Effectively Supporting of Your Clients and Using of Field Data to Guide Improvement in the Quality of Your Feeds

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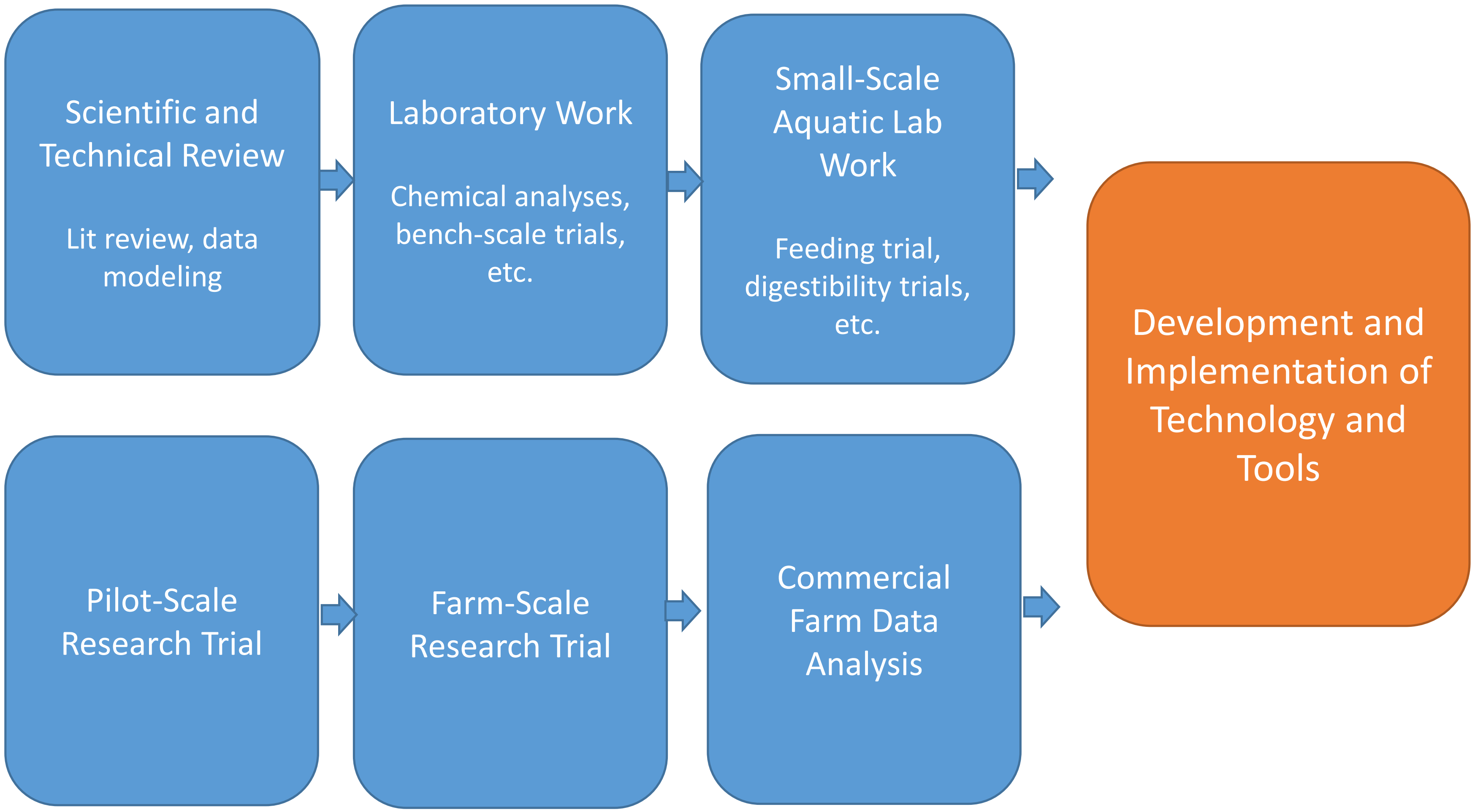
USSEC IAFFD Feed Formulation Workshop Day 1

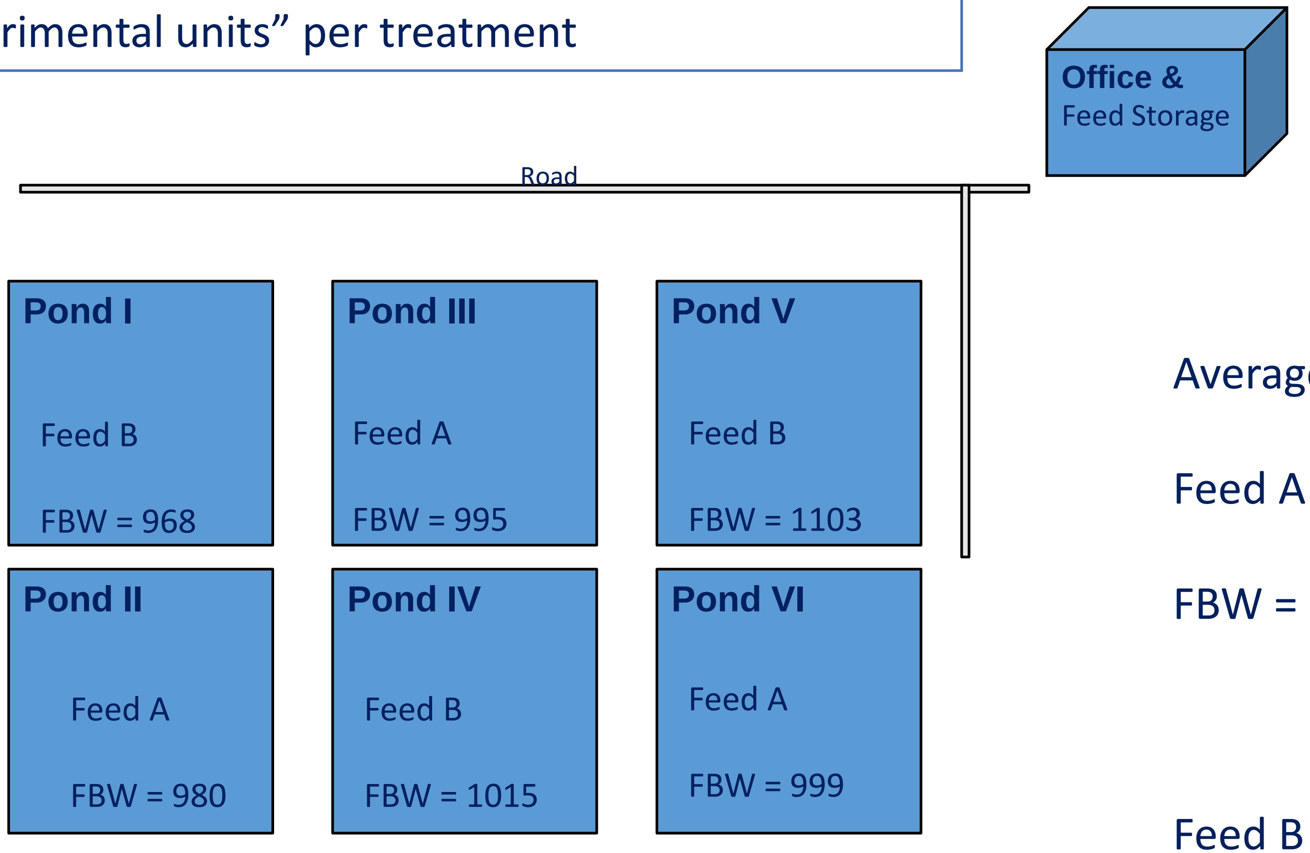
Research Scale-Up Approach



Design of Experiment and Statistical Power of Pilot-Scale or Field Studies

Design of an Experiment Comparing Two Feeds

Proper design requires several replicates or "experimental units" per treatment



Average

Feed A

FBW = 992 g

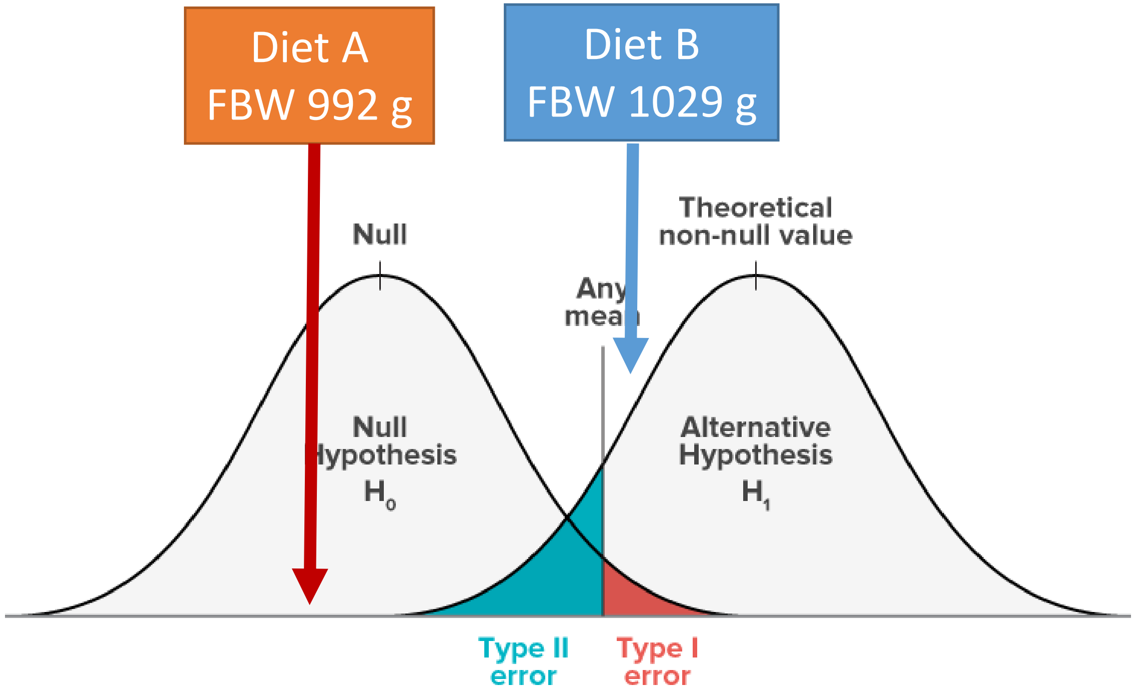
Feed B

FBW = 1029 g

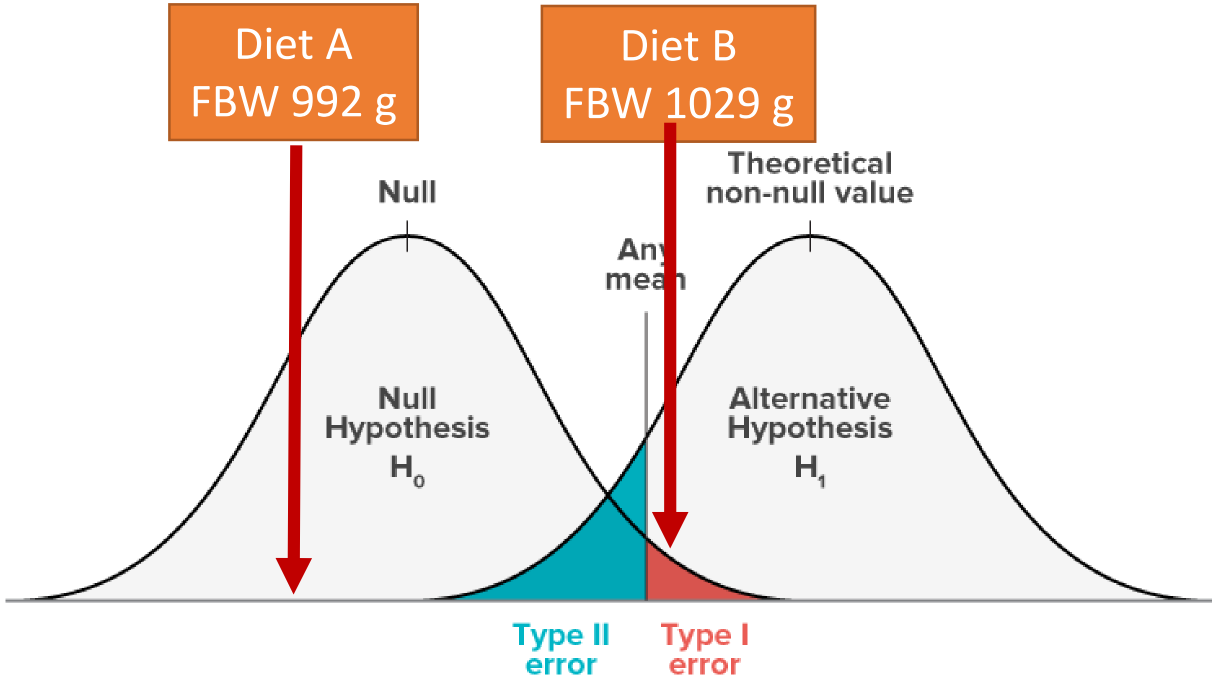
Proper replication = Allows randomization of experimental error

Truth

Two diets =
Two different “populations”



Two diets =
Same “population”



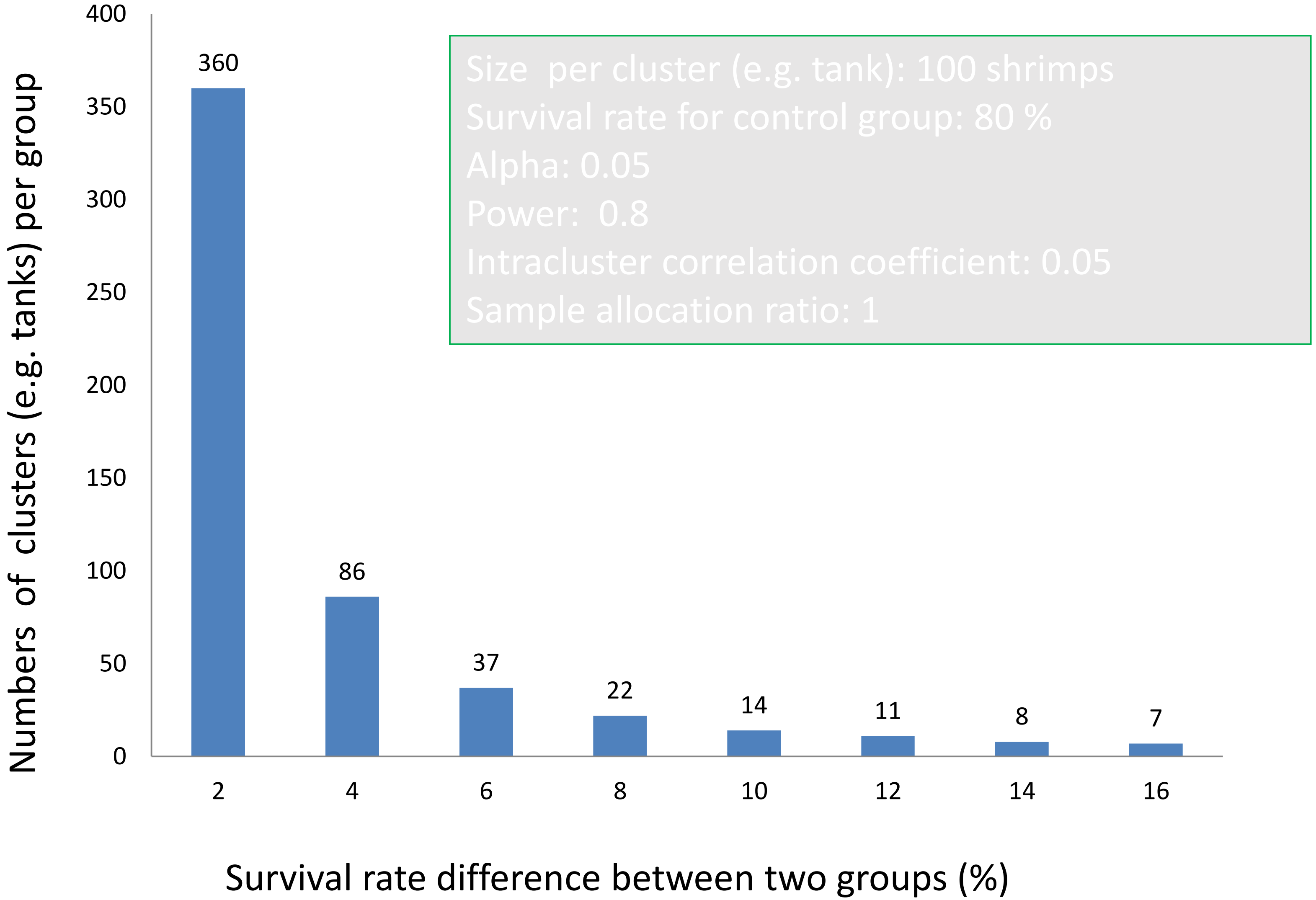
Scenario for FCR

Actual difference	Replicates per group
0.05	64
0.10	17
0.15	9
0.20	6
0.25	4
0.30	4
0.35	3
0.40	3
0.45	3
0.50	3
0.55	3
0.60	2
0.65	2
0.70	2

