INDOOR SHRIMP FARMING WORKSHOP



# OPTIMIZING FEED PROGRAMS FOR PROFITABILITY

Craig L. Browdy
Thomas R. Zeigler

# Profits

"Many receive advice, only the wise profit from it"
Publilius Syrus

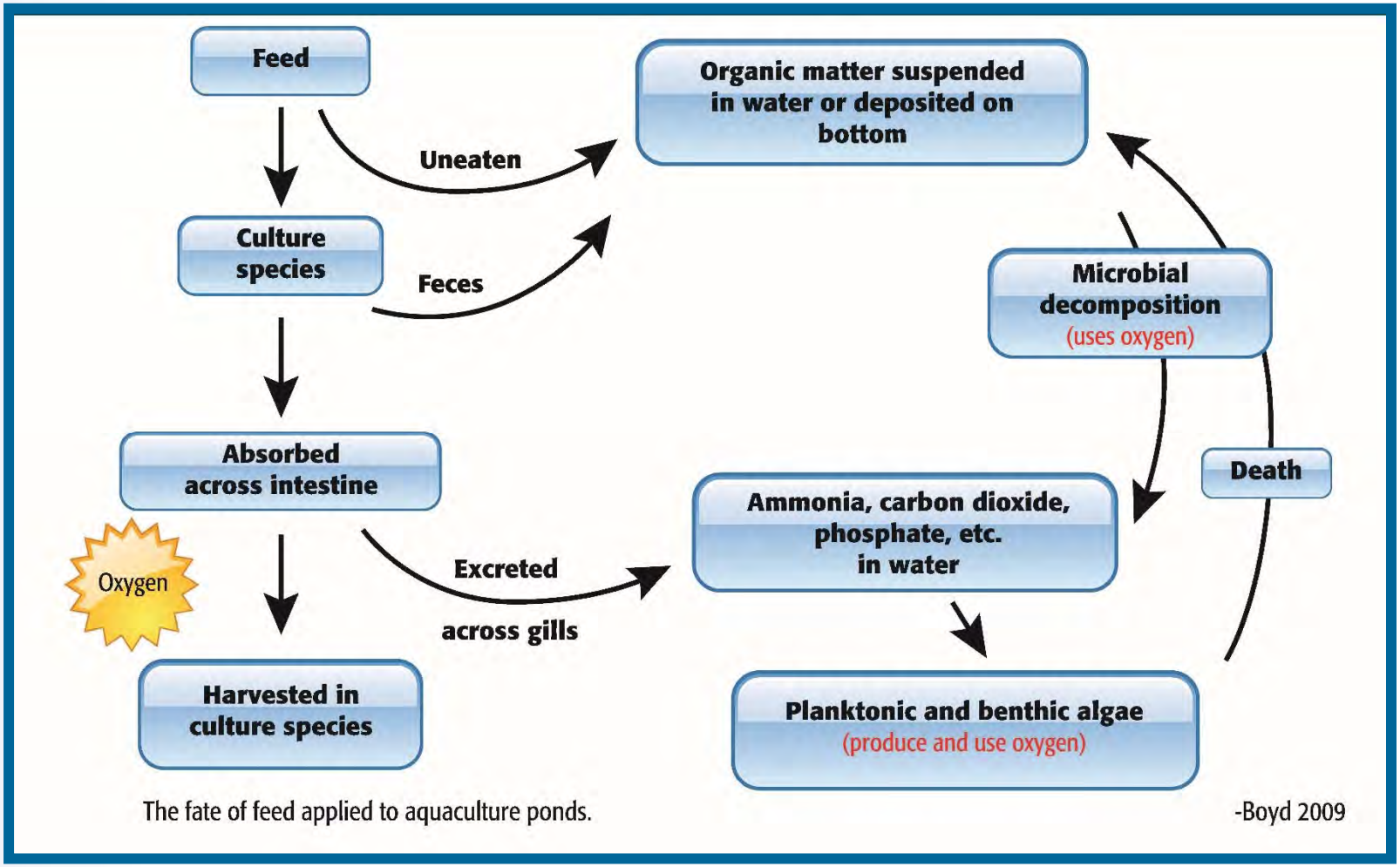
- Profits are much like breathing
  if we don't breathe we are dead
- If we don't achieve enough profit
  for the risk we take, we are also dead
- Profits are a risk premium we need as we commit today's definite resources to tomorrow's uncertain return

