2018 | THE ALMOND CONFERENCE

OPTIMIZING ALMOND HULLS FOR DAIRY, POULTRY AND INSECT FEEDSTOCKS IN THE U.S. AND ABROAD

ROOM 306-307 | DECEMBER 6, 2018

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growing ADVANTAGE
The Almond Conference

AGENDA

Moderator:

- **Mike Curry**, Johnson Farms

Speakers:

- **Jed Asmus**, January Innovation, Inc.
- **Woo Kyun Kim**, University of Georgia
- **Jean VanderGheynst**, UC Davis
- **Eric Tilton**, HermetiaPro

Feedstuffs for Dairy Cow Diets: Considerations for Almond Hull use and Production

Jed Asmus, M.S., PAS

January Innovation Inc.

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What we are going to review:

- The objective of Dairy producers, and how it relates to feeding cows
- How feed stuffs are selected, measured and compared
- Comparing Almond Hulls to other feeds commonly used
- Information known about Almond Hulls
- …. And the things we have yet to learn.
- Concerns with feeding them.

The goal for Dairy Producers

- Like all businesses, the objective is to be as profitable as possible.
- If milk is money (which it is), the goal of all dairy producers is to produce milk as efficiently as possible.
- The single largest cost center on a dairy is feed; Accounting for up to 60% of total expenses.
- This means, that the more efficiently the cow uses the feed she consumes, the more productive she is, and can mean the more profitable she is.

- Its worth remembering that milk is a commodity, with average profit margins running around 3-5% over time.

Which one to choose

- Designing diets for dairy cattle is a very technical, and scientific undertaking
  - Variables considered when designing diets include

Age of Cattle	Cattle Grouping
Milk production	Risk
Stage of Lactation	Margin of Error
Components	Cash Flow
Feed prices	Genetics
Feed quality	Breed
Feed Supply	Geographical Location
Weather	Milk Pricing structure
Labor	Owners business objectives
Equipment	Future herd demographics

How the industry looks at feeds for diet design

- Feed stuffs are compared on an analytical basis
  - Samples are sent out for chemical analysis, often resulting in 30+ variables being reported and used in diet design.
- Diets are designed using more and more complicated nutrition programs.
  - All programs use the chemical analysis of feeds as inputs, along with the variables from the prior slide to constrain the diets
  - None of the software account for variability of a feed supply, risk or human error… assuming the output will be implemented perfectly.

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An example of a nutrient report.

SAMPLE INFORMATION			
Lab ID:	24886 079	Series:	
Crop Year:	2018	Version:	1.0
Cutting#:			
Feed Type:	ALMOND HULLS		

CHEMISTRY ANALYSIS RESULTS	
Moisture	8.1
Dry Matter	91.9

PROTEINS	% SP	% CP	% DM
Crude Protein			6.2
Adjusted Protein			6.2
Soluble Protein		39.7	2.5
Ammonia (CPE)			
ADF Protein (ADICP)		13.3	0.82
NDF Protein (NDICP)		23.4	1.44
NDR Protein (NDRCP)			
Rumen Degr. Protein			
Rumen Deg. CP (Strep.G)			

FIBER	% NDF	% DM
ADF	53.7	10.9
aNDF		20.3
aNDFom		
NDR (NDF w/o sulfite)		
peNDF		
Crude Fiber		
Lignin	29.67	6.01
NDF Digestibility (12 hr)		
NDF Digestibility (24 hr)		
NDF Digestibility (30 hr)		
NDF Digestibility (48 hr)		
NDF Digestibility (240 hr)		
uNDF (30 hr)		
uNDF (240 hr)		

CARBOHYDRATES	% Starch	% NFC	% DM
Silage Acids			
Ethanol Soluble CHO (Sugar)		51.0	33.0
Water soluble CHO (Sugar)			
Starch		2.2	1.4
Soluble Fiber			
Starch Digestibility (7 hr)			
Fatty Acids, Total (%DM)			
Crude Fat			2.26

MINERALS	
Ash (%DM)	8.01
Calcium (%DM)	0.27
Phosphorus (%DM)	0.10
Magnesium (%DM)	0.14
Potassium (%DM)	3.19
Sulfur (%DM)	0.04
Sodium (%DM)	0.01
Chloride (%DM)	0.05
Iron (PPM)	137
Manganese (PPM)	18
Zinc (PPM)	10
Copper (PPM)	4
Molybdenum (PPM)	
Selenium (PPM)	
Nitrate Ion (%DM)	