Two-sample t test for mean difference

Fixed scenario elements
Distribution: Normal
Method: Exact
Standard deviation: 0.1
Nominal power: 0.8
Number of sides: 2
Null difference: 0
Alpha: 0.05
The POWER Procedure (SAS)

Scenario for survival rate



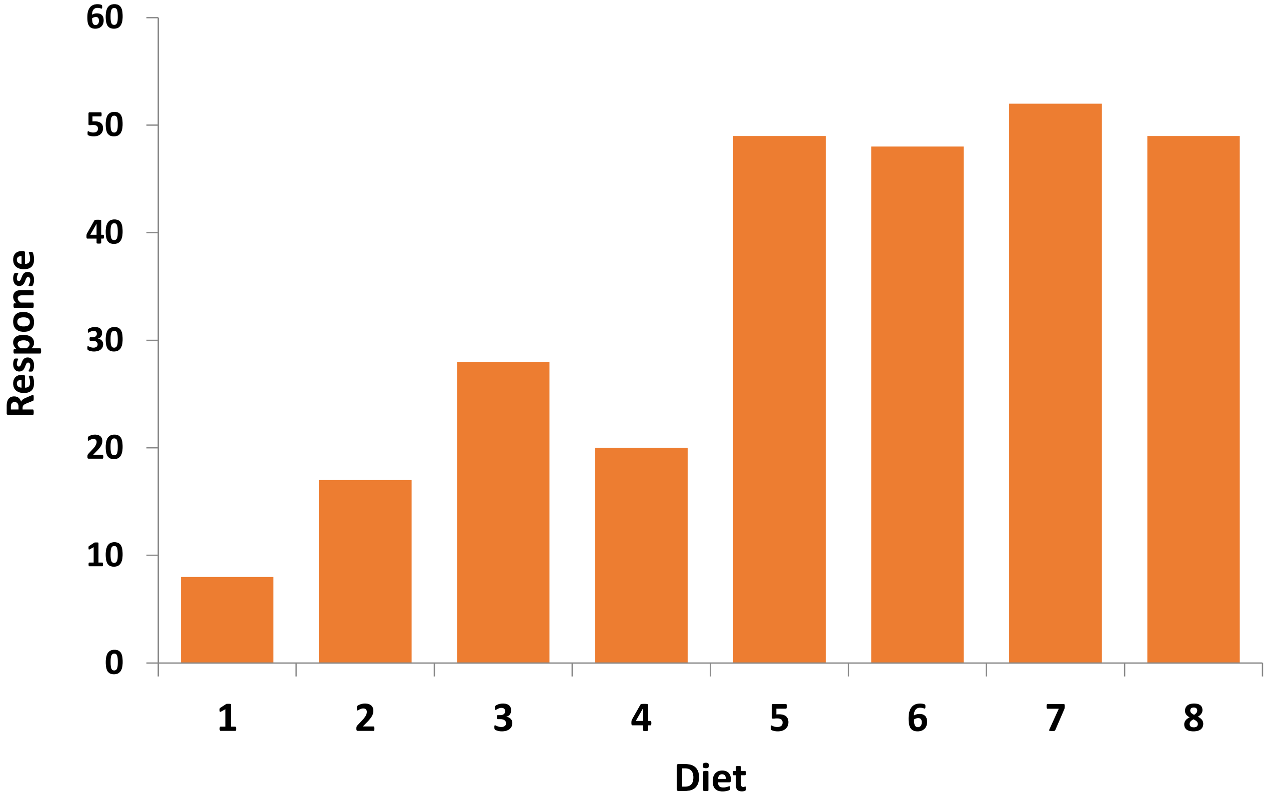
Note: produced by R package CRTSize

Experimental Cages for Shrimp Experimentation

Photo courtesy of M. Castex

Structure and Quality of Independent Variables (Treatments)

Comparison of Eight Feed "Recipes"



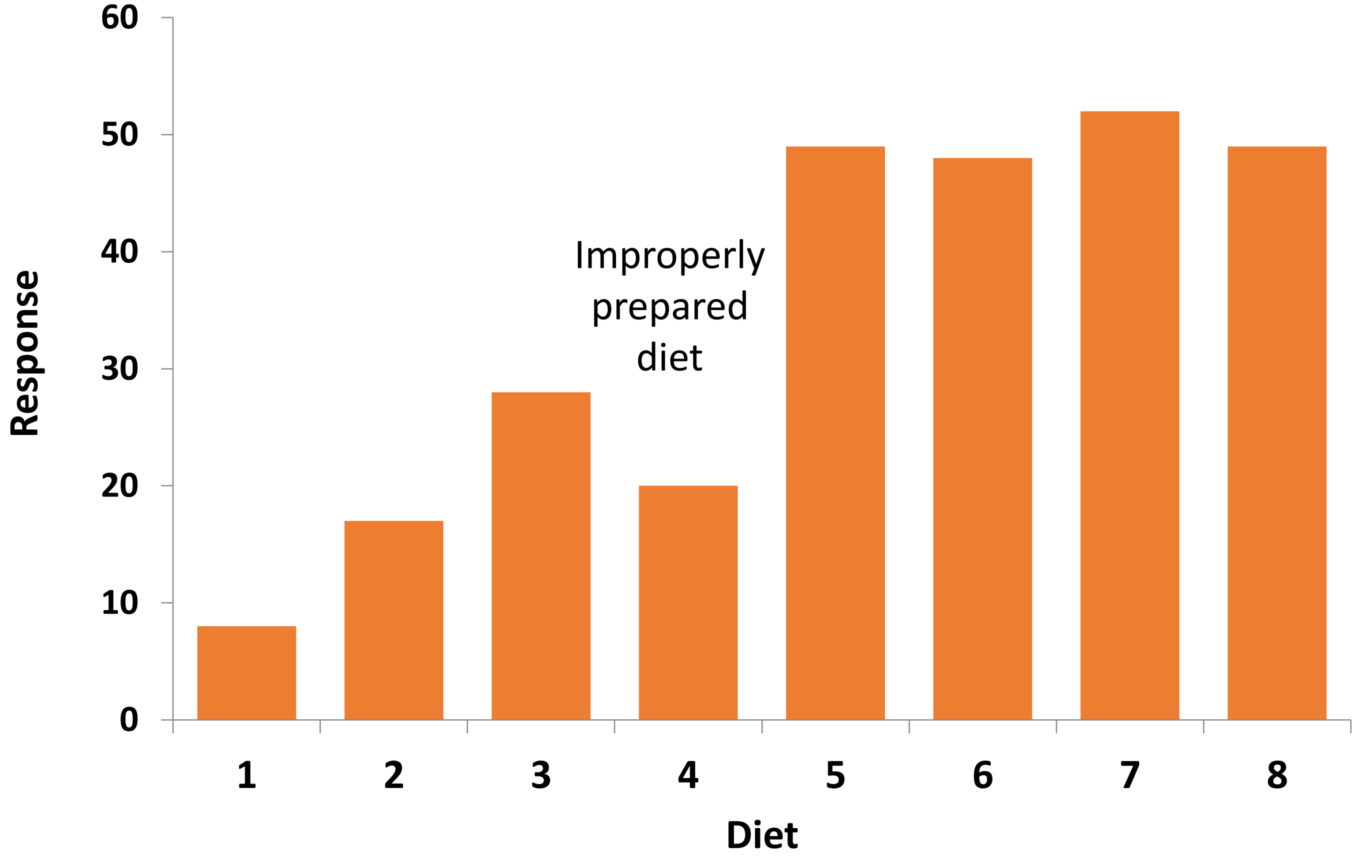
Diets 5, 6, 7, 8 are better than Diet 1, 2, 3, 4

The relevant question to ask is: Can we say why?

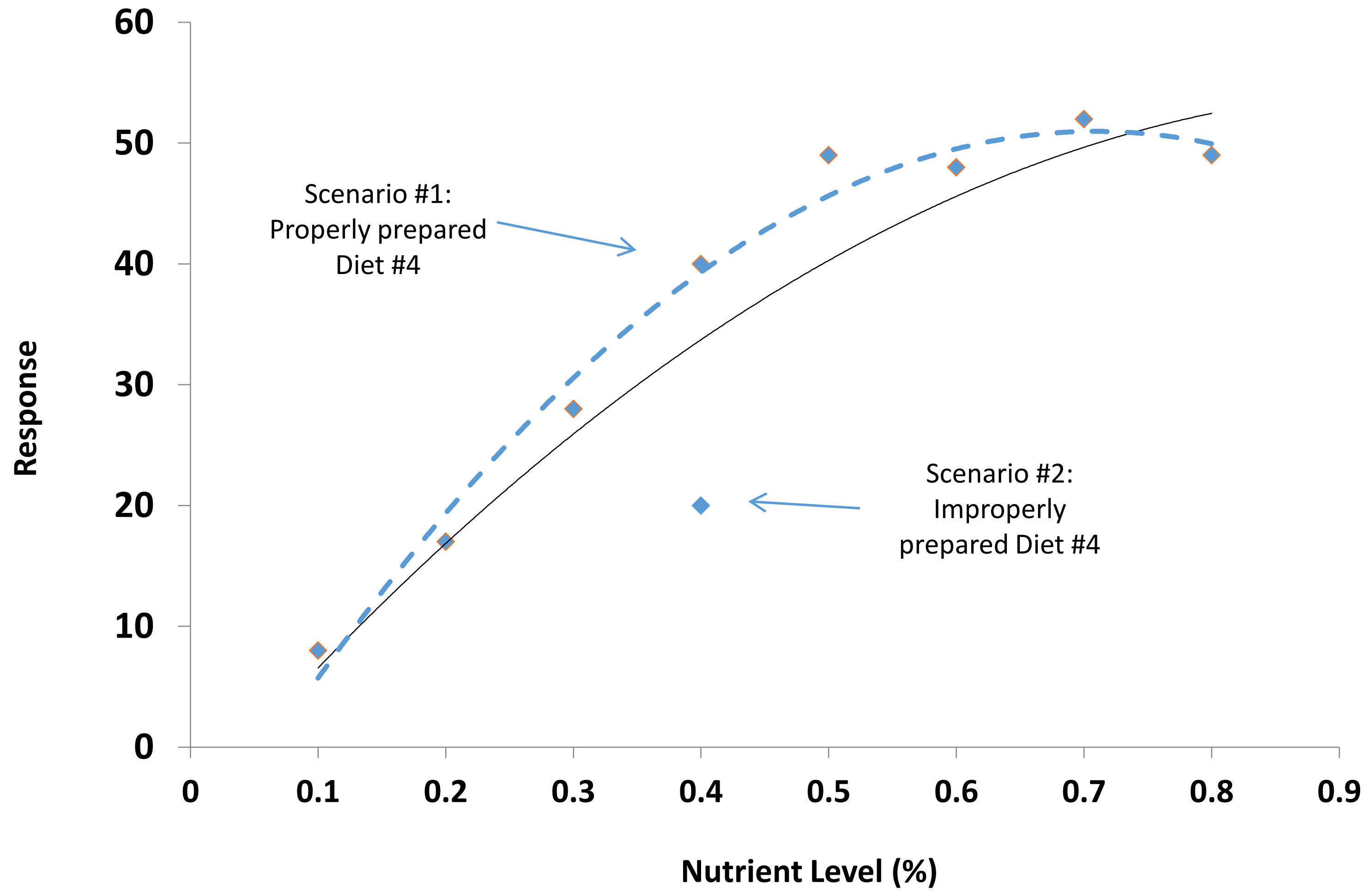
Secret 11 herbs and spices recipe

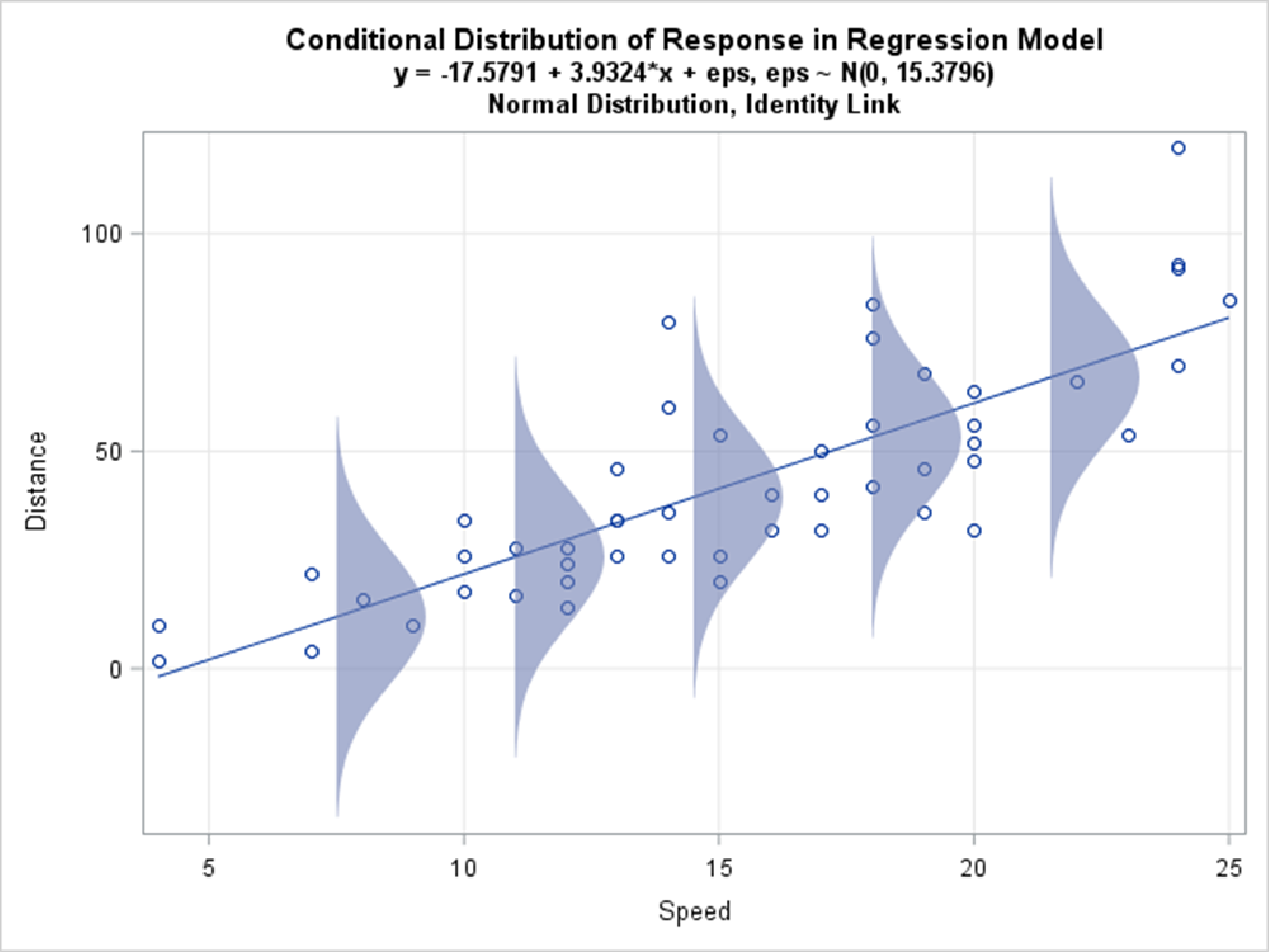
Why does KFC taste better (or worse) than
Mary Brown’s, Chester’s or Popeye’s fried chicken???