# The Keys to Success

**One of the most fundamental keys to successful, profitable shrimp culture:**

## Feeds and Feed Management

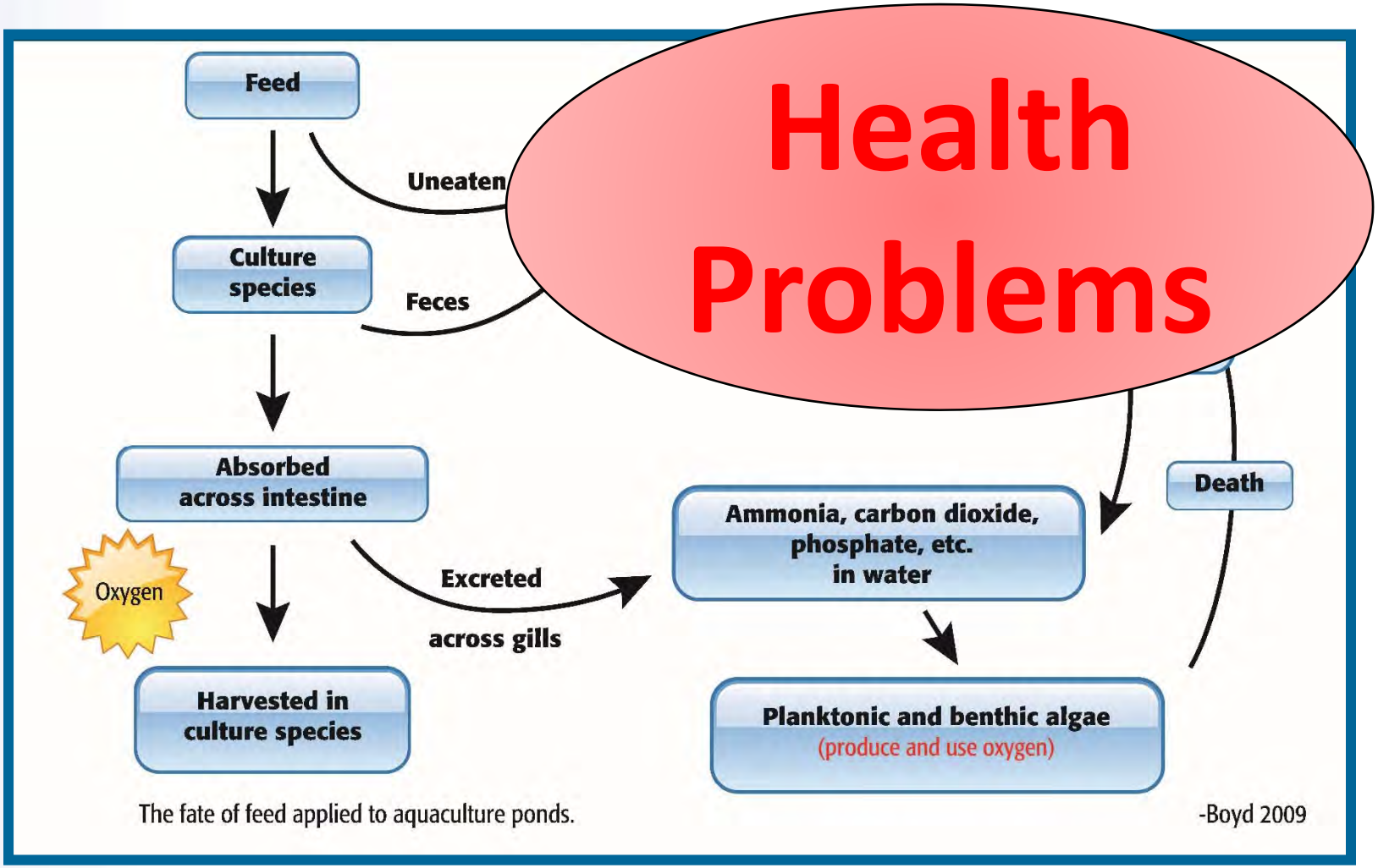
# Feed Drives the System



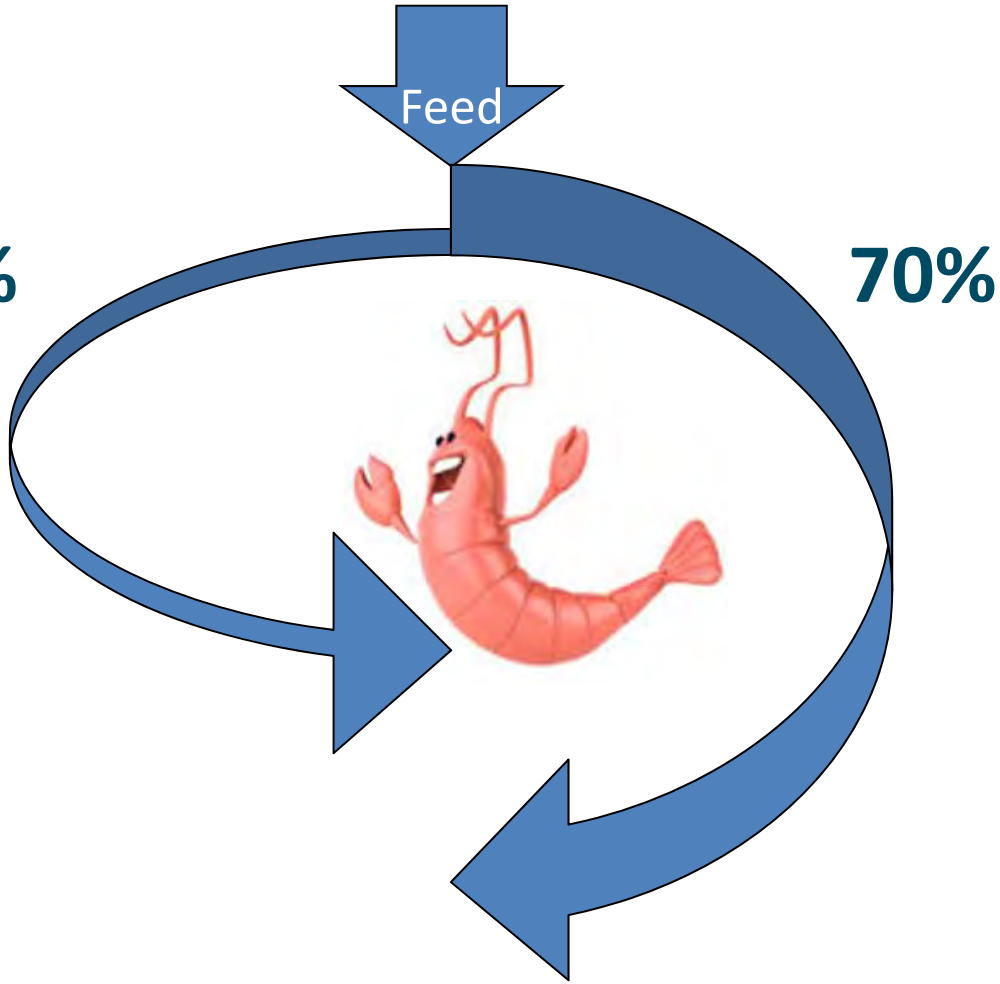

The fate of feed applied to aquaculture ponds.

-Boyd 2009

# Feed Drives the System



# Maximize Nitrogen Assimilation




# Precision Feeding

Precision Feeding Concept:

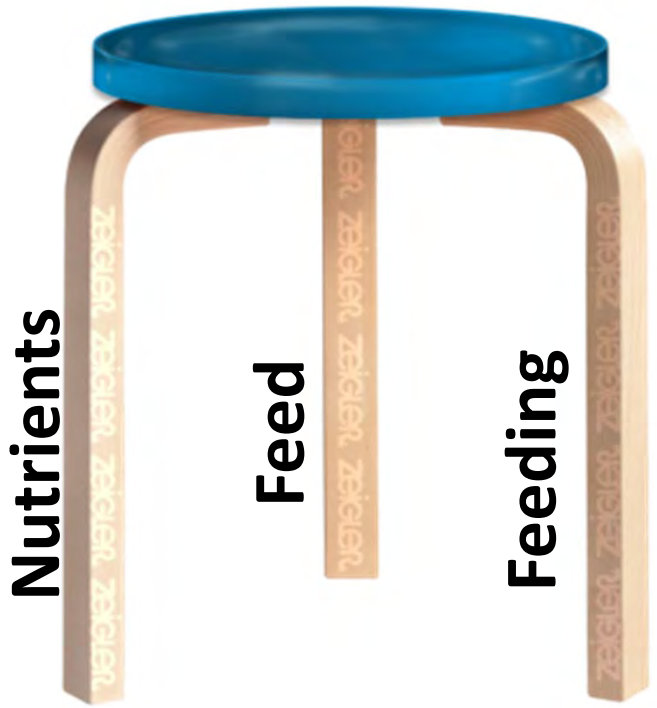
**Provide each Animal with:**

- the exact quantity of feed that it can consume,
- when the animal is ready to consume it,
- the exact nutrition that the animal requires,
- the correct feed particle sizes and optimum texture,
- In the location where the animal is located