FERMENTATION	
Total VFA	
Lactic Acid (%DM)	
Lactic as % of Total VFA	
Acetic Acid (%DM)	
Propionic Acid (%DM)	
Butyric Acid (%DM)	
Isobutyric Acid (%DM)	
1, 2 Propanediol (%DM)	

ENERGY & INDEX CALCULATIONS	
pH	
TDN (%DM)	70.6
Net Energy Lactation (Mcal/lb)	0.72
Schwab/Shaver NEL (Processed)	
Schwab/Shaver NEL (Unprocessed)	
Net Energy Maintenance (Mcal/lb)	0.73
Net Energy Gain (Mcal/lb)	0.46
NDF Dig. Rate (Kd, %HR, Van Amburgh, Lignin*2.4)	
NDF Dig. Rate (Kd, %HR, Van Amburgh, iNDF)	
Relative Feed Value (RFV)	
Relative Forage Quality (RFQ)	
Milk per Ton (lbs/ton)	
Dig. Organic Matter Index (lbs/ton)	
Non Fiber Carbohydrates (%DM)	64.7
Non Structural Carbohydrates (%DM)	34.4
DCAD (meq/100gdm)	78.7

Lets compare some feeds…

	Corn Silage	BMR	Almond Hulls	Pure Hulls	Non Hulls
Sample #	532	21	177	1	1
Dry Matter	34.5	34.6	86.1	91.3	91.7
Protein	7.96	7.94	5.81	4	4.7
NDF	41.6	44.7	28.3	21.7	58.2
NDFD30	59.1	69.7	29.5	-	-
ADF	26.1	27.7	20.7	15.5	41.9
Lignin	2.96	2.37	12.3	11.4	19.95
Starch	28.6	24.6	2.03	0.4	0.4
Sugar	2.43	2.97	32.03	38.1	12.3

So where do Almond Hulls fit?

- Almond Hulls are a source of fiber and digestible carbohydrates in the diet.
- Almond Hulls have been feed successfully for many years in commercial operations.
- The fiber they provide “can” be used as a substitute for traditional forages.
  - However we don’t have a good understanding of the rate of digestion of the fiber fraction of almond hulls.
- Oba and Allen reported that a 1% increase in NDF digestibility resulted in:
  - 0.17 kg (0.37 lbs) increase in dry matter intake by the cow
  - 0.25 kg (0.551 lbs) increase in milk production (4% fat corrected milk)
- At todays market prices for feed, this change would result in a net increase of $0.041 per head per day in revenue
- This is equivalent to spending $1 and generating $1.92 gross in return.
- In a low margin business, efficiency of use from your largest cost is very important.

Lets review how the forage digestibility compares

	Corn Silage	BMR	Almond Hulls	Pure Hulls	Non Hulls
Sample #	532	21	177	1	1
Dry Matter	34.5	34.6	86.1	91.3	91.7
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NDFD30	59.1	69.7	29.5	-	-
ADF	26.1	27.7	20.7	15.5	41.9
Lignin	2.96	2.37	12.3	11.4	19.95
Starch	28.6	24.6	2.03	0.4	0.4
Sugar	2.43	2.97	32.03	38.1	12.3

What don’t we know

- To be honest… We have a lot to learn!
- We don’t truly know what percent of the NDF fraction of the feed will be digested efficiently.
  - The reason is we have not looked at the variables that affect the analytical analysis.
    - Contamination (Both in the supply from foreign material and in the lab from other nutrients)
  - No significant research has been conducted to look at the affects of higher levels of inclusion (above 6 pounds per head day.

- We don’t know what affect the growing season / conditions has on the crop.
  - Weather / environment has a significant impact on how forages grow, and thus how they digest for other crops. Does this apply to hulls also?

Practical Concerns from the field

- From a practical basis, the feed industry sees some challenges with almond hulls
  - Most of these challenges exist for all feeds at some level (we are not just picking on almond hulls)
- The largest one is contamination from other material.
  - The less shell in a load the more valuable the hulls are to the cow and the more profitable they are for the dairymen.
  - The industry lacks a fast and accurate way to measure this.
- Variation:
  - Brokers, aggregators, feed companies can supply one dairy with almond hulls from many different sources. This can create variation on the dairy that is not due to the variance created when produced, but from the difference in producers.
- Price Volatility

The good news … We are working to answer some of the questions.

In 2018 the Almond Board funded research proposed by a team on behalf of California ARPAS and UC Davis to explore the upper limits of feeding Almond Hulls.

In January we will start the feeding trial with the objective of quantifying the digestibility of Almond hulls commercially available as a feed stuff for lactating cow diets.