Comparison of Eight Feed “Recipes”
(Unstructured Treatments)



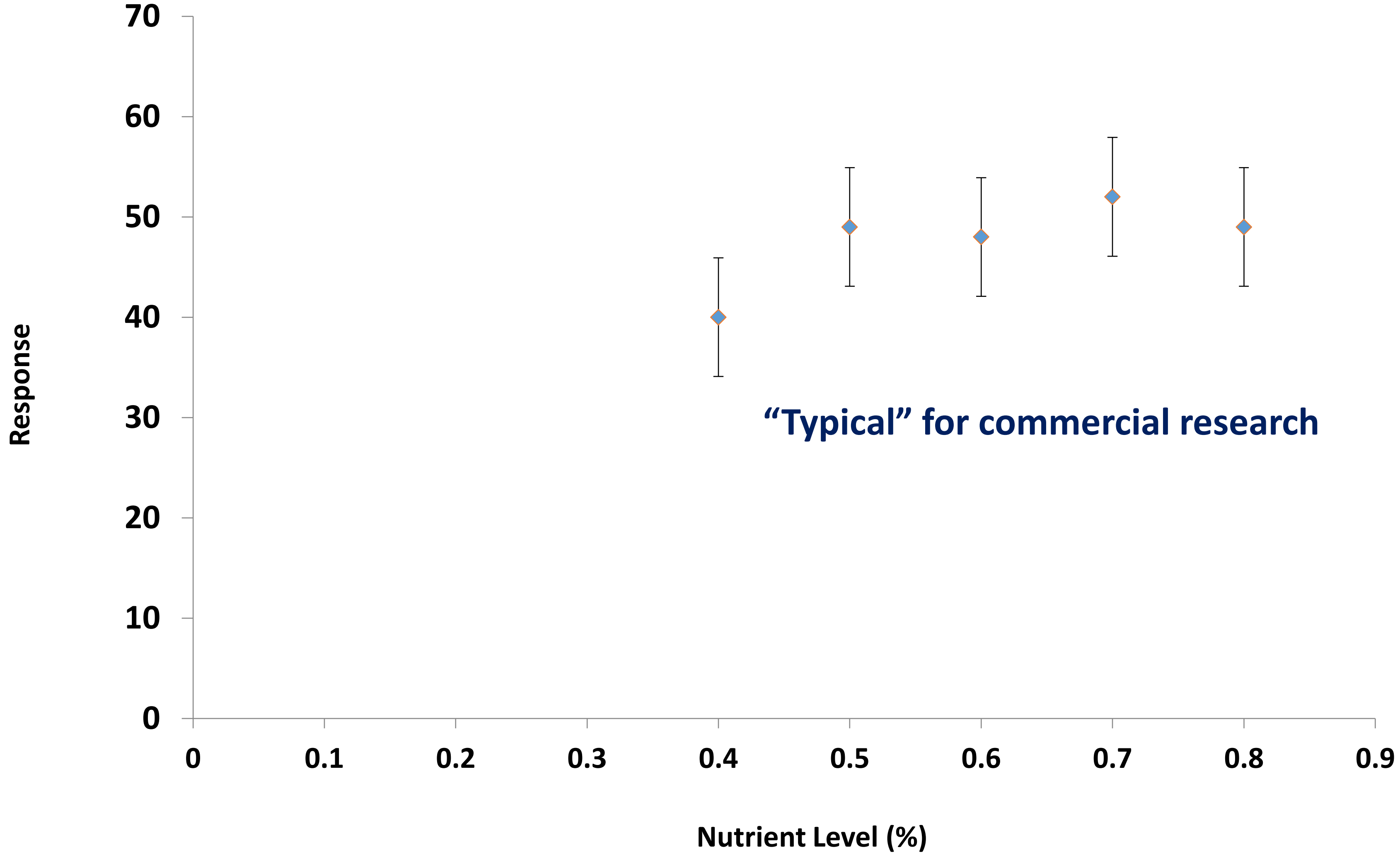
Response to Treatments with Strong Structure
(Structured Treatments)




Conditional Distribution of Response in Regression Model
y = -17.5791 + 3.9324*x + eps, eps ~ N(0, 15.3796)
Normal Distribution, Identity Link
Distance
100
50
0
5
10
15
20
25
Speed

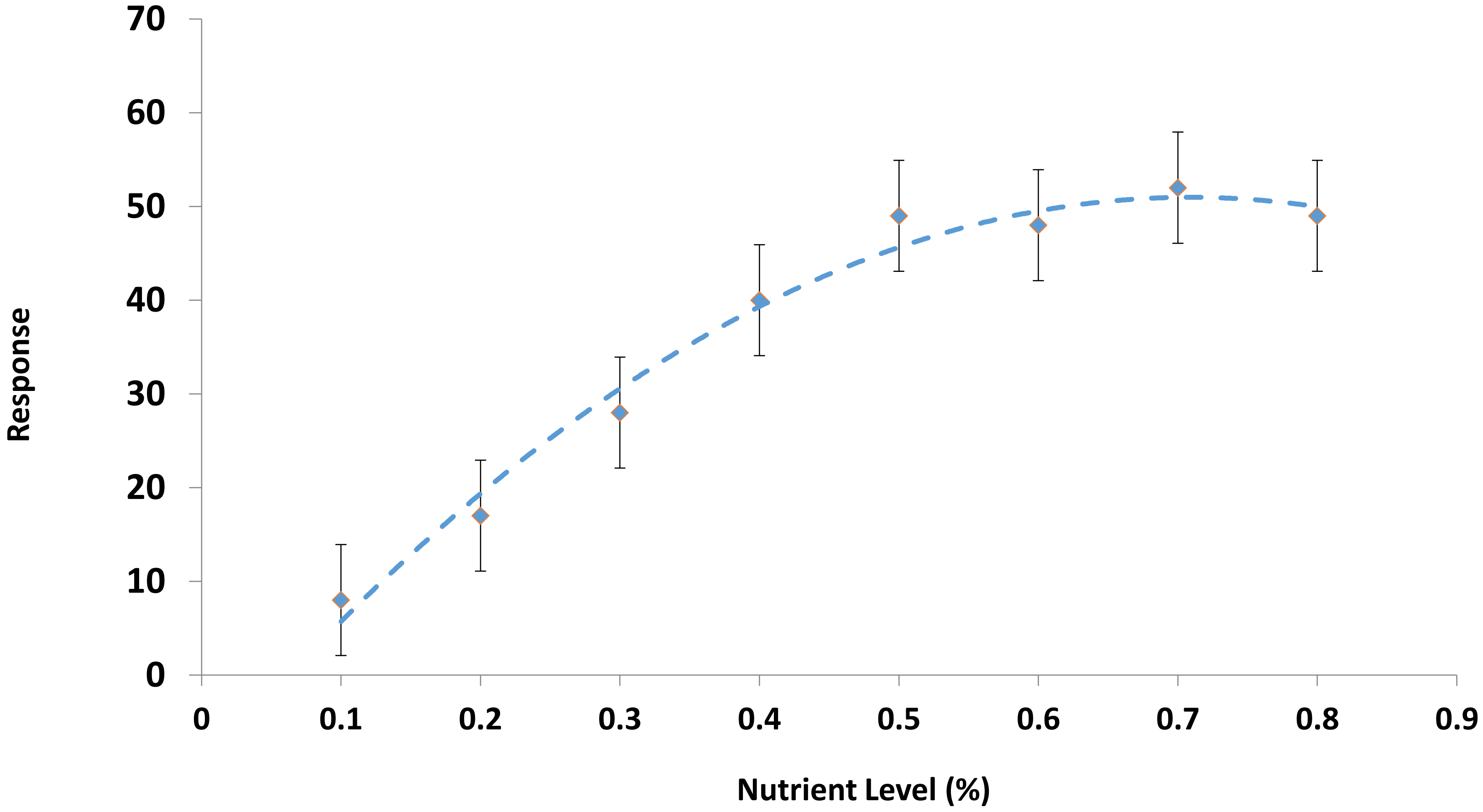
Response to Treatments with Strong Structure

Treatments have good structure (i.e. equally spaced graded levels of nutrients) but the "range" of the treatment appears too narrow or not centered around on the requirement or "commercial relevant" level



Response to Treatments with Strong Structure

A strong treatment structure and a broad "range" of the treatments (covering from significantly deficient levels to adequate levels) allows to more clearly understand the nature of the response and analyze this response



Aquaculture Operations Love Collecting Data!

A lot of information is collected every day/week/month by aquaculture operations and feed manufacturers.

Much of the information is collected and analyzed in a “piece-meal” fashion (i.e. not very systematically or meaningfully)

Many factors are varying or different across operations and over time (Ex: feed composition, genetic, environment, stocking density, etc.)

Information collected is often unreliable

How can we make best use of this information?

“Old-New” Perspective on Farm R&D

- Aquaculture feed manufacturers each serve 100s of clients
- Each farm is producing several “production lots” per year
- Different feed lots (batches) are used for different production lots
- Farmers and technical field personnel are monitoring production/performance and collecting a LOT of data
- Can’t we take advantage of this situation and make use of collected information more effectively???

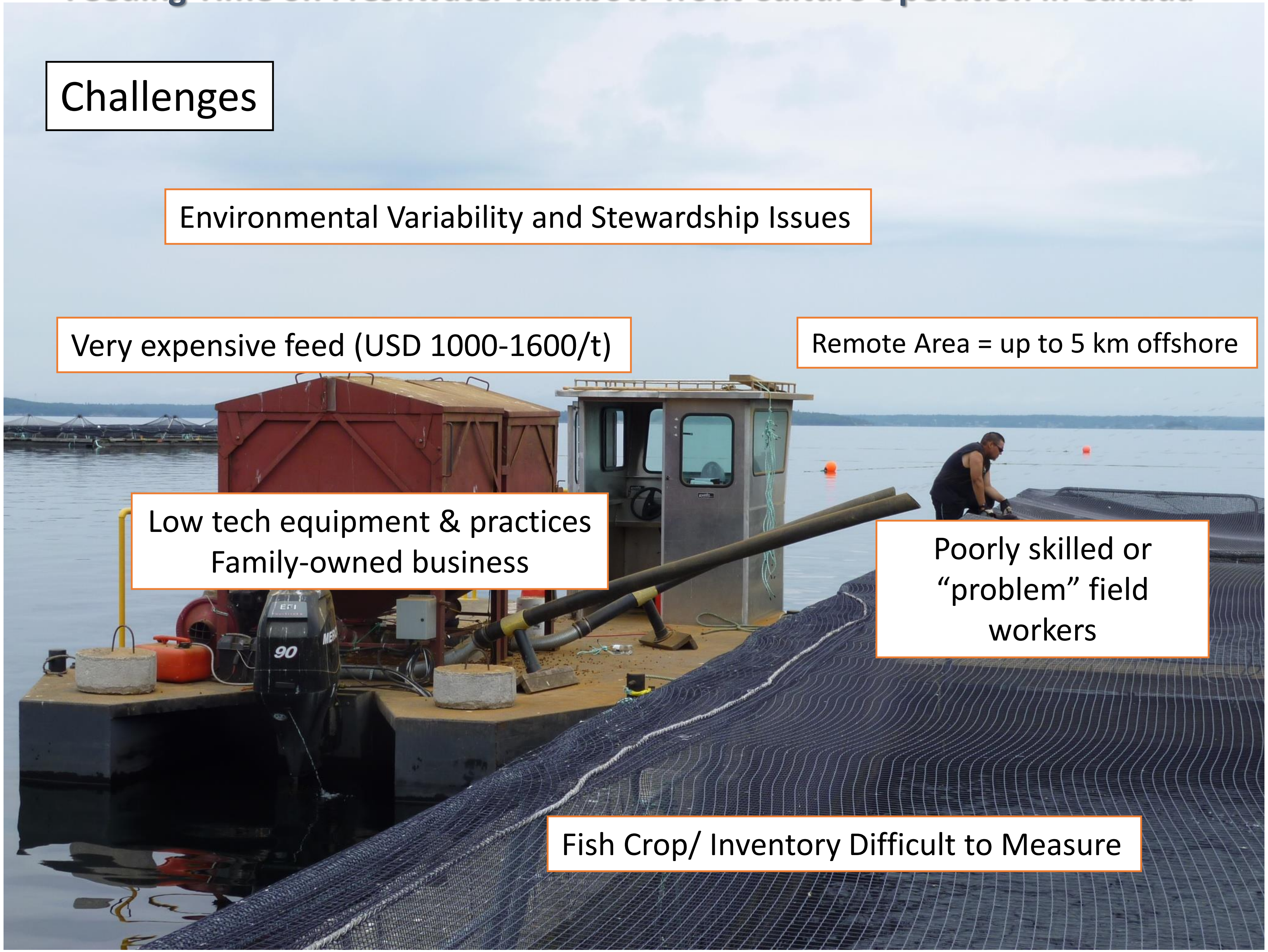
Freshwater Cage RBT Culture in Ontario, Canada

- Open-water cage production of rainbow trout
- Average grow-out period (10 g to 1 kg BW) = 12 to 16 months (long and risky!)