**“With the objective to optimize the desired results”**

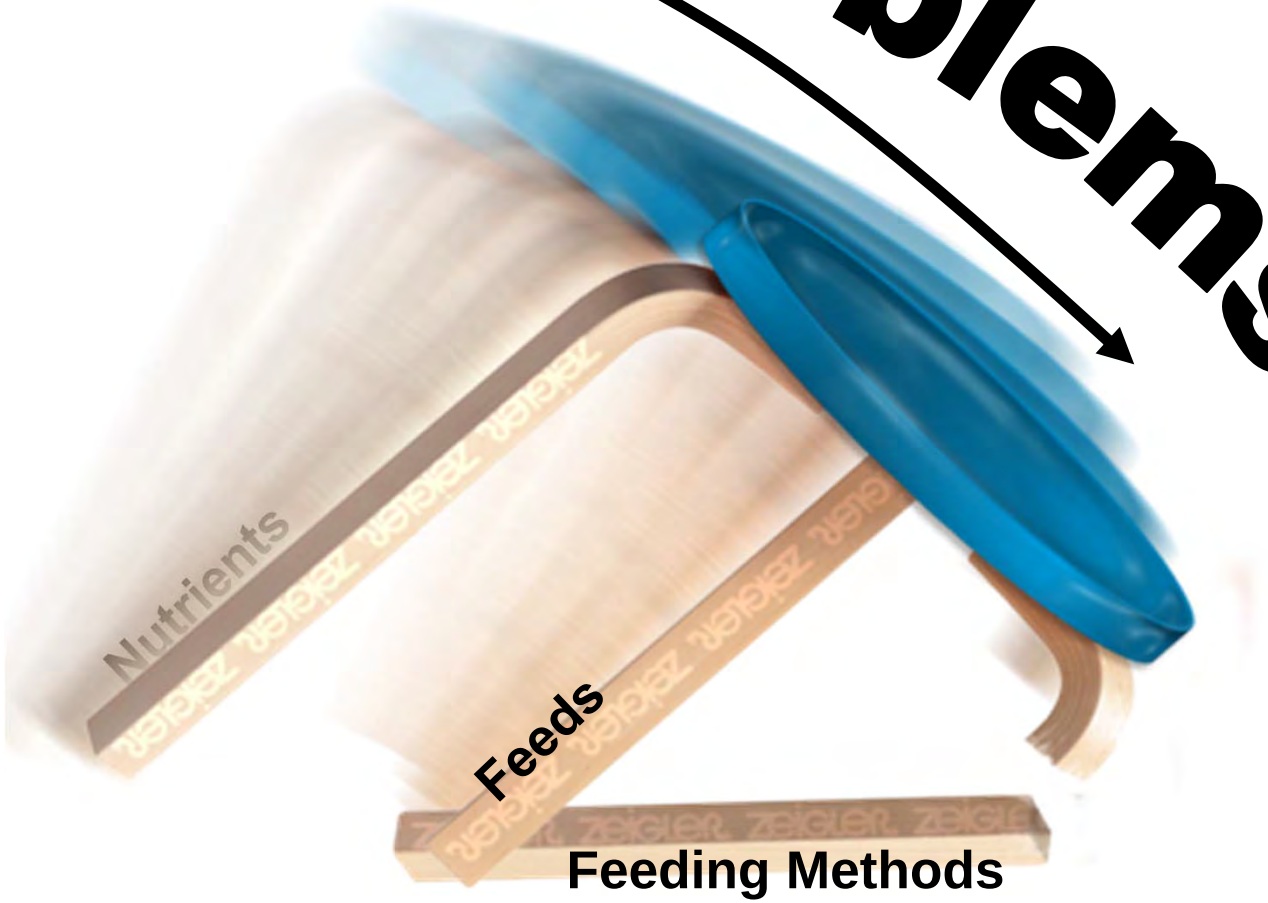
# Complete Feed Program

- Formulation
- Manufacturing
- Feeding Methods



ZEIGLER
nutrition through innovation

# Problems



# Diet Formulation

- Specialized according to system and life stage
- All required nutrients in correct quantities
- Concentrated dense balance of essential nutrients
- Palatable, very digestible
- Void of toxins and anti-nutritionals
- Support health
  - Immune system balance
  - Stress management

↑ Nitrogen conversion efficiency

↓

↑ Growth

↓

↓ Water quality problems

# Aquaculture: The nutrient conflict

**Limited Aqua nutrient supply from raw materials**

- Limited raw materials from marine origin
- High prices for protein and lipid sources
- Variable quality of raw materials

**Increased nutrient requirements**

- Increasing total aqua production and lower margins
- Genetically improved faster growing strains
- Better farming/Higher yield expectations

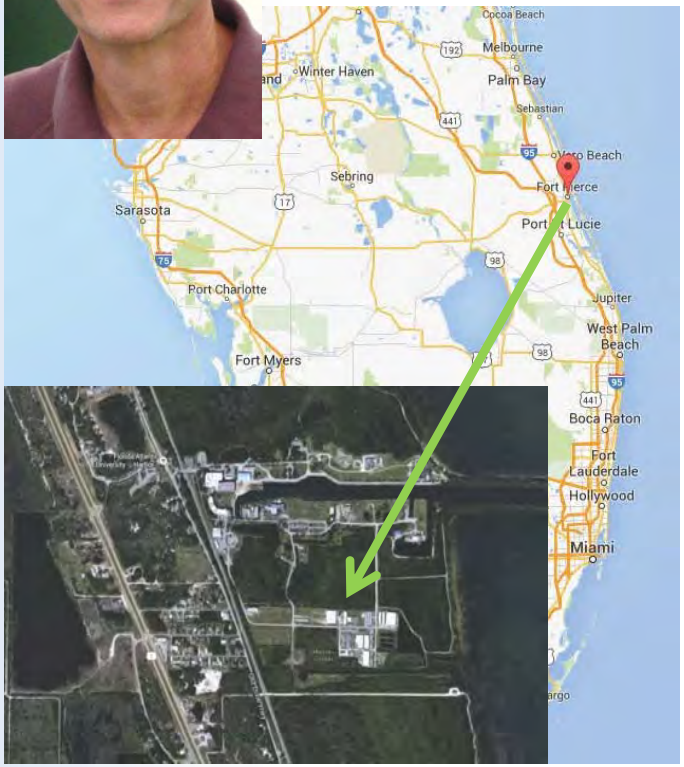
Solutions demand a better understanding of nutrient requirements, digestible nutrients in ingredients and nutrient supplementation

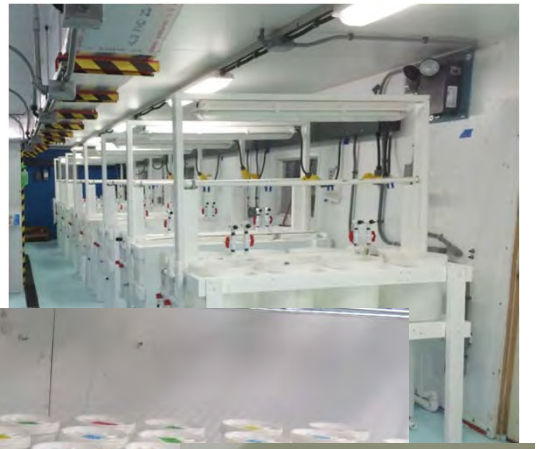
# New Tools Beyond the Basics

- Better assessment of ingredient digestibility, palatability, nutrient utilization
- Experimental systems for testing species specific requirements and for testing different life stage requirements under varying environmental conditions.
- More accurate and faster assessment of raw material quality and nutritional composition.
- Improving understanding of new raw material opportunities and limitations.
- Measurement of immunocompetence, gut integrity, and overall health status

