CaCO_3$ – buffering capacity
- Ammonia – nitrogen - TAN = Total Ammonia Nitrogen.
- The pH base increases ammonia; pH9 could be toxic
- Nitrate is preferred plant food
- Denitrification – lowers N when flowering
- Feeding builds ammonia – bacteria forms and changes to nitrate; don't buy it as it happens naturally
- NH_3 is toxic. NH_4 is not
- Need to know ammonia level before bumping pH up
- Fewer plants results in more ammonia
- Need to remove ammonia; stop feeding bacteria removes it as well
- pH, DO (dissolved oxygen) and bacteria all affect ammonia. Ex: snails eat bacteria = BAD for RED SUNFISH
- Nitrification: ammonia to nitrite to nitrate
- Fixed film filtration – slime on wall equals bacteria
- Nitrite to Nitrogen.; if too much stop feeding
- Nitrate to Nitrogen

DENITRIFICATION

- Dump water
- Plant
- Promote no oxygen with anaerobic bacteria
- Stop feeding fish
- To promote P uptake at the flower

- Not cleaning orchard newts for one week (regular cleaning vs. 2 times per week) makes anaerobic zones and bleeds off as gas (3-4 days)
- Orchard nets house bacteria to clean dissolved solids (clarifier removes big solids)
- Can run water through troughs full of anaerobic sludge. Goes in high and comes out stripped. Sludge takes time to build
- Check schedule
- pH – 1500 g raises 0.1 in UVF system. pH goes up a little every day
- Do – Aquatic Ecosystems helps with pump information. Monitor when problems arise. Pressure wash air stones weekly
- Monitor ammonia, nitrite, and nitrate monthly
- Alkalinity – monthly high buffering capacity; helps to not adjust pH
- Plants with quick turnaround (4 weeks) are more economical (such as lettuce)
- Low solids and salt in well water or river (parasites, ozone) is OK
- Solar sterilize
- Tilapia are resistant to disease
- Foreign fish bring disease; need to quarantine for one month
- Tilapia eat roots – only females
- Start up time: it takes 5 weeks to acclimate after you build; four weeks to grow and they can be harvested at 9 weeks
- Pith – root fungus dormant at low temperatures. Below 27 degrees C should be safe. What crops are resistant if temperatures rise? Cooler is more economical
- Avoid NaCl for Aquaponics; OK in Biofloc. Ca(H) and KHO are good
- Fe, Ca, K: usually add to rainwater.

IRON (Fe)

- Chelated agent: DPTA iron better; EDTA iron, not better
- DPTA more absorbable @ 7.0 pH
- 2 mg/L
- Deficiency results in yellowing plants
- 2272 g Fe bumps 2 mg/L – every 3 weeks for $25
- Add a degassing tank which goes straight to the plants. Aerated heavily. Tank is divided simply for ease of separation
- Algae is good in BioFloc; bad in Aquaponics
- EC: 0.4 seems low but not in Aquaponics. It's low because food is added daily; hydro is added weekly so EC must be higher
- In Aquaponics, nitrites are toxic. Stop feeding only solution. Add store bought bacteria too. Use water from existing tanks to jumpstart bacteria. Also add bioballs
- pH – feed in the morning; adjust at noon

EGG COLLECTING

- 2 weeks for conditioning
- Empty mouths every 5 days; only eggs. No age mismatch
- Gently crowd fish in hopper with net
- Tank full of adults; 3:1 female to male
- Only air stone and light food will maintain health
- Male bigger with open mouth
- Female has clamped mouth
- Net fish – dip head in water through net. Eggs fall out
- Fish can survive 30 minutes out of water
- Open mouth and gills to flush eggs out
- Filet glove is helpful
- 4" to 6" pvc pipe sections make safe houses for females
- Good eggs sink. Flush out grass and misc. stuff
- 4 days until eggs have eyes.