Autumn

Winter

Feeding Time on Freshwater Rainbow Trout Culture Operation in Canada



Wanted: Effective Production Management Tools

Aquaculture producers require tools to:

Forecast and manage growth and production

Estimate feed requirements and manage feeding (both fish and staff!)

Compare performance (growth, survival, FCR) achieved

Objectively compute "sustainability" parameters / metrics

Ex: Waste outputs (solid, N, P wastes)

Fish in: Fish out (FIFO) ratio

Approaches for Dealing with Current Challenges?

Systematic collection, **compilation**, **analysis** and **sharing** of production information (production records, pedigree information, etc.) has been key to improvement of production and efficiency in other animal industries (dairy, swine, beef, sheep, etc.)

Mathematical, statistical, nutritional and genetic models have proven to be very valuable for other animal industries and stand as prominent tools to meet current challenges in aquaculture

Mathematical modeling has been shown to be an effective way of **compiling, integrating, and interpreting production information** and enabling the development of practical and reliable tools for feed formulation and production, feeding, and waste outputs management.

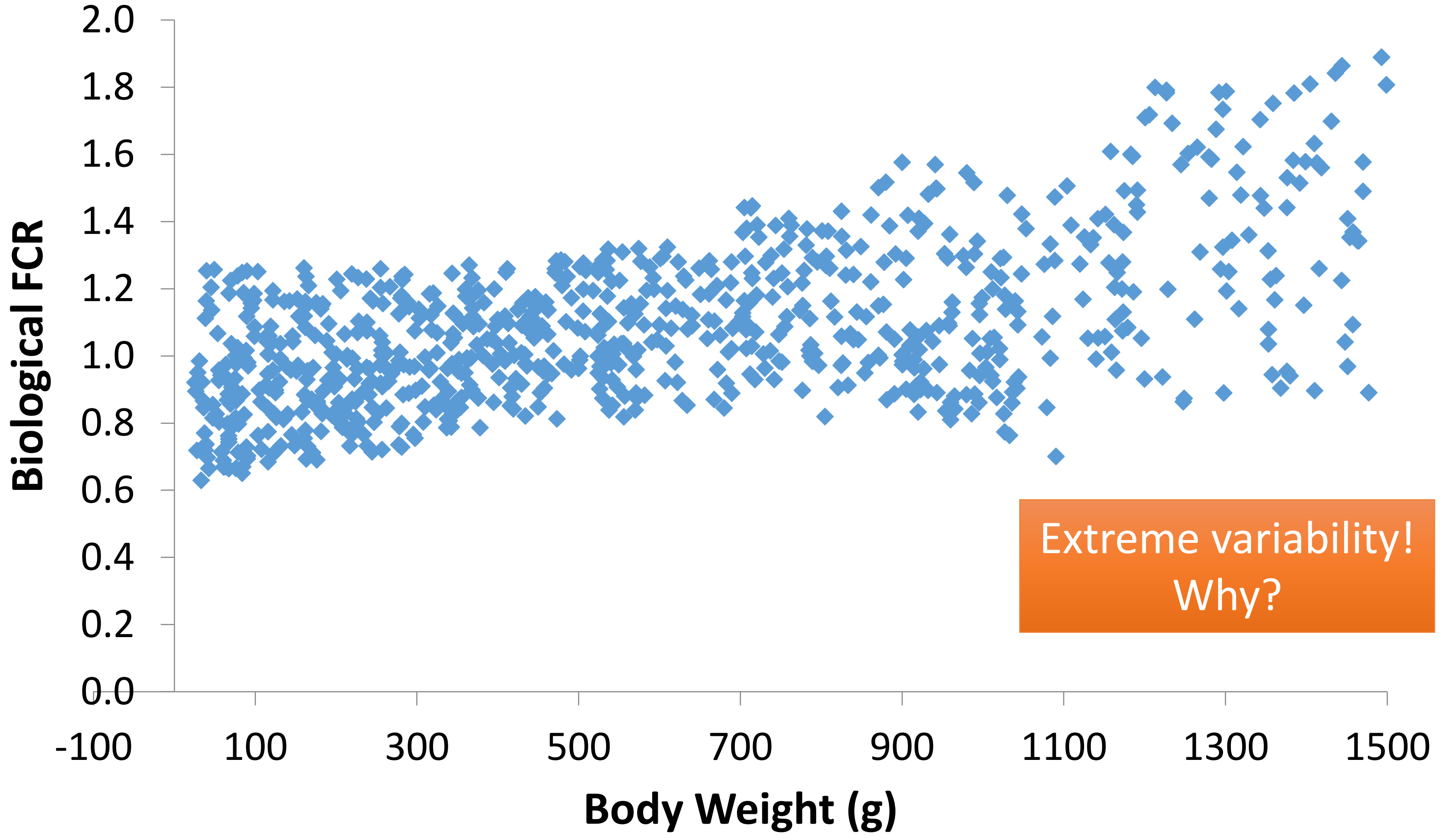
Dairy producers have been using mathematical models to manage production, breeding and feeding of dairy cows for decades

Descriptive Statistics for Production Parameters

Production Parameter	Count	Average	Weighted Average	Standard Deviation	Min	Max	10th Percentile	90th Percentile	ELA Model Farm Average
Initial Body Weight (g)	101	38.8	35.6	22.8	6.9	110.0	11.1	64.0	103.1
Final Body Weight (g)	159	1137	1139	295	531	2425	754	1534	955
Days (#)	159	477	473	117	185	736	302	627	158
Temperature (°C)	149	9.3	9.4	1.8	6.3	15.4	7.1	11.6	18.0
Thermal-Unit Growth Coefficient (TGC)	140	0.172	0.175	0.030	0.095	0.232	0.130	0.206	0.185
Mortality Rate (%)	154	10.6	9.8	10.4	0.3	62.4	25.2	1.0	9.0
Biological FCR	159	1.32	1.31	0.18	0.79	1.98	1.53	1.13	1.22
Economic FCR	144	1.42	1.39	0.29	0.90	3.89	1.68	1.20	1.25

Based on data from 5 aquaculture operations and 140 production lots from 2008-2012

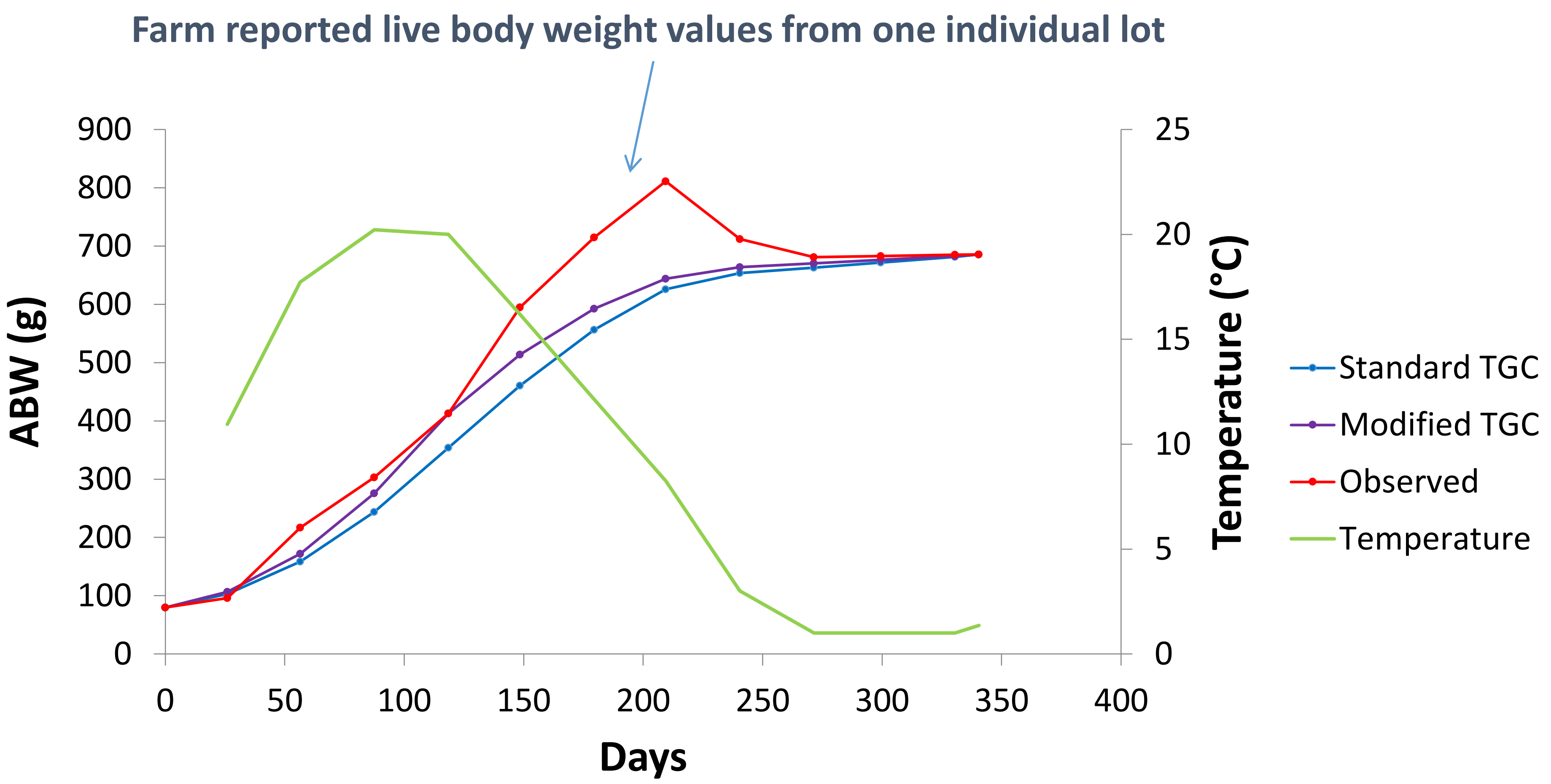
Feed Conversion Ratio (FCR) of Rainbow Trout Reported by Farms Using Similar Feeds



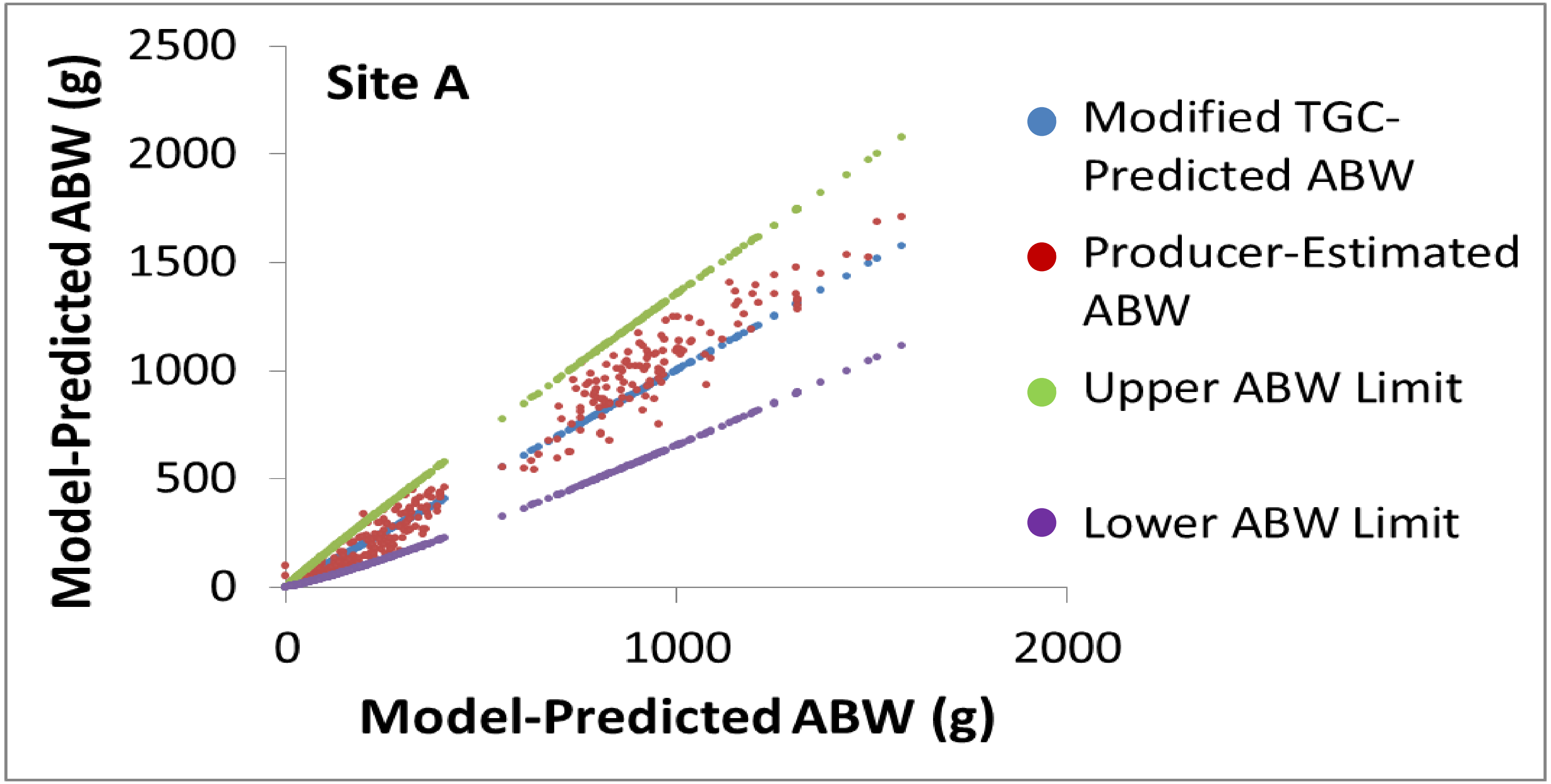
What the source of this variability???

Biological/environmental/dietary variability or sampling errors?

Application to commercial rainbow trout farm data



Farm Estimates Appear to Deviate Towards Size of Largest Individuals Within Cages



*****Farm-reported estimates of fish weight at different intervals are thus not highly reliable*****

Reliability of Farm Estimates?