ZEIGLER
nutrition through innovation

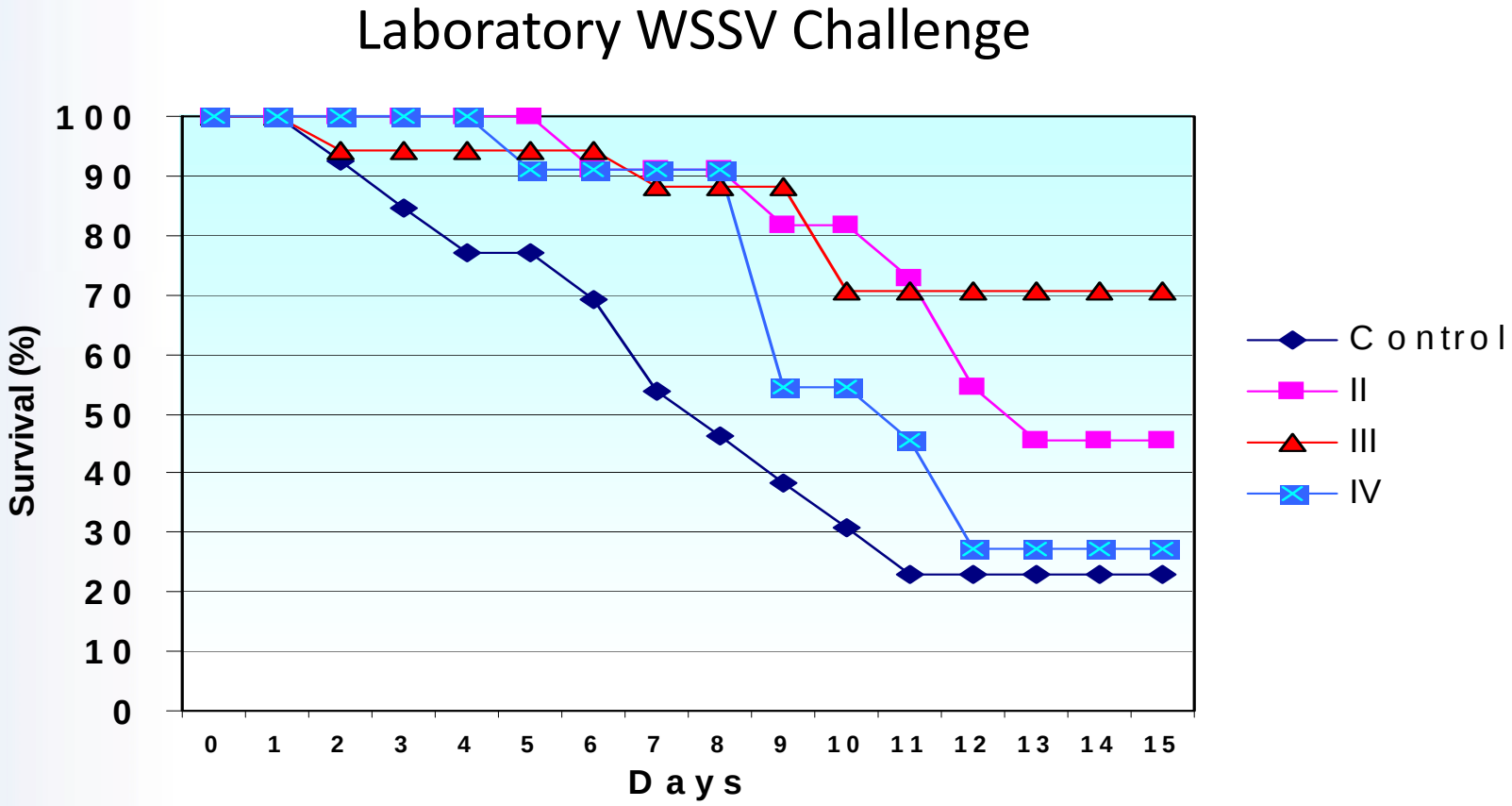
# ZARC
zeigler-aquaculture.research.center





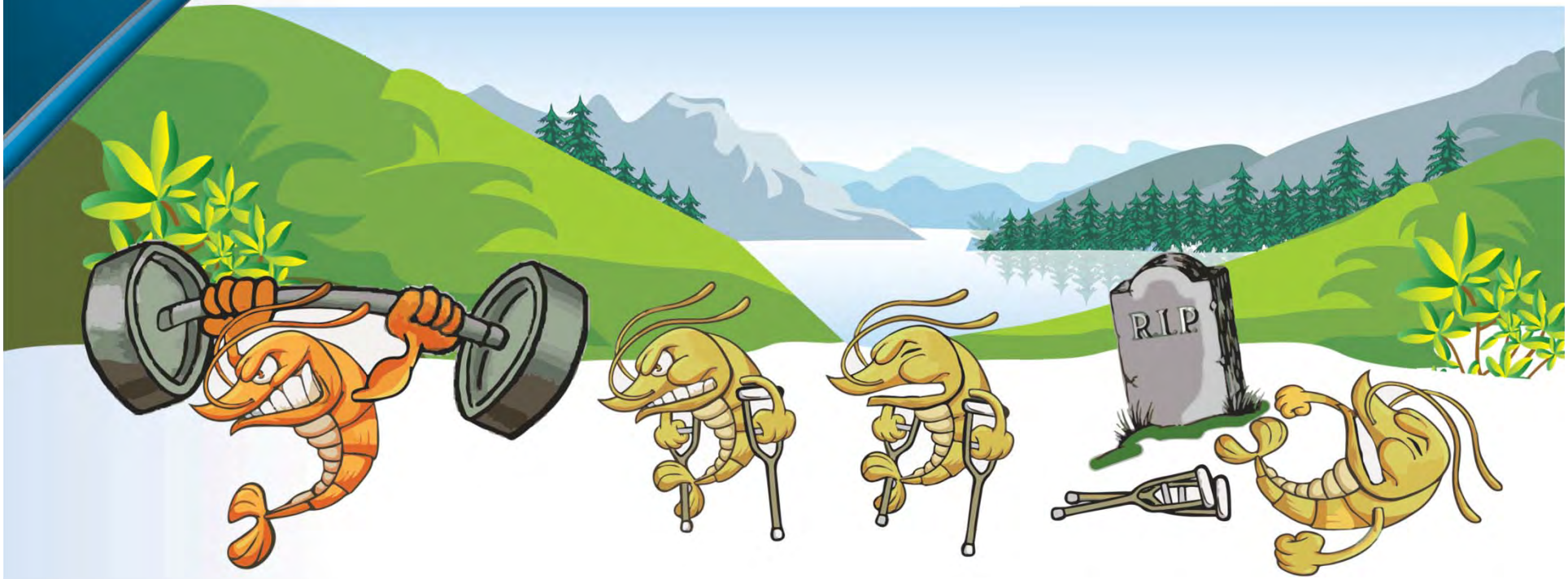
# Nutritional Immunology - Vpak™



# Feed Physical Characteristics

- Particle size and uniformity depend on shrimp size and uniformity
- Freshness – check labels for manufacture dates
- Packaged to retain quality, shelf life and palatability
- Water stability adequate to retain nutrients
- Shape and texture as preferred by shrimp
- Proper storage