SEXING

- Dye "crystal violet"
- Female catches spec of dye at oviduct
- Male will now show spec @ inside of papilla (urethra)
- 20g smallest
- 50g-200g ideal
- Stock hopper w/1000 microns – hangs above and in the tank
- Nursery only gets aeration and handful of food. Clean tank @ 1 year
- Breeders stay the same for 1 year
- Nursery has low population so does not require clarifier. 100 fish and only 1 air stone
- 1/250 gal
- 750 – 20'diameter; 20K gal (30 x 20') big tank
- 5000 fish need 50 pounds of feed per day
- Require clarifier
- 3000 gal = 12 x 4' common tank

PLANTING AND HARVEST

- UVI cuts basil back to 3". Change plants every 2-3 months. Genovese: pesto $20
- Kale and mustard greens = aphids. Impede is a safer soap
- Tarragon and tilapia
- Cantaloupe is not economical. Takes 2-3 months and yields few fruit; 12/raft

- Wax box - $2 and can't reuse
- Don't spray board bottom – good bacteria there
- Cleaning involves spraying and drying for a week
- 1 7/8" to 2" cup – just drop start and plug in cup
- 1 raft of lettuce - $25 per case – 24 per case
- Count 10 fish, put in a basket and weigh
- Frankie runs the farm
- 1g – sex reversal
- 40-50g reach nursery capacity
- Production uniformity, remove slackers
- Grading and culling: 40-48 grader = 40-70g per fish

NURSERY

- Double pipe in the middle
- Notches in bottom of larger pipe only allows dirty water to swirl out of the bottom
- Drum catches solids
- Biofilter converts ammonia and nitrates into nitrites
- Turn off flow, remove large pipe and cap smaller pipe (no back flow)
- Pump water to empty tank – no waste then leapfrog water and tanks
- Grade for desirable size. Small stay in tank to grow; graded move to different tank
- Zooplankton and phytoplankton on roots prohibit oxygen
- Temp and species
- Species and production and spacing
- Can space tighter than when grown in soil
- Cleaning nets promotes nitrogen. Basil 2 x per week
- Crops: harvest greens at the bottom; Nasturtium; tropical flowers; trellis beans; peppers (small ones grow very well; okra is hard to harvest; study insects
- **FOR PLANT PRODUCTION IN AQUAPONIC SYSTEMS YOU MUST HAVE A MARKET FOR YOUR PLANTS**

FISH NUTRITION

- Protein and amino acid = flesh
- Poor quality protein will be burnt off
- Demand feeder is bad
- Oxygen levels go down after feeding. Used to metabolize and digest food
- Buy food in 3 month supply or by expiration

BIOFLOC

- Feed fish and fish effluent and sun = algae and air = bacteria
- Bacteria creates floc which break down fish effluent. Clarifier to remove solids
- 30 kg feed: 1 kg base
- Geotextile vs. burlap
- Optimum feeding rate is 60-100 g/m^2
- Remove solids ASAP – net
- Frequency of cleaning bacteria off nets controls nitrogen
- If pH holds and doesn't decrease for an extended length of time look for anaerobic zones of denitrification within the system
- Important to be continually adding base Ca(H) and KHO also as supplemental nutrients
- Nets in degassing catch fry before water goes to plants
- Protect bottom of clarifier when installing with 5 gal
- Heat exchange if necessary , near sump

ENVIRONMENTAL CONTROL IN AN AQUAPONIC GREENHOUSE (NELSON AND PADE)

- Greenhouse controller
- Generator
- Radiant heat
- Water quality test early
- 20-32'/ narrow – snow/wind/ 40-50'

PROCESSING AND MARKETING

- Localvore/Locavore: those who shop/buy/consume locally or local food fare
- Processing regulations – certify online HACCP
- Market industry too, not just the product

PLANTS, PESTS, DISEASES AND TREATMENTS

- Pesticide – is it toxic to aquatic life? It cannot kill the bacteria
- Pythium: probiotics can combat – "guardian angel", BioBrand. Can be expensive
- Crop: identify pest before spraying
- Ants farm aphids. Use ants as an indicator. Work together. Ants don't make aphids go away. Kill both.
- Insects stay away from high brix value. High sugars will ferment inside and kill insect. Surfactant and blackstrap is a high sugar spray. Insects don't attack healthy sweet fruit
- Can use hot pepper spray and other organic methods.
- UV trap-like hospital. UV and sticky trap

MISC:
Hydro-Gardens catalogue

BUDGET

- Sensitivity Analysis. Inputs and costs of variables
- Optimization of crops and space
- Schedule

Nam Sai Hatchery in Thailand. Buy hoppers here. 5% of US cost Also sell nets. Water tank method for pressure increase