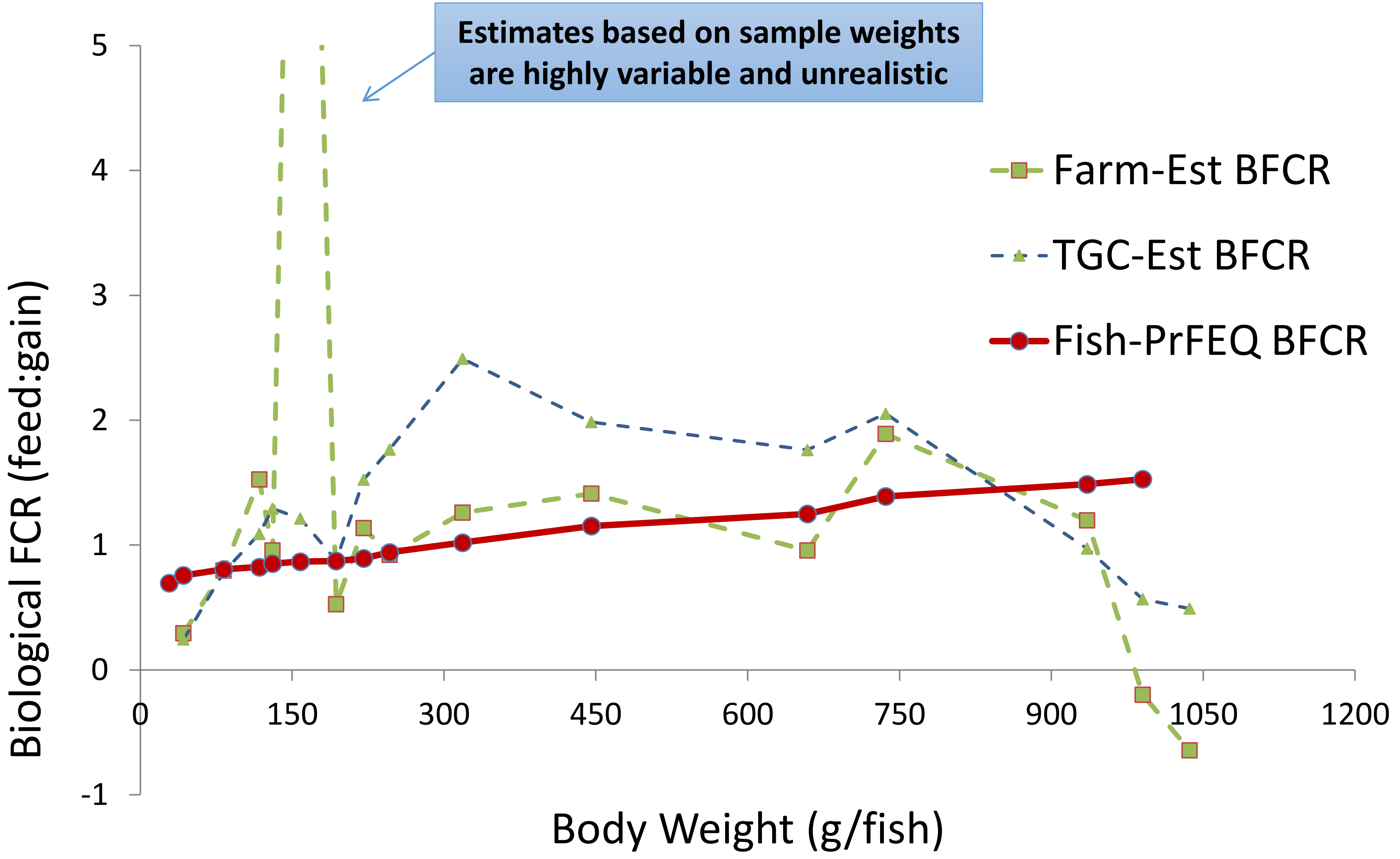
- To estimate body weight of fish, most producers use feed enticement and dip-netting

- Typical body weight estimates involve small numbers of fish (e.g. <1% of population)

- Little to no quantification of within-cage size variability

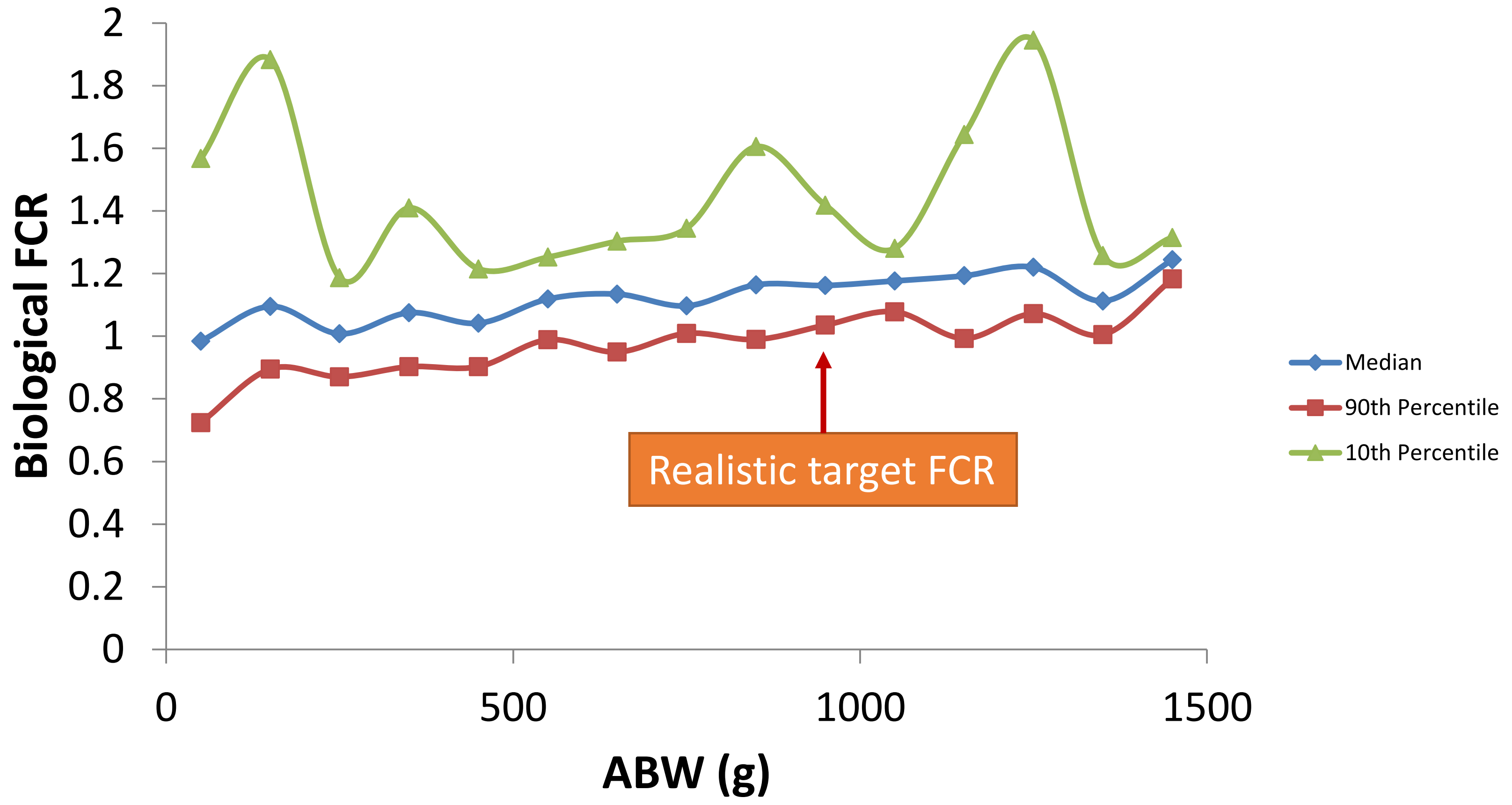
Dip-netting with seine net

Biological FCR: Farm Estimates vs. Model Estimates
(Interval Basis)



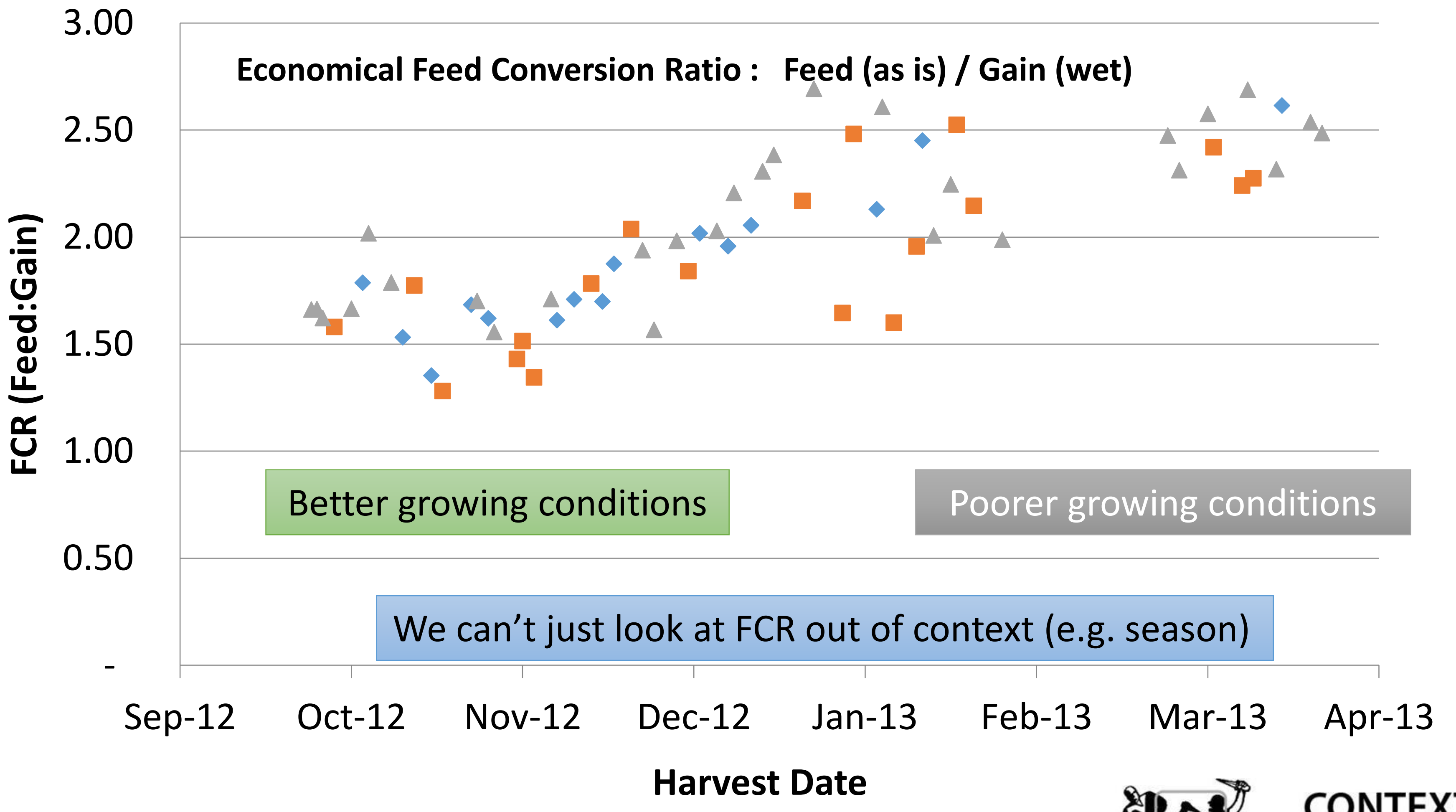
The Power of Advanced Analysis of Real Production Data

Ex: FCR vs. Average Body Weight (ABW)



- Advanced statistical analysis of the data provide novel way of looking at highly variable field data and identifying achievable “targets” (as opposed to “ad hoc” ones)
- Auditing/cleaning of field data against model simulation and combining or contrasting theoretical feed requirement model simulation and realistic targets could prove very powerful

FCR of Tilapia Produced on Different Aquaculture Operations
(using the same commercial feed, SE Asia country)



More information can be extracted with systematic organization and analysis of information

CONTEXT

Remember:
A single statistic doesn't tell the whole story.

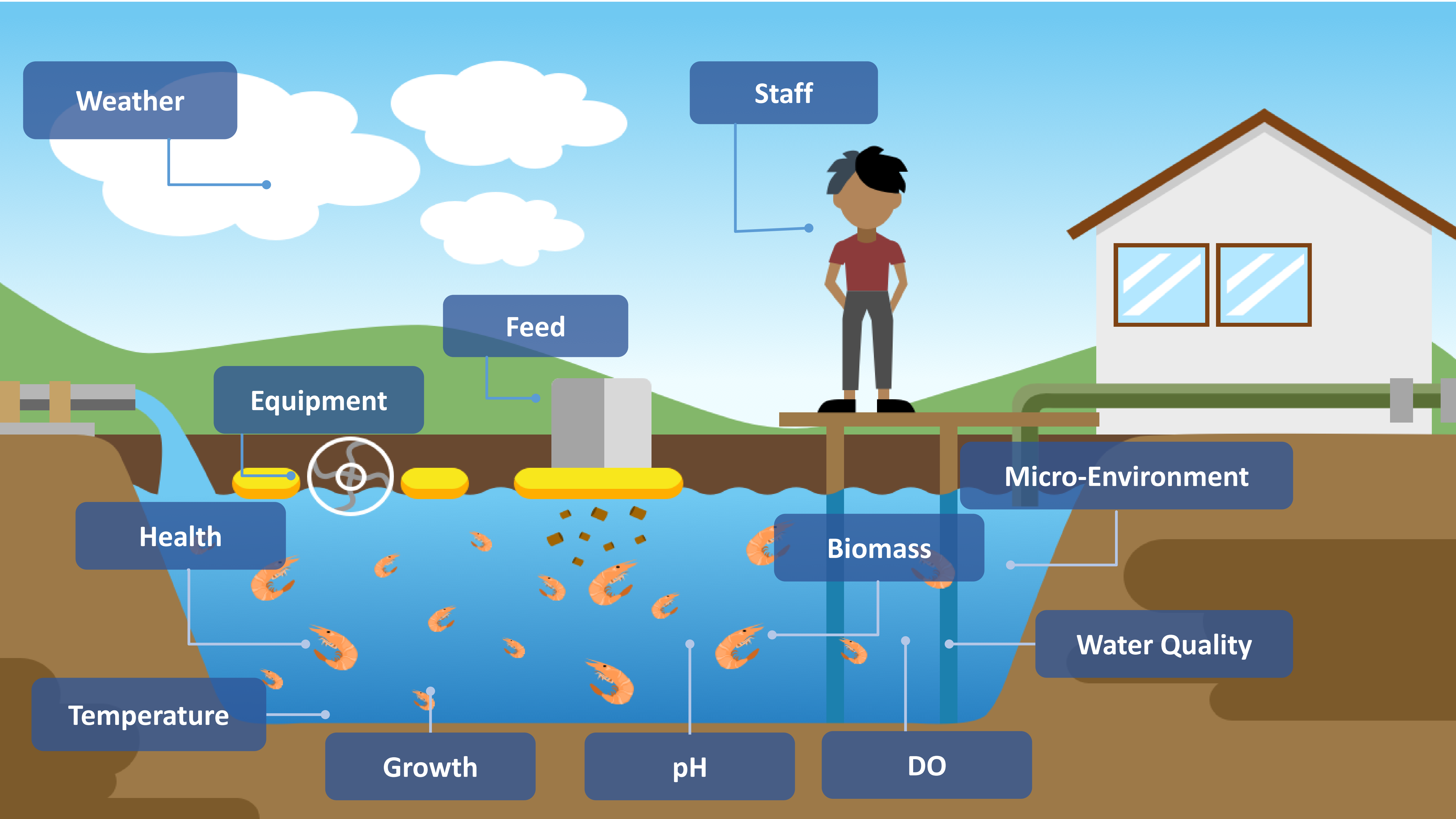
Wittaya Aqua

Making Farm Management Accessible to Aquaculture

Farms are complex, chaotic operations making decisions with imperfect information..