# We become what we eat

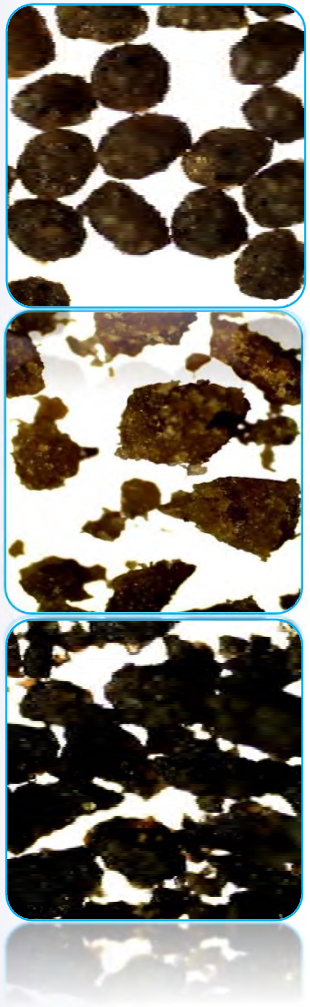



Strong, Healthy

Sick

Dead

# Feed Size



ZEIGLER
nutrition through innovation

# Driving a Ferrari on a Dirt Road


**How do we improve feeding as we improve feed technologies**

# Overfeeding

- Overfeeding is a very common mistake with very serious consequences, including:
  - Increases floc and bacteria populations
  - Increases requirements for probiotics
  - Increases oxygen demand, $CO_2$ production
  - Increases ammonia and nitrite production
  - Sludge accumulation, toxic hydrogen sulfide
  - AHPNS outbreaks

# Feeding is based on Gains and Expected FCR

- A better method of calculating feeding rates:
  1. Develop a typical growth curve for the growing conditions and genetic stock
  2. Calculate the daily weight gain
  3. Multiply the expected gain by the Population Estimate and Expected Feed Conversion Factor (FCR)

***Feed Quantity = Daily Gain x Population x FCR***

# Zeigler Precision Feed Program©

- Growth curve based on the system's history and genetics of animals
- The feeding is based on accurate population projections, gains per day, FCR, and temperature
- Includes a mechanism to adjust the feed rate on the basis of average weight samples, population estimates, adjustments to projected growth per day, and temperature.

# Zeigler Precision Feed Program©

ZEIGLER
nutrition through innovation

Product of Zeigler Technology
Zeigler Bros. Inc.
© 2015

VERSION 2.0
Last Modified:
1/23/2016

CHANGE ANY NUMBER IN BLUE CELLS

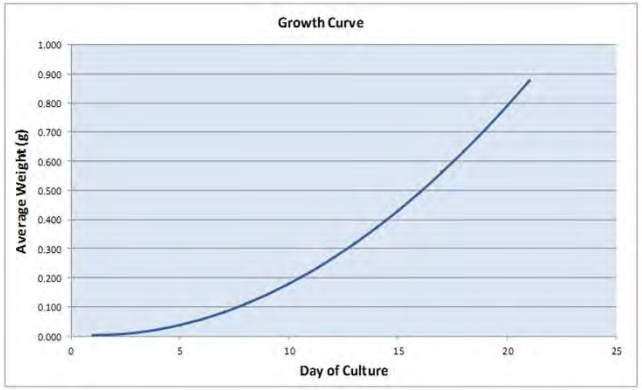
| LANGUAGE: | English |
|---|---|

| 0 |
|---|

| Rearing Unit Volume (m3) | |
|---|---|
| Rearing Unit ID | Raceway 2 |
| Rearing Unit Volume (m3) | 0.03 m3 |
| Carrying Capacity | 1.50 kg/m3 |

| Seedstock | |
|---|---|
| Shrimp Origin | |
| Genetic Growth Potential (g/wk) | 1.50 g/week |

| Production Assumptions | |
|---|---|
| Stocking Date: | 11/1/2015 |
| Age of PLs Stocked: | PL 20 |
| Ave. Wt. of Shrimp Stocked (g) | 0.0030 |
| Number Stocked: | 30 |
| Stocking Density (pcs/m3) | 1,000 |
| Expected Stocking Mortality | 5.0% |
| Predicted Survival Rate | 80.0% |
| Culture Days | 21 |
| Expected Ave. Temp. (°C) | 30 |




| Particle Size | Feed Selection |
|---|---|
| EZ Artemia 300-300 µm | Not Used |
| <400 µm | PL Raceway Plus |
| 400-600 µm | Shrimp Starter |
| 600-850 µm | PL Raceway 40-9 |
| 850 - 1200 µm | PL Raceway 40-9 |
| 1.5 mm | PL Raceway 40-9 |
| 2.0 mm | PL Raceway 40-9 |
| 2.4 mm | HI - 35 |

| SUMMARY OF FEED REQUIREMENTS | | | | | | |
|---|---|---|---|---|---|---|
| Not Used 300 - 500 µm | PL Raceway Plus <400 µm | Shrimp Starter <600 µm | PL Raceway 40-9 600-850 µm | PL Raceway 40-9 850-1200 µm | PL Raceway 40-9 1.5 mm | PL Raceway 40-9 2.0 mm |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAILY FEED REQUIREMENT BY FEED TYPE & PARTICLE SIZE