- In this study we will be pushing the “upper” limits of inclusion to determine what levels can be fed, and what the possible out come is.

Summary

- Almond hulls are a California Feed… and we have a lot of them and a lot to learn.
- Dairy cows can use Almond Hulls as a input to their daily diets
- We have much to still learn, but the process has already started.
- Though the industry has concerns, all of them can be managed and mitigated

Thank you!!!

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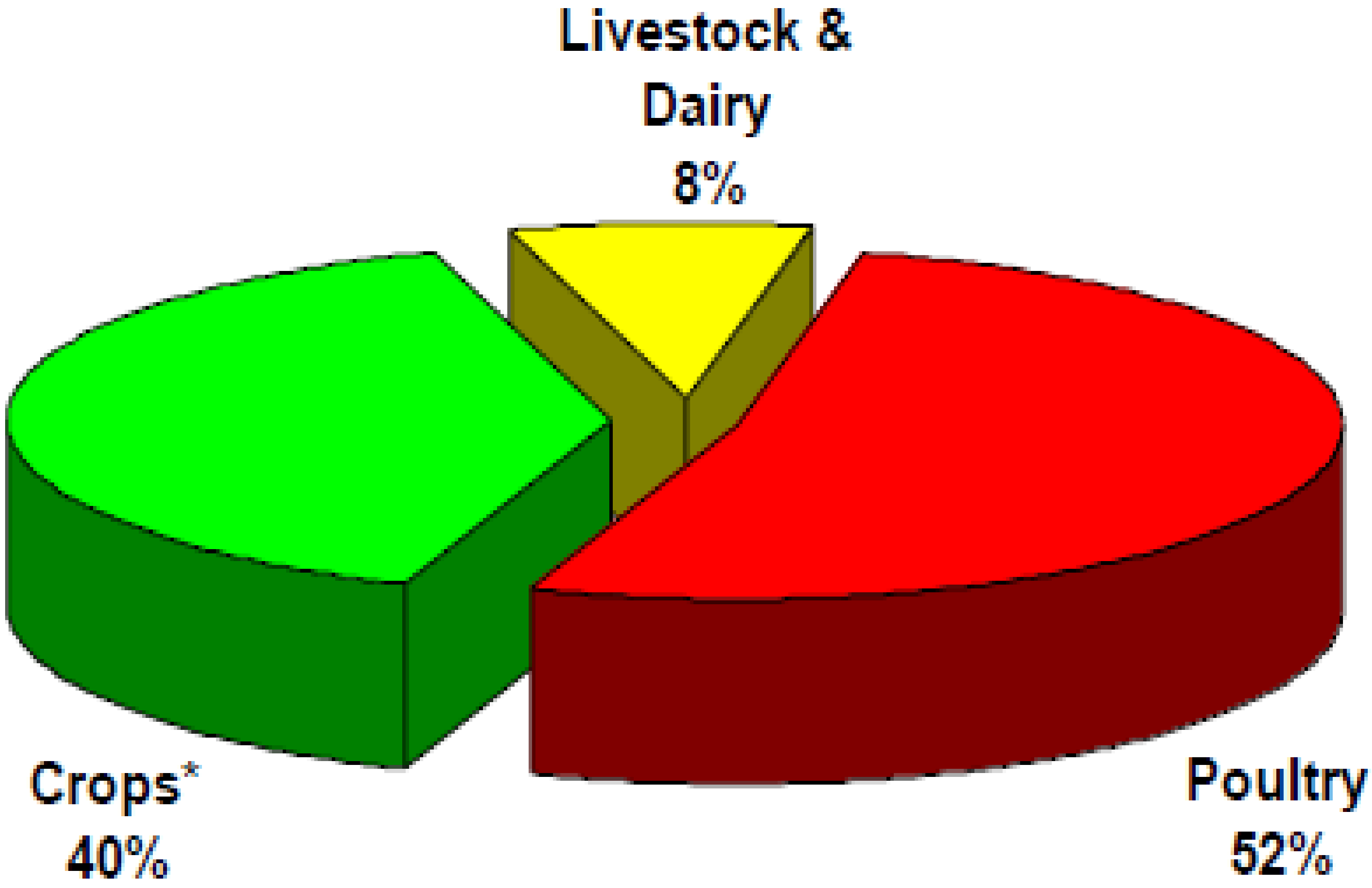
Utilizing almond hulls as a novel feed ingredient for poultry