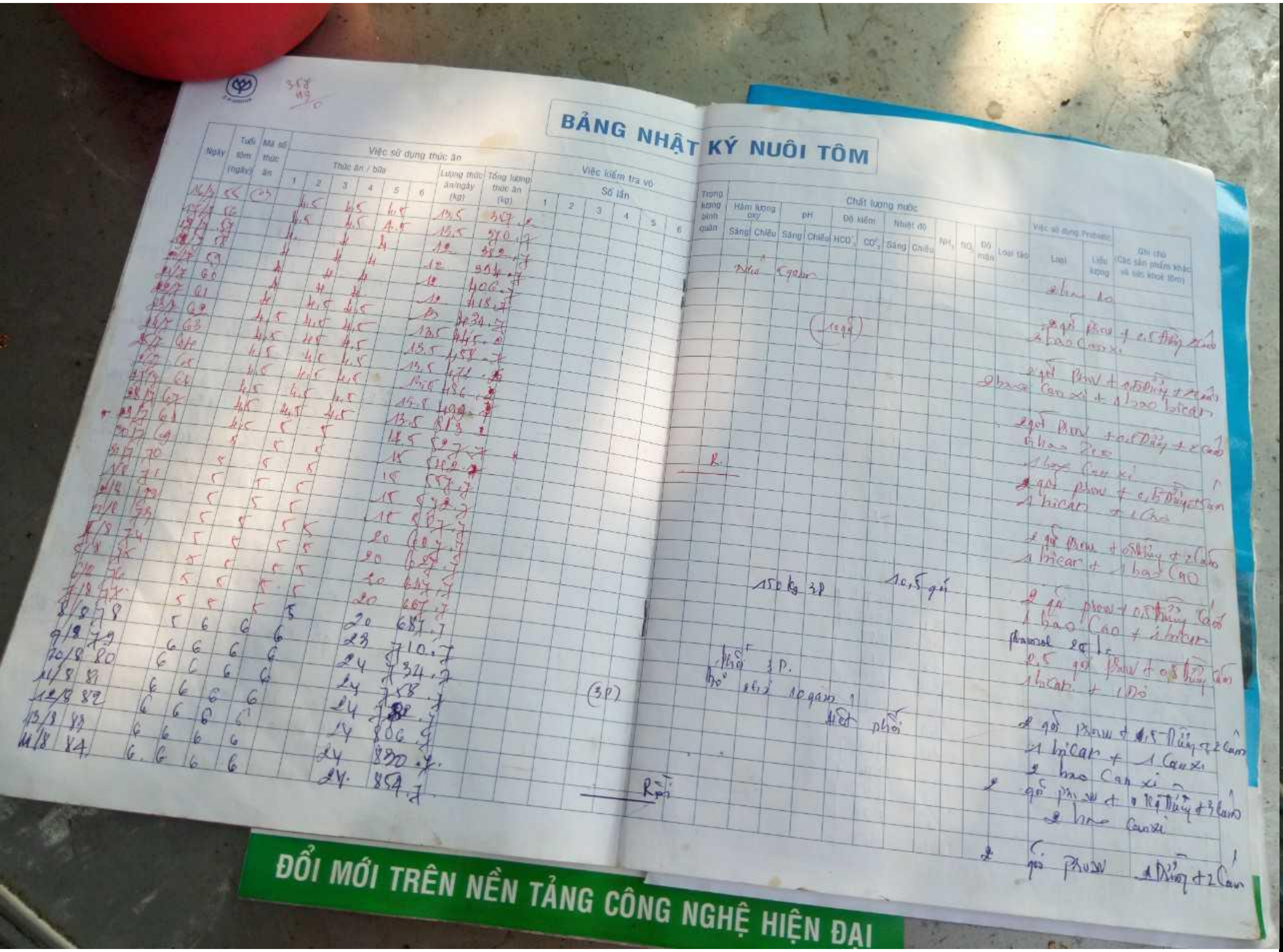
How Many Tilapia Can You Count?

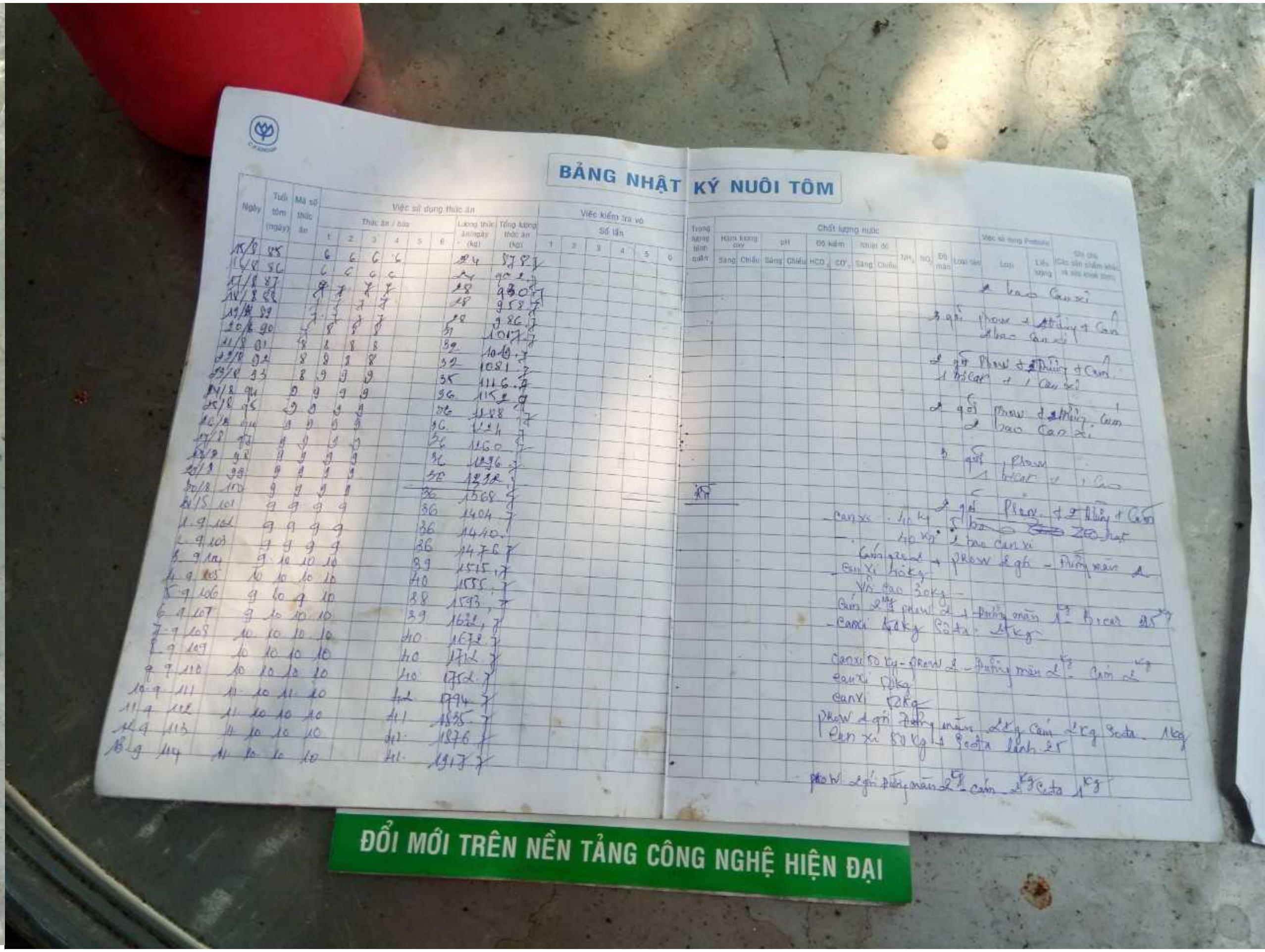
It can be very difficult to accurately assess performance of an aquaculture operation



Weather
Staff
Feed
Equipment
Micro-Environment
Health
Biomass
Water Quality
Temperature
Growth
pH
DO

How Data is Used in **Aquaculture**





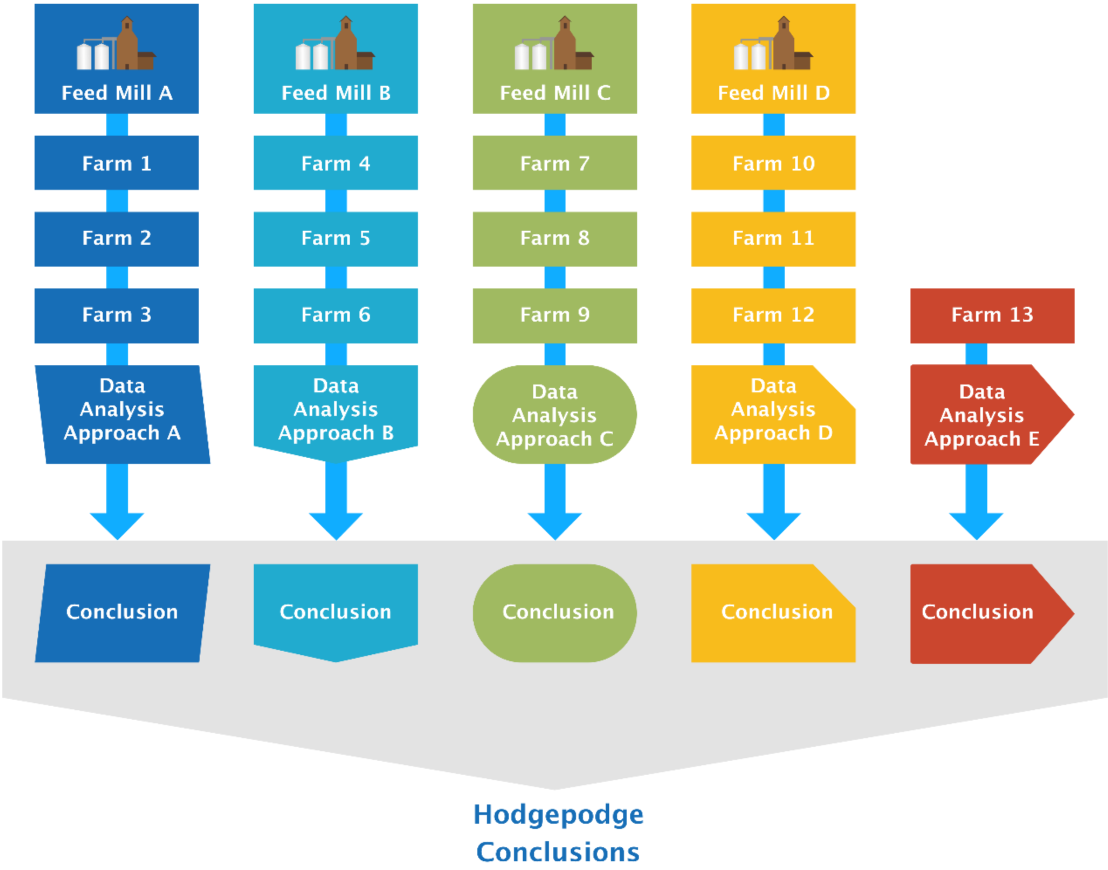
Typical Farm Growth + Feed Records Collected by Technical Field Staff

Growth performance and feed conversion of white pacific shrimp in East Java & Lampung

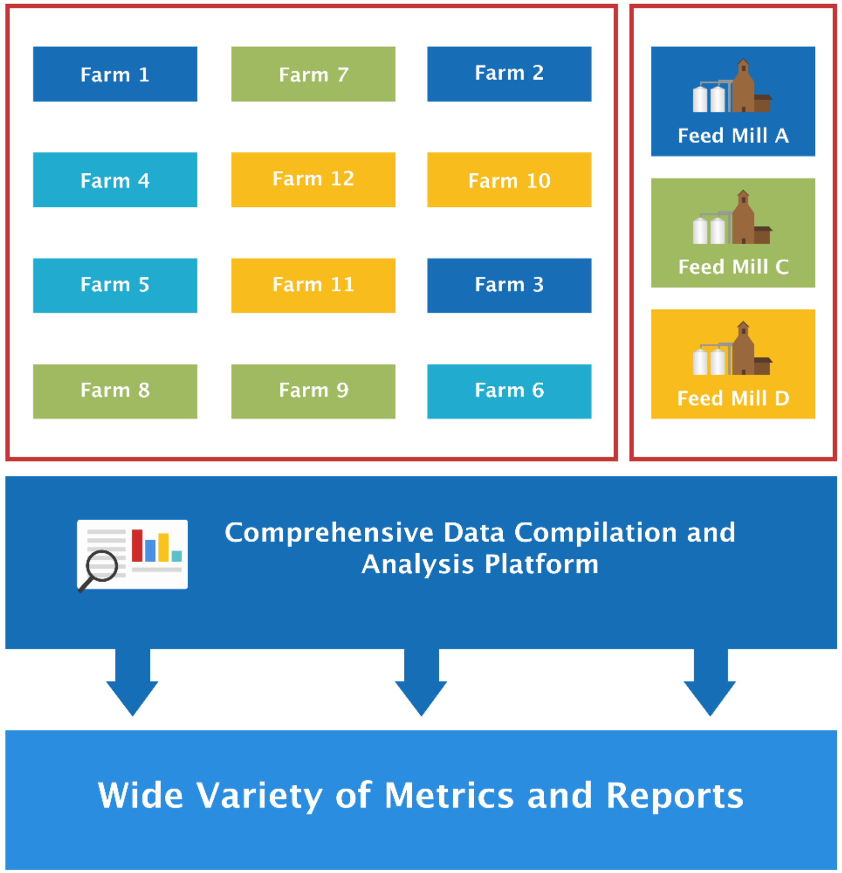
No	Pond Area (M2)	Stocking date	DOC (day)	Est ABW (g / pc)	Est SR (%)	Biomass (kg)	Feed consumed	Est FCR	Feed Type
1	Pond No:15	6/6/2008	63	8.2	76.0	1645.2	1423.0	0.86	S1
	2900 m2		71	9.5	91.0	2282.3	2134.0	0.94	G1
	Stock : 264,000 (± 91 pc/m2)		81	10.2	97.0	2612.0	2839.0	1.09	G1
	Hatchery : PPM		91	11.5	95.7	2905.5	3628.0	1.25	G1
			110	15.5	79.0	3232.7	4210.0	1.30	G1
2	Pond No:16	6/6/2008	63	7.5	82.0	1494.5	1262.0	0.84	S1
	2500 m2		71	8.6	97.0	2027.1	1913.0	0.94	G1
	Stock : 243,000 (± 97 pc/m2)		81	9.5	100.0	2308.5	2572.0	1.11	G1
			91	10.2	98.5	2441.4	3243.0	1.33	G1
			109	13.5	75.0	2460.4	4140.0	1.68	G1

A few certainties, a lot of non-sense….