| Date | Day of Culture | Stage | Survival % | Estimated Population | Corrected Population Estimate | Predicted Ave. Wt. (g) | Sample Ave. Wt. (g) | Growth Adjustment Factor (% of Max) | Predicted Temperature (°C) | Biomass (kg) | Density (kg/m3) | Predicted Gain/Day (g) | Predicted Daily FCR | Feed per Animal /day (mg) | Daily Feed Amt - Dry Wt (kg) | Cumulative Feed Amt (kg) | Cumulative FCR | Not Used 300 - 500 µm | PL Raceway Plus <400 µm | Shrimp Starter <600 µm | PL Raceway 40-9 600-850 µm | PL Raceway 40-9 850-1200 µm | PL Raceway 40-9 1.5 mm | PL Raceway 40-9 2.0 mm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/1/2015 | 1 | PL 20 | 100% | 30 | | 0.0030 | | 100% | 30 | 0.0 | 0.00 | 0.0022 | 0.645 | 7.0 | 0.00 | 0 | | | 0.00 | | | | | |
| 6/2/2016 | 2 | PL 21 | 94.3% | 28 | | 0.0052 | | 100% | 30 | 0.0 | 0.00 | 0.0066 | 0.66 | 7.5 | 0.00 | 0 | 3.74 | | 0.00 | | | | | |
| 6/3/2016 | 3 | PL 22 | 93.5% | 28 | | 0.0117 | | 100% | 30 | 0.0 | 0.01 | 0.0109 | 0.67 | 7.3 | 0.00 | 0 | 1.77 | | 0.00 | 0.00 | | | | |
| 6/4/2016 | 4 | PL 23 | 92.8% | 28 | | 0.0227 | | 100% | 30 | 0.0 | 0.02 | 0.0153 | 0.68 | 10.4 | 0.00 | 0 | 1.16 | | | 0.00 | 0.00 | | | |
| 6/5/2016 | 5 | PL 24 | 92.0% | 28 | | 0.0379 | | 100% | 30 | 0.0 | 0.03 | 0.0197 | 0.69 | 13.6 | 0.00 | 0 | 0.96 | | | 0.00 | 0.00 | | | |
| 6/6/2016 | 6 | PL 25 | 91.3% | 27 | | 0.0576 | | 100% | 30 | 0.0 | 0.05 | 0.0240 | 0.70 | 16.9 | 0.00 | 0 | 0.87 | | | | 0.00 | | | |
| 6/7/2016 | 7 | PL 26 | 90.5% | 27 | | 0.0816 | | 100% | 30 | 0.0 | 0.07 | 0.0284 | 0.72 | 20.3 | 0.00 | 0 | 0.83 | | | | 0.00 | | | |
| 6/8/2016 | 8 | PL 27 | 89.8% | 27 | | 0.1100 | | 100% | 30 | 0.0 | 0.10 | 0.0328 | 0.73 | 23.9 | 0.00 | 0 | 0.80 | | | | 0.00 | 0.00 | | |
| 6/9/2016 | 9 | PL 28 | 89.0% | 27 | | 0.1427 | | 100% | 30 | 0.0 | 0.13 | 0.0371 | 0.74 | 27.5 | 0.00 | 0 | 0.79 | | | | 0.00 | 0.00 | | |
| 6/10/2016 | 10 | PL 29 | 88.3% | 26 | | 0.1799 | | 100% | 30 | 0.0 | 0.16 | 0.0415 | 0.75 | 31.2 | 0.00 | 0 | 0.79 | | | | | 0.00 | | |
| 6/11/2016 | 11 | PL 30 | 87.5% | 26 | | 0.2213 | | 100% | 30 | 0.0 | 0.19 | 0.0459 | 0.76 | 35.0 | 0.00 | 0 | 0.79 | | | | | 0.00 | | |
| 6/12/2016 | 12 | PL 31 | 86.8% | 26 | | 0.2672 | | 100% | 30 | 0.0 | 0.23 | 0.0502 | 0.78 | 39.0 | 0.00 | 0 | 0.79 | | | | | 0.00 | | |
| 6/13/2016 | 13 | PL 32 | 86.0% | 26 | | 0.3174 | | 100% | 30 | 0.0 | 0.27 | 0.0546 | 0.79 | 43.0 | 0.00 | 0 | 0.80 | | | | | 0.00 | | |
| 6/14/2016 | 14 | PL 33 | 85.3% | 26 | | 0.3720 | | 100% | 30 | 0.0 | 0.32 | 0.0590 | 0.80 | 47.2 | 0.00 | 0 | 0.80 | | | | | 0.00 | 0.00 | |
| 6/15/2016 | 15 | PL 34 | 84.5% | 25 | | 0.4309 | | 100% | 30 | 0.0 | 0.36 | 0.0633 | 0.81 | 51.4 | 0.00 | 0 | 0.81 | | | | | 0.00 | 0.00 | |
| 6/16/2016 | 16 | PL 35 | 83.8% | 25 | | 0.4943 | | 100% | 30 | 0.0 | 0.41 | 0.0677 | 0.82 | 55.8 | 0.00 | 0 | 0.82 | | | | | 0.00 | 0.00 | |
| 6/17/2016 | 17 | PL 36 | 83.0% | 25 | | 0.5619 | | 100% | 30 | 0.0 | 0.47 | 0.0720 | 0.84 | 60.2 | 0.00 | 0 | 0.82 | | | | | 0.00 | 0.00 | |
| 6/18/2016 | 18 | PL 37 | 82.3% | 25 | | 0.6340 | | 100% | 30 | 0.0 | 0.52 | 0.0764 | 0.85 | 64.8 | 0.00 | 0 | 0.83 | | | | | 0.00 | 0.00 | |
| 6/19/2016 | 19 | PL 38 | 81.5% | 24 | | 0.7104 | | 100% | 30 | 0.0 | 0.58 | 0.0808 | 0.86 | 69.4 | 0.00 | 0 | 0.84 | | | | | | 0.00 | |
| 6/20/2016 | 20 | PL 39 | 80.8% | 24 | | 0.7912 | | 100% | 30 | 0.0 | 0.64 | 0.0852 | 0.87 | 74.2 | 0.00 | 0 | 0.85 | | | | | | 0.00 | |
| 6/21/2016 | 21 | PL 40 | 80.0% | 24 | | 0.8763 | | 100% | 30 | 0.0 | 0.70 | 0.0895 | 0.88 | 0.0 | 0.00 | 0 | 0.86 | | | | | | 0.00 | |

# Managing Feed Costs

- Feed cost per unit gain

  FCR * Feed Cost = FC/UG

- Profit

  Total expenses – Total revenues

- In aquaculture, a close economic relationship exists between cost inputs and output revenues
- Feed plays a critical role in determining, growth potential, water quality, health etc.

# Value of Quality Feed

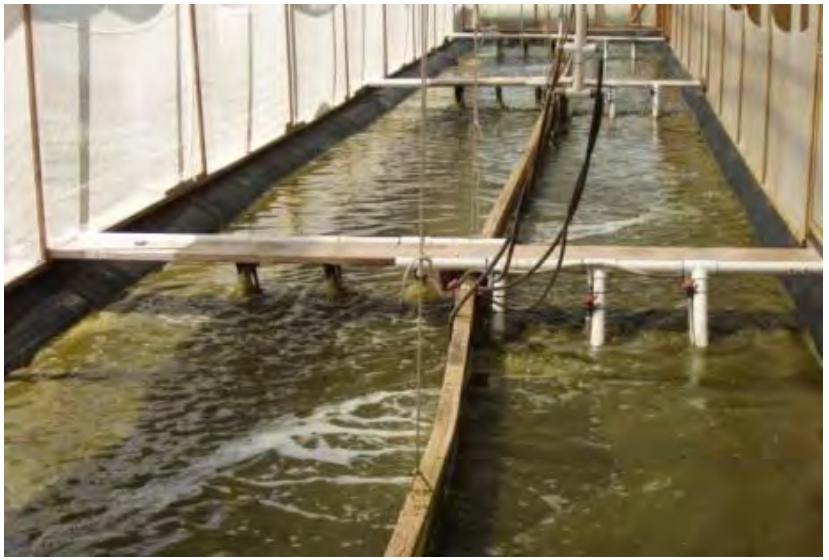
- Larger animals = more value per lb
- Healthier animals = less shrinkage, improved processing efficiency, better meat quality, improved shelf life
- Better water quality = less cost for treatment, probiotics etc., faster growth, lower FCR, higher carrying capacity
- Faster growth = more cycles, less operating cost, lower risk

# Closed System Feeding Strategy

- Design feeds and feeding program to efficiently meet shrimp requirements
  - High protein nutrient dense formulations
  - Tight control of feeding rates to meet requirements for growth
  - Supplemental carbon addition as necessary until nitrifying community established
  - Dilution or denitrification to control nitrate buildup
  - Avoid waste nutrient buildup over time, Phosphorus, Minerals etc.