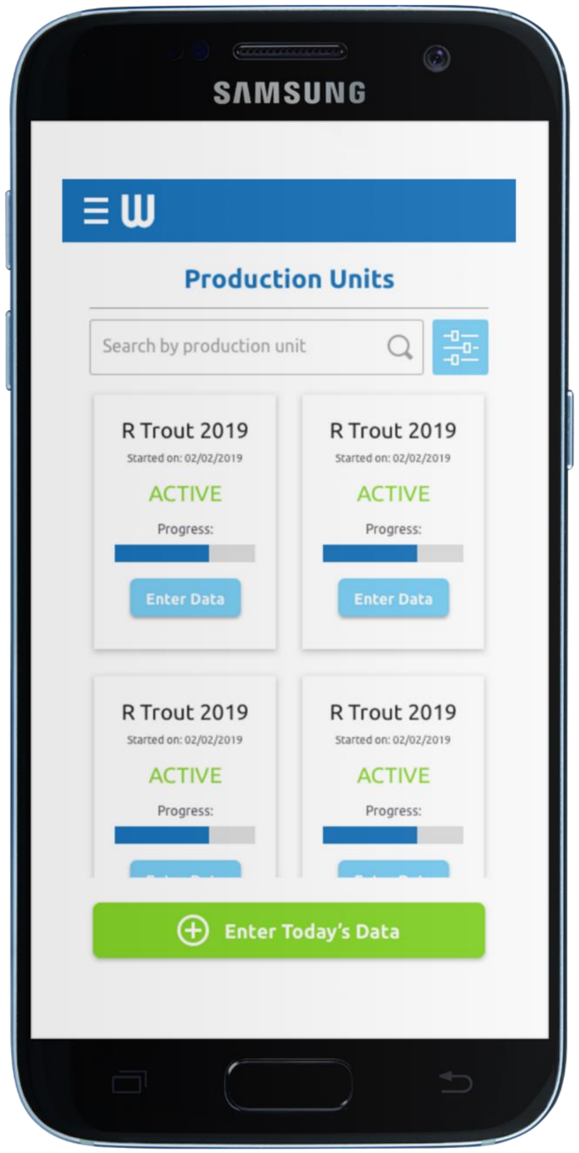
Current situation = Multiple Systems Each Accessible to a Few

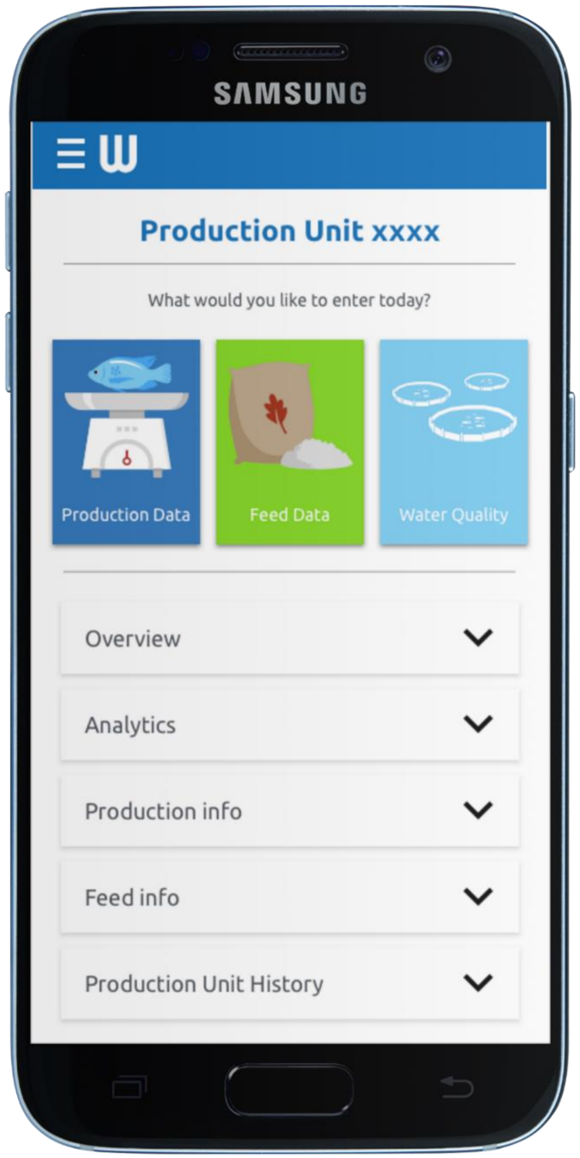


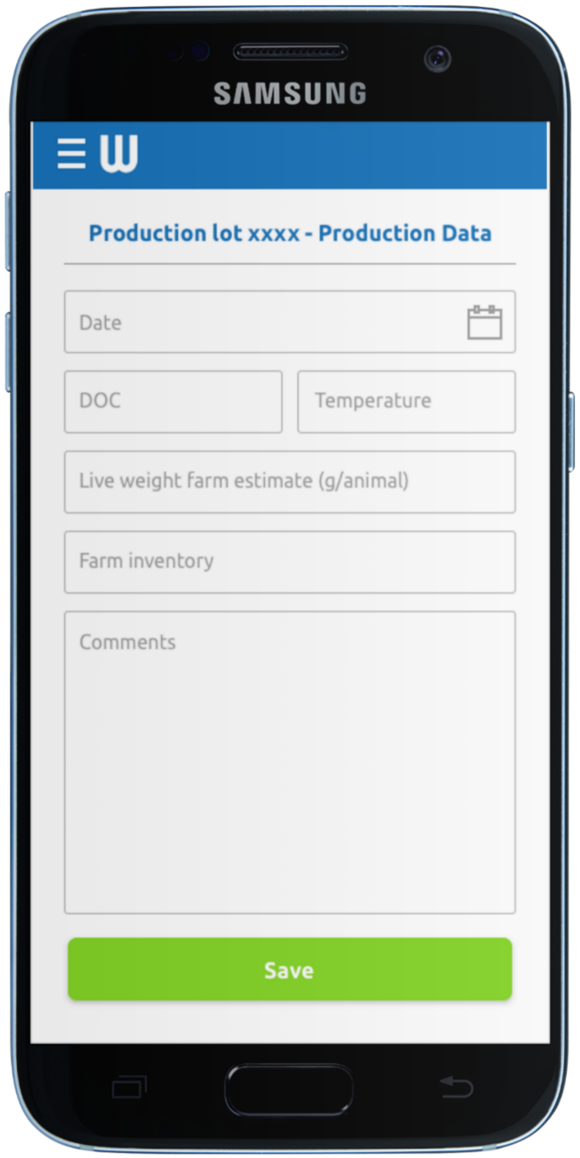
Ideal Situation = Robust, Comprehensive but Flexible Systems Accessible to All



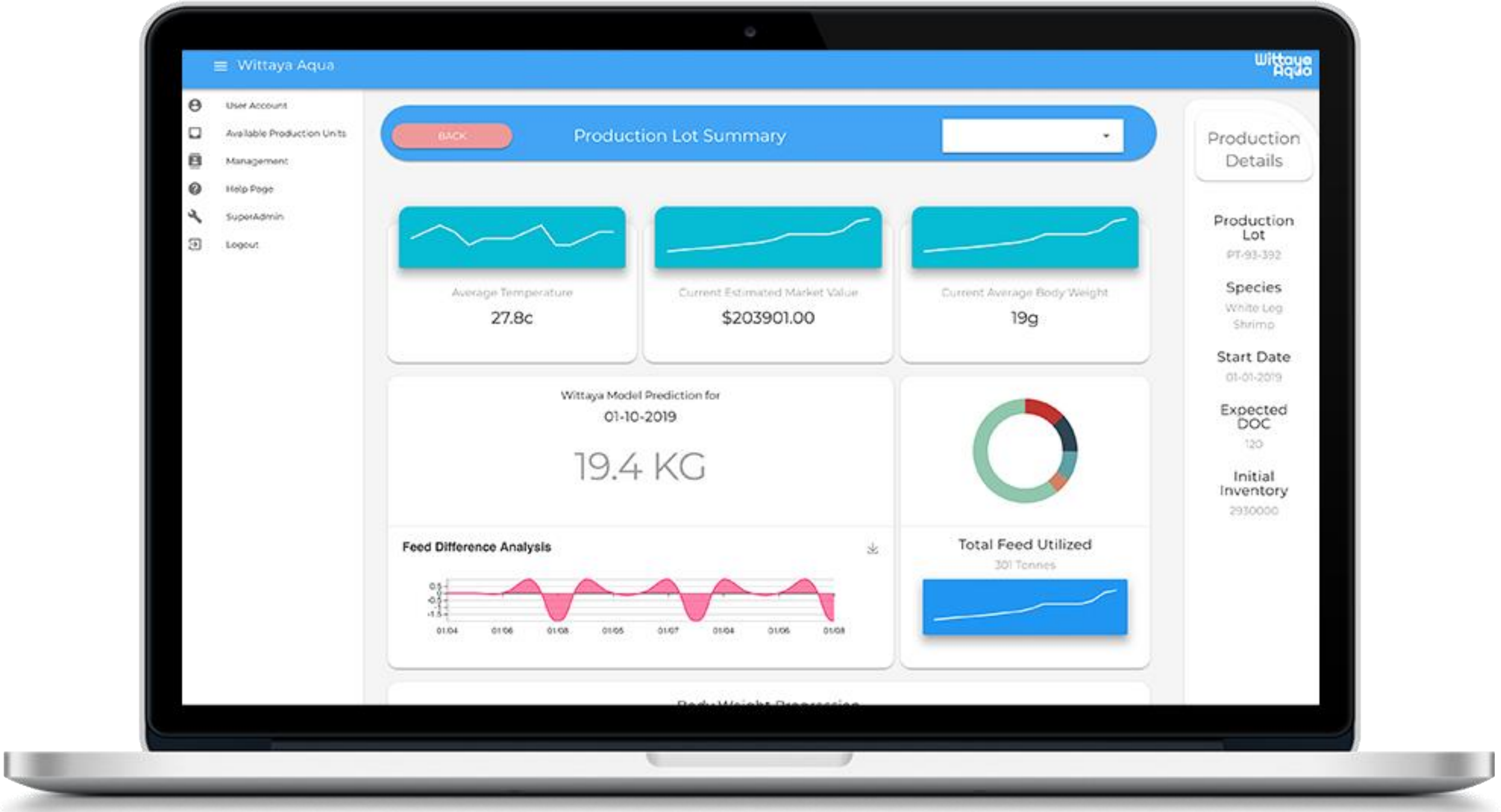
Our Solution- Easy Data Input





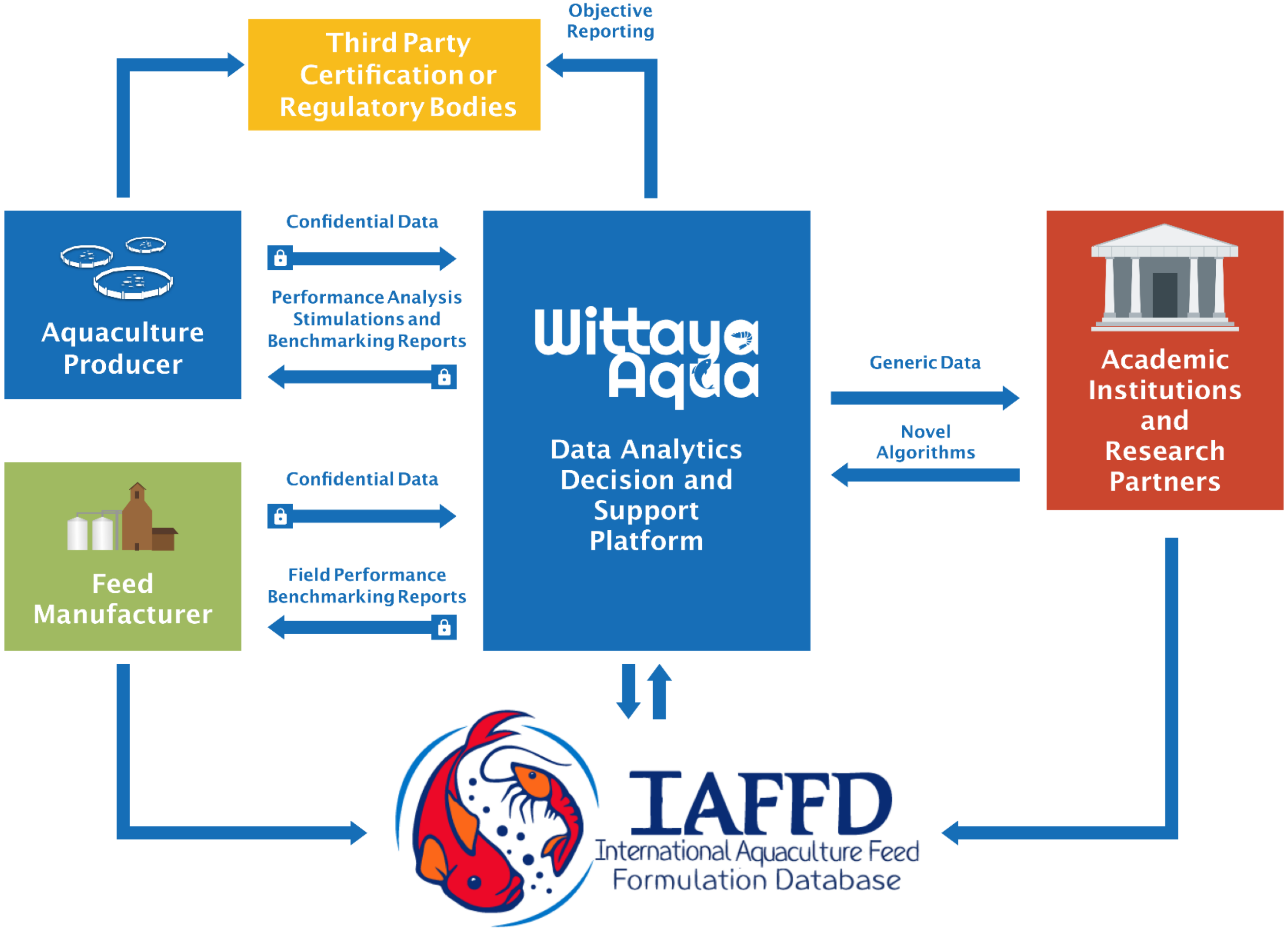


Our Solution- Easy Data Analysis



Conceptual Architecture of Wittaya Aqua

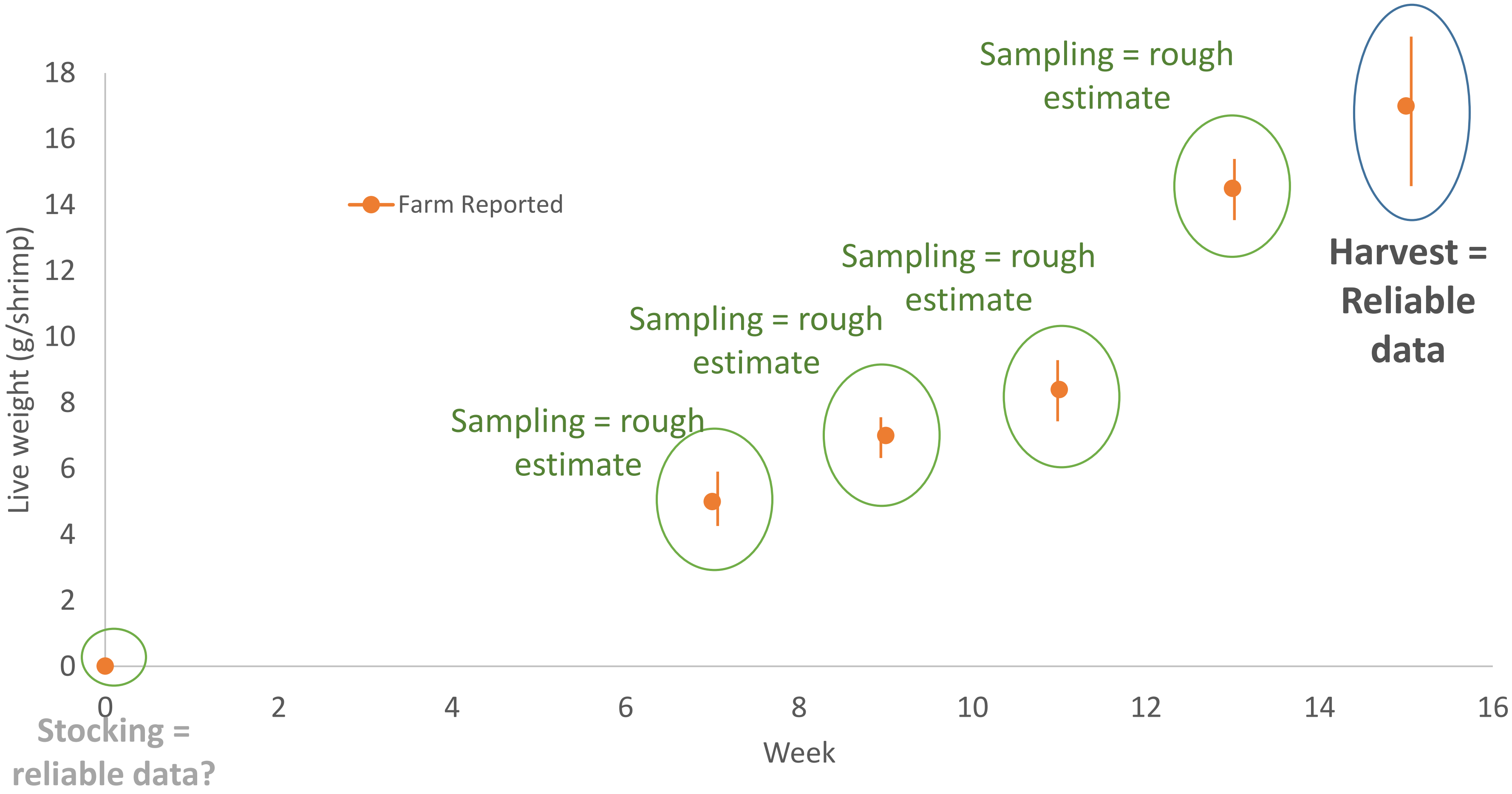
Wit in Aquaculture Production and Feeding Management



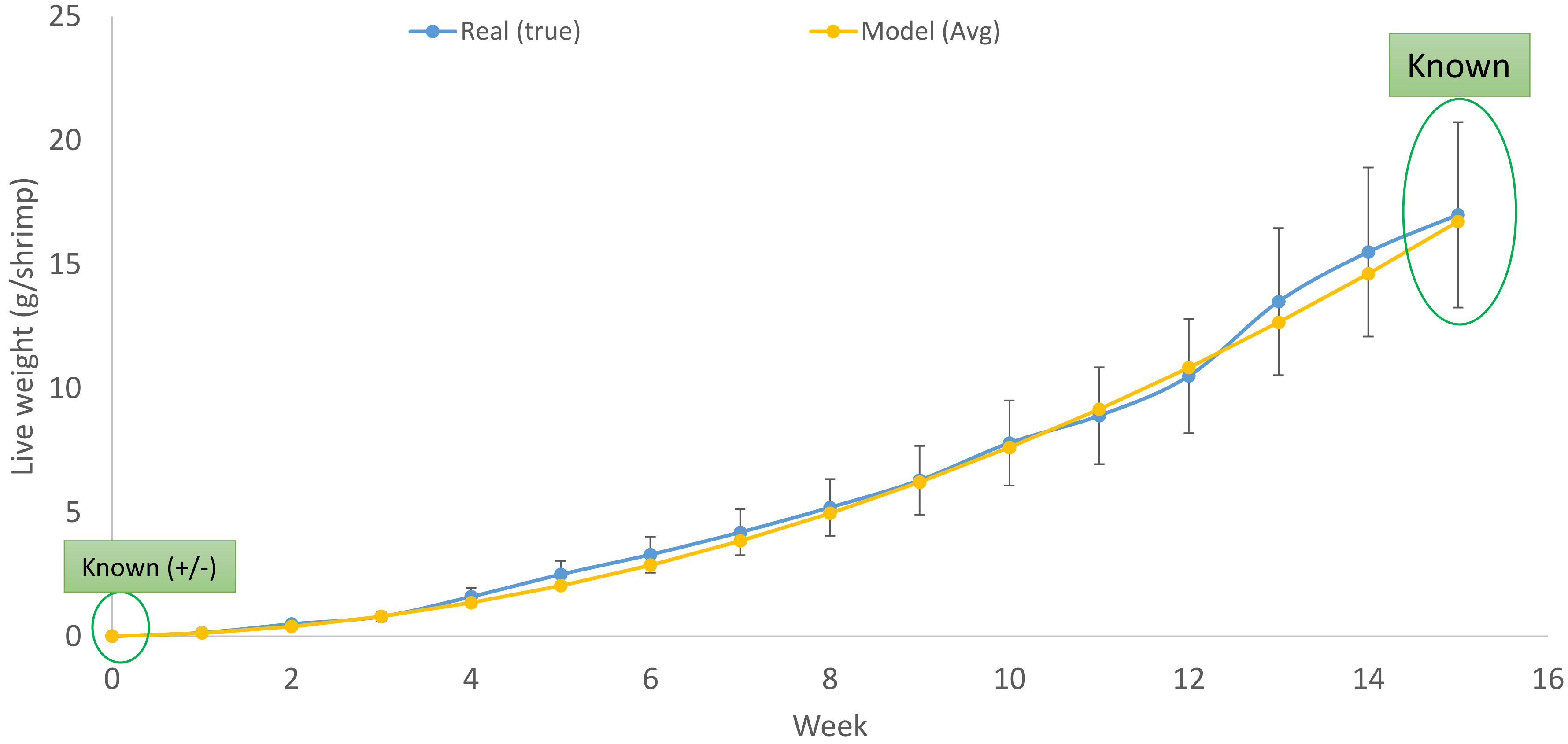

Aquaculture Operations
Feed Manufacturers
Wittaya Aqua-Op
Production and Feeding Management Tools
Production Data
Benchmark and Reports
Feed Information
Nutrition Optimization and R&D Tools
Wittaya Feed
Wittaya Aqua
Data Analytics and Decision Support Platform
Geo Spatial and Temporal Analysis
Market Intelligence
Epidemiological Analysis
Genetic Evaluation

Typical Shrimp Farm Data

Estimates of live weight



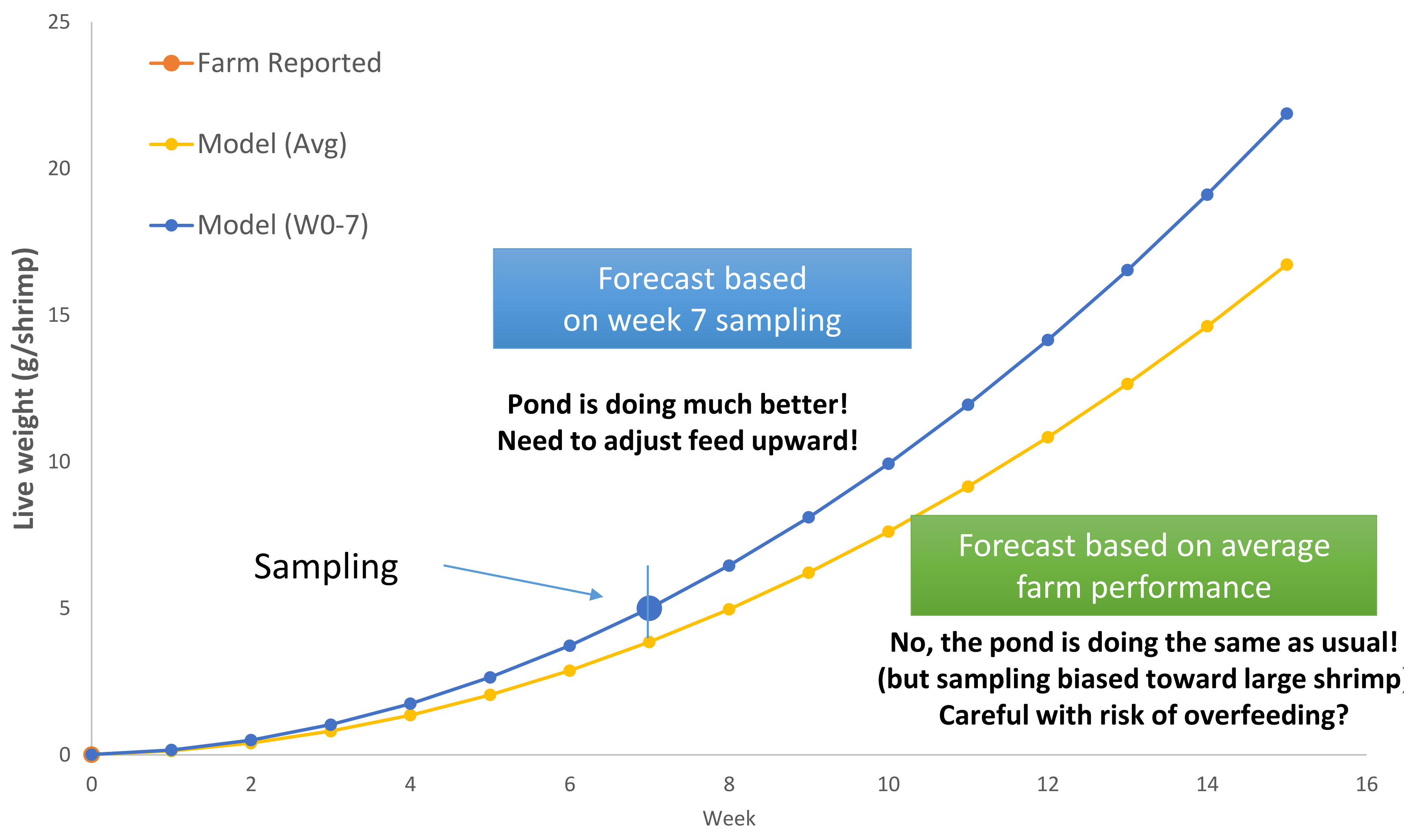
The expected growth trajectory of L. vannamei based on farm average and estimated growth trajectory of one production lot



Most these points in between are just rough estimates. Should we care?
Any value in having reasonable estimates?

Scenario: Testing a new PL source, a new feed or different production protocol

Forecasting Growth of Shrimp Based on first <u>Sampling Weight</u> or <u>Farm Average</u> Performance



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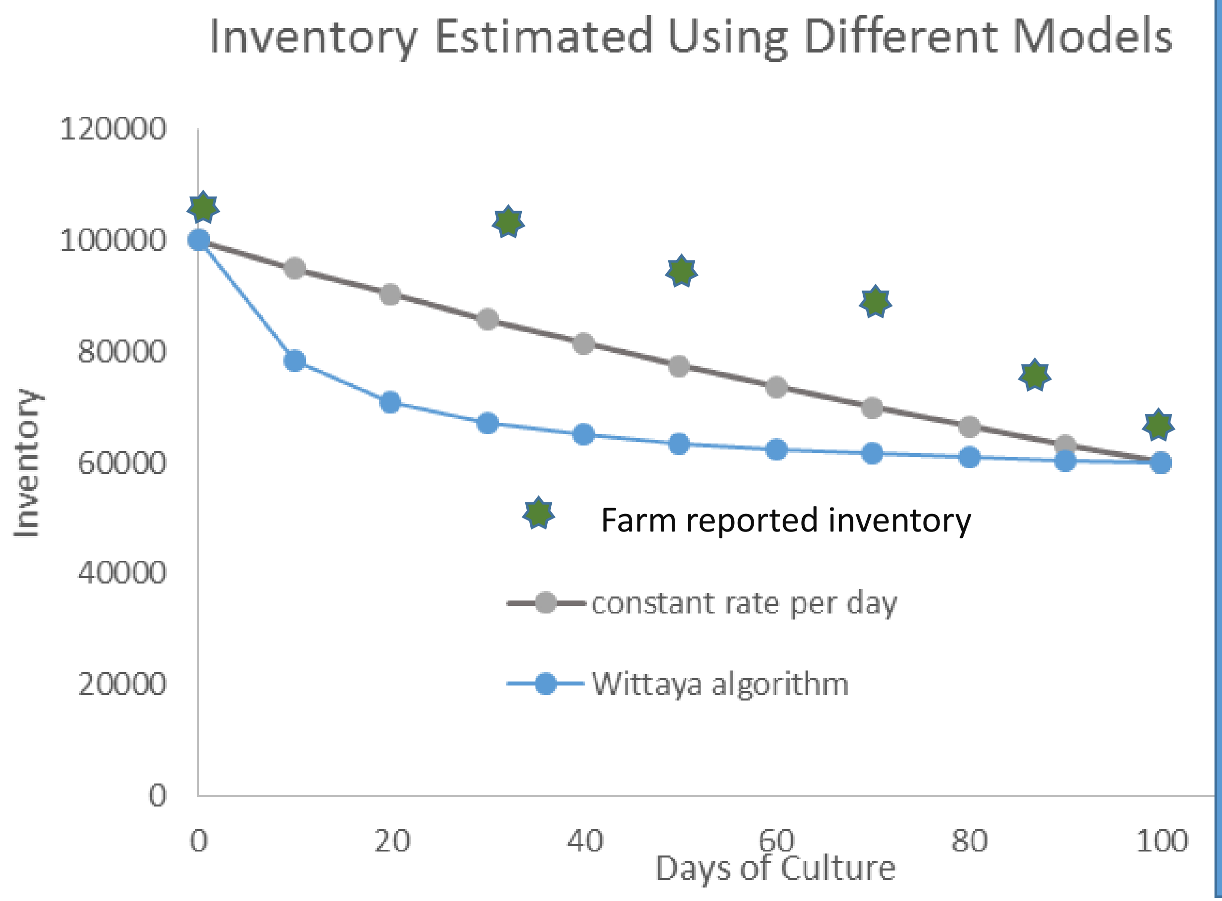
A few certainties, a lot of non-sense….

Client: Blue Horizon Venture Species: L. Vannamei

Production Lot: WA-BHAV-201509-LV-P091- 23456



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Wittaya Feed - Features

Nutritional Features

Tools enabling the prediction of optimal nutritional specifications of feeds

Models of estimation of the digestible nutrients and energy of feeds

Feed ingredient economical valuation (aka. price shadowing)

Client Support Tools

Feeds and farm-specific feeding charts

Feed inventory and ordering management system

Monitoring and Reporting Features

Systematic monitoring of commercial field performance and nutritional characteristics of feeds

Objective computation of complex metrics / indicators (FIFO, waste outputs, etc.)

Confidential and non-interfering benchmarking and collaboration amongst stakeholders

Ex: aquaculture producers, feed manufacturers, breeders etc.