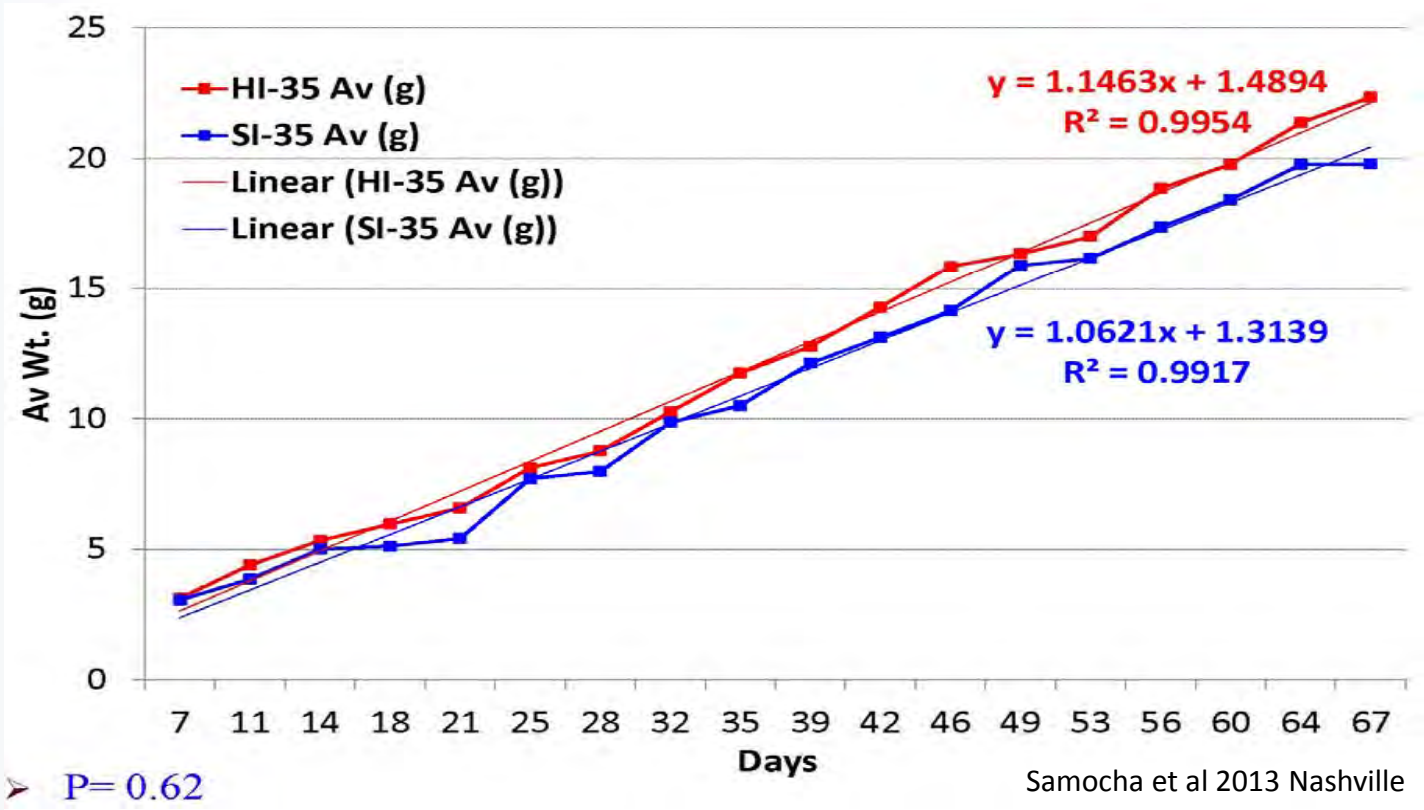
# Samocha 2013 - Example

- Standard commercial pond feed (SI-35) vs (HI-35) specially formulated for intensive closed system culture
- Both feeds with 35% protein and 7% fat
- 67 days
- 3x - 40-$m^3$ raceways
- 500/$m^3$
- 2.66 g initial weight



# Feeding and Growth

- Rations determined assuming FCR of 1.4, growth of 1.5 g/wk, and mortality of 0.5%/wk,
- Adjusted according to twice a week growth samples




- P= 0.62

Samocha et al 2013 Nashville

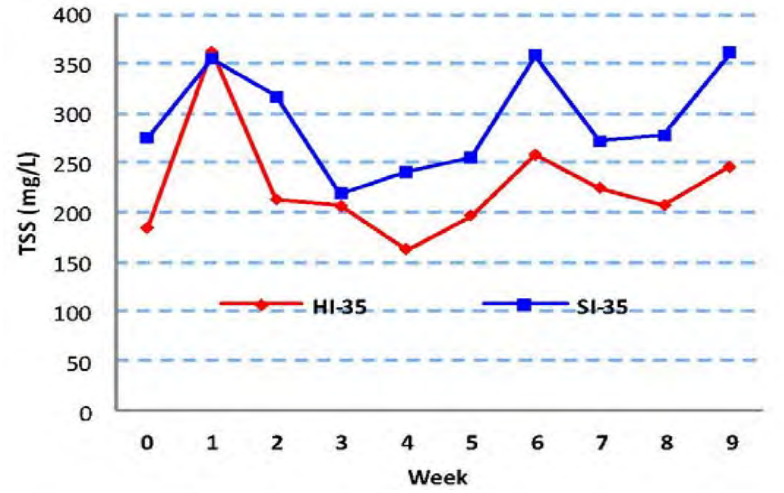
# Performance Results

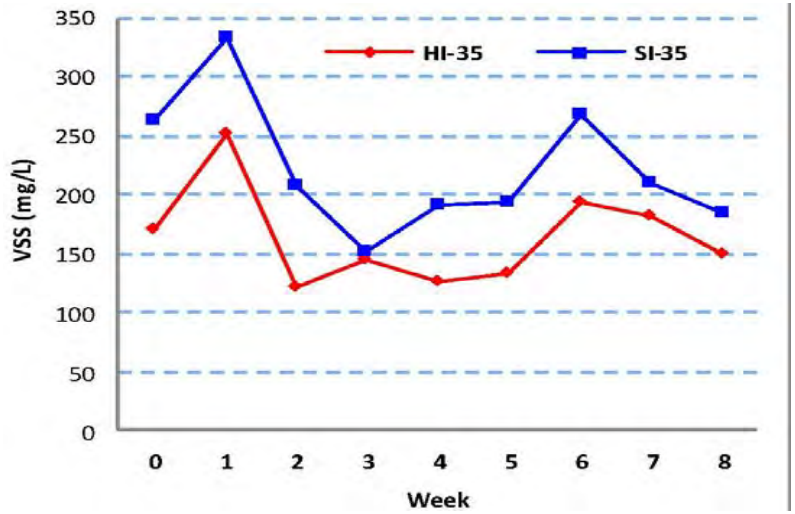
Performance of shrimp fed HI-35 & SI-35 diets in a high-density 67-d in biofloc dominated system

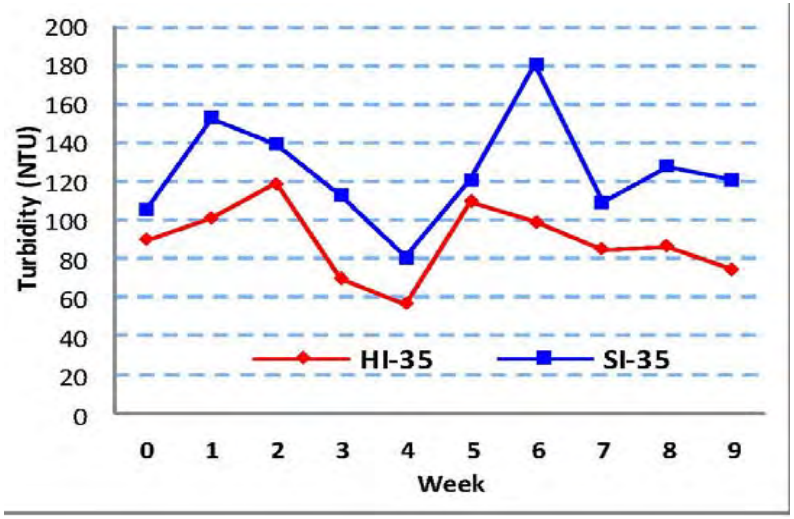
| | HI-35 | SI-35 |
|---|---|---|
| Final Weight (g) | $22.12 \pm 11.35^{a}$ | $19.74 \pm 8.28^{b}$ |
| Growth (g/wk) | $2.03 \pm 0.01^{a}$ | $1.76 \pm 0.10^{b}$ |
| Total Biomass (kg) | $389.8 \pm 1.77^{a}$ | $348.5 \pm 9.21^{b}$ |
| Yield ($kg/m^3$) | $9.74 \pm 0.04^{a}$ | $8.71 \pm 0.22^{b}$ |
| FCR | $1.25 \pm 0.01^{a}$ | $1.43 \pm 0.04^{b}$ |
| Survival (%) | $87.4 \pm 0.52^{a}$ | $88.3 \pm 4.18^{a}$ |

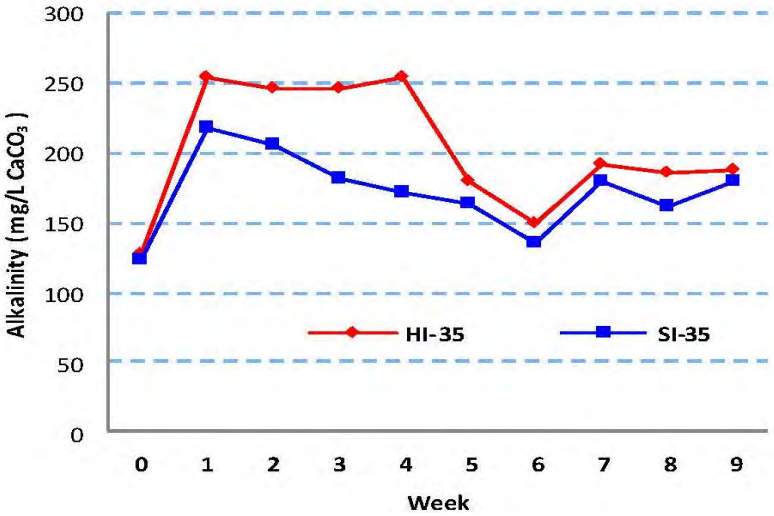
ZEIGLER
nutrition through innovation

# Water Quality Effects



# Economic Analysis

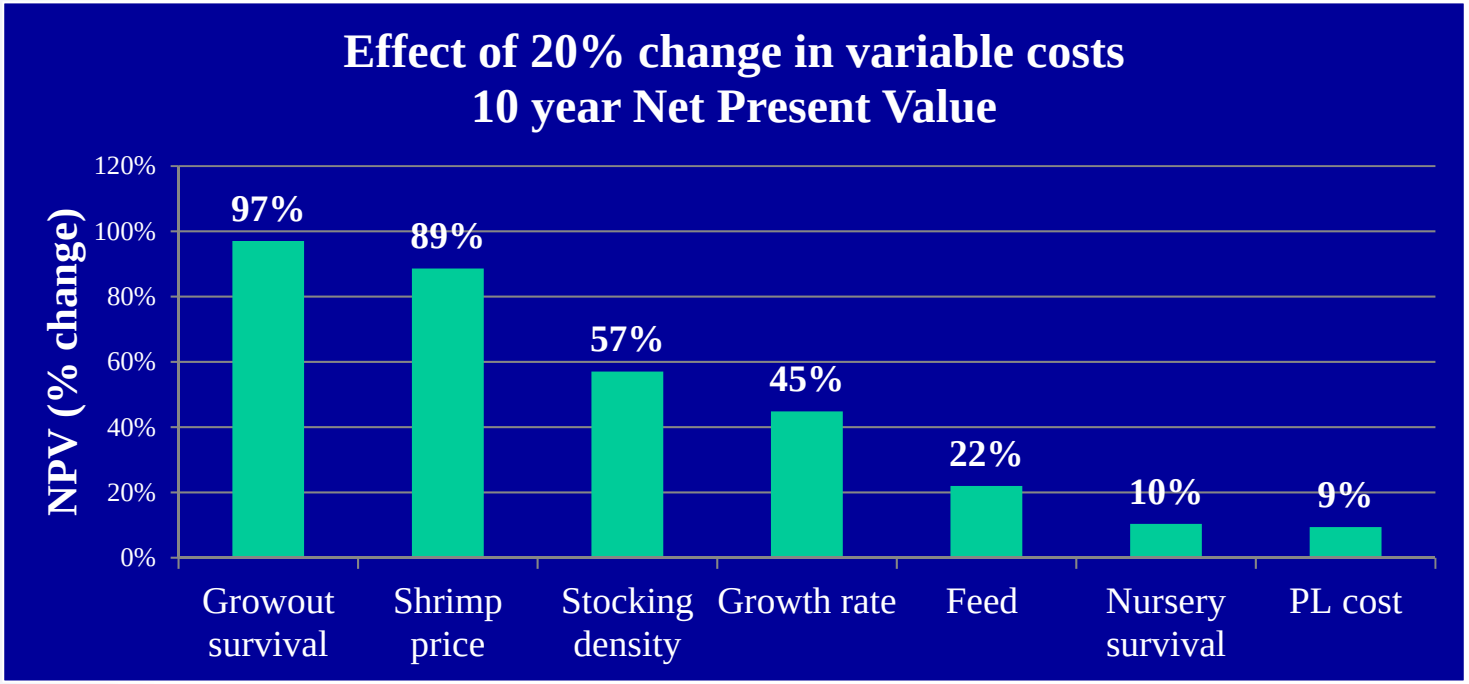
- Shrimp sales price: averaged $7.20/kg ($3.27/lb)
- Grow-out feed: Zeigler Brothers
  - Semi-Intensive (SI-35): $0.99/kg = $ 990/MT or $0.452/lb = $ 904/ton
  - Hyper-Intensive (HI-35): $1.75/kg = $1,750/MT or $0.795/lb = $1,590/ton
- Juveniles production cost: $20.00/1,000
- Interest rate for loans: 8%
- Initial Investment $ 991,997
- Greenhouse system with eight 500$M^3$ Raceways

# Enterprise Budgets ($/kg)

| | HI-35 | SI-35 |
|---|---|---|
| Total Sales per year | $ 1,542,816 | $ 1,379,664 |
| Gross Receipts | $ 7.20 | $ 7.20 |
| Variable Costs | $ 4.06 | $ 4.54 |
| Income Above Variable Cost | $ 3.14 | $ 2.66 |
| Fixed Cost | $ 0.47 | $ 0.53 |
| Total of All Specified Expenses | $ 4.53 | $ 5.07 |
| Net Returns Above All Costs | $ 2.67 | $ 2.13 |
| Payback period, years | $ 1.4 | $ 1.9 |
| Net present value ($ mil.) | $ 2.9 | $ 2.0 |
| Internal Rate of Return (%) | $ 66.6 | $ 50.1 |

# Invest in feed quality

- Cost of high quality feeds are quickly justified by small increases in crop growth and survivability




Hanson et al. 2007

# Shrimp production efficiencies

- Feeding early stages properly is crucial to overall crop success
- Maintain high performance standards developing and applying the correct metrics against global standards
- Feed drives the system apply precision feeding
- Do not compromise performance to cut cost, feed is an investment in overall profitability

# INDOOR SHRIMP FARMING WORKSHOP

ZEIGLER®

nutrition through innovation

KENTUCKY STATE UNIVERSITY®

LAND GRANT PROGRAM


**"The ability to learn faster than your competition may be the only sustainable competitive advantage."**