Dr. Woo Kyun Kim
Department of Poultry Science
University of Georgia

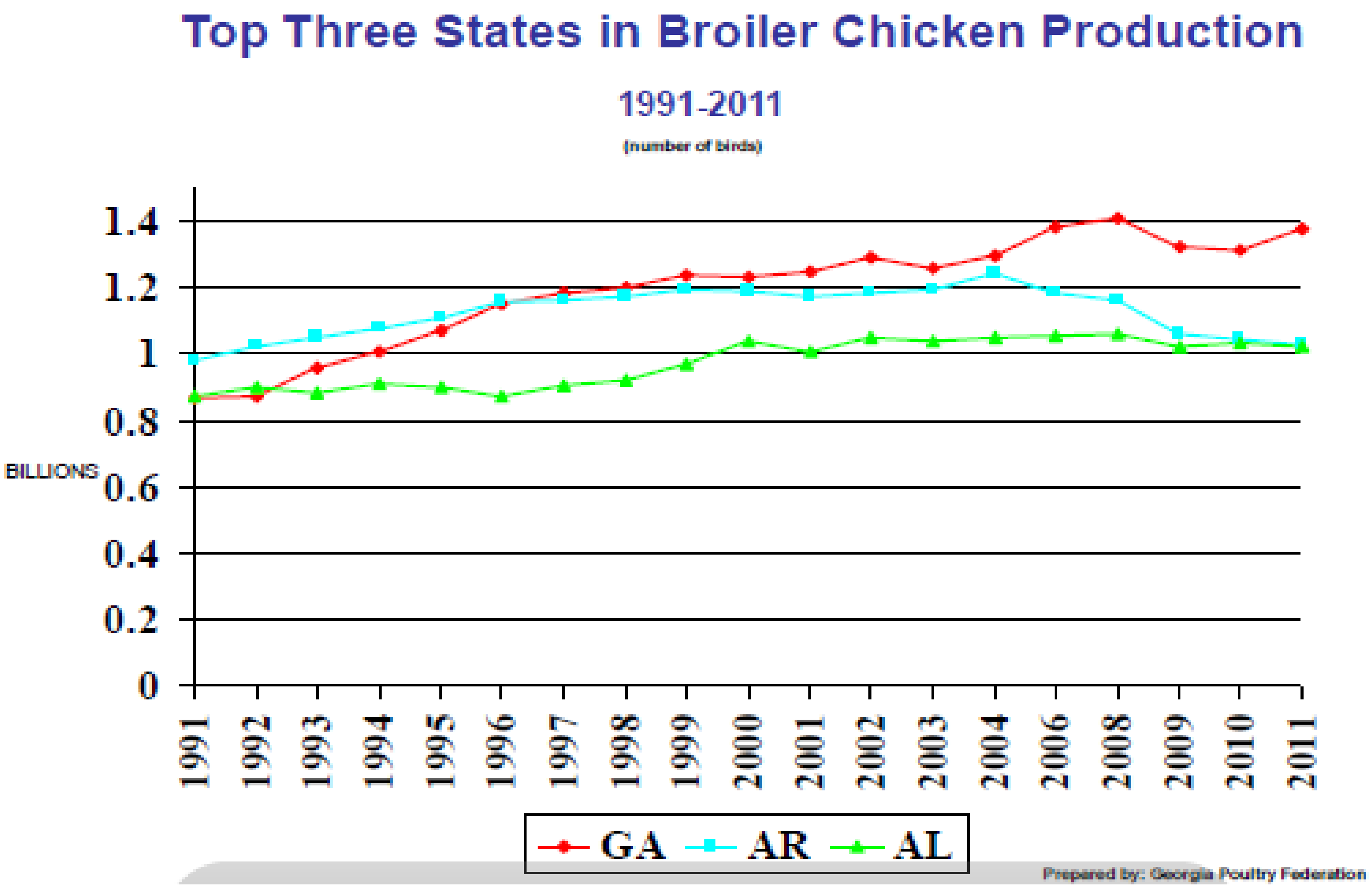
Almond Board of California

Georgia Poultry Industry

Georgia Poultry Industry



Georgia Poultry Industry



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Georgia Poultry Industry

If Georgia were a country, it would be the 7th largest in Broiler Production

(1,000 metric tons forecast for 2012)

United States	16,401
China	13,730
Brazil	13,250
India	3,200
Mexico	2,925
Russia	2,725
GEORGIA	2,425
Argentina	1,850
Turkey	1,687
Indonesia	1,540

Prepared by: Georgia Poultry Federation
Source: USDA/FAS
Updated: July 2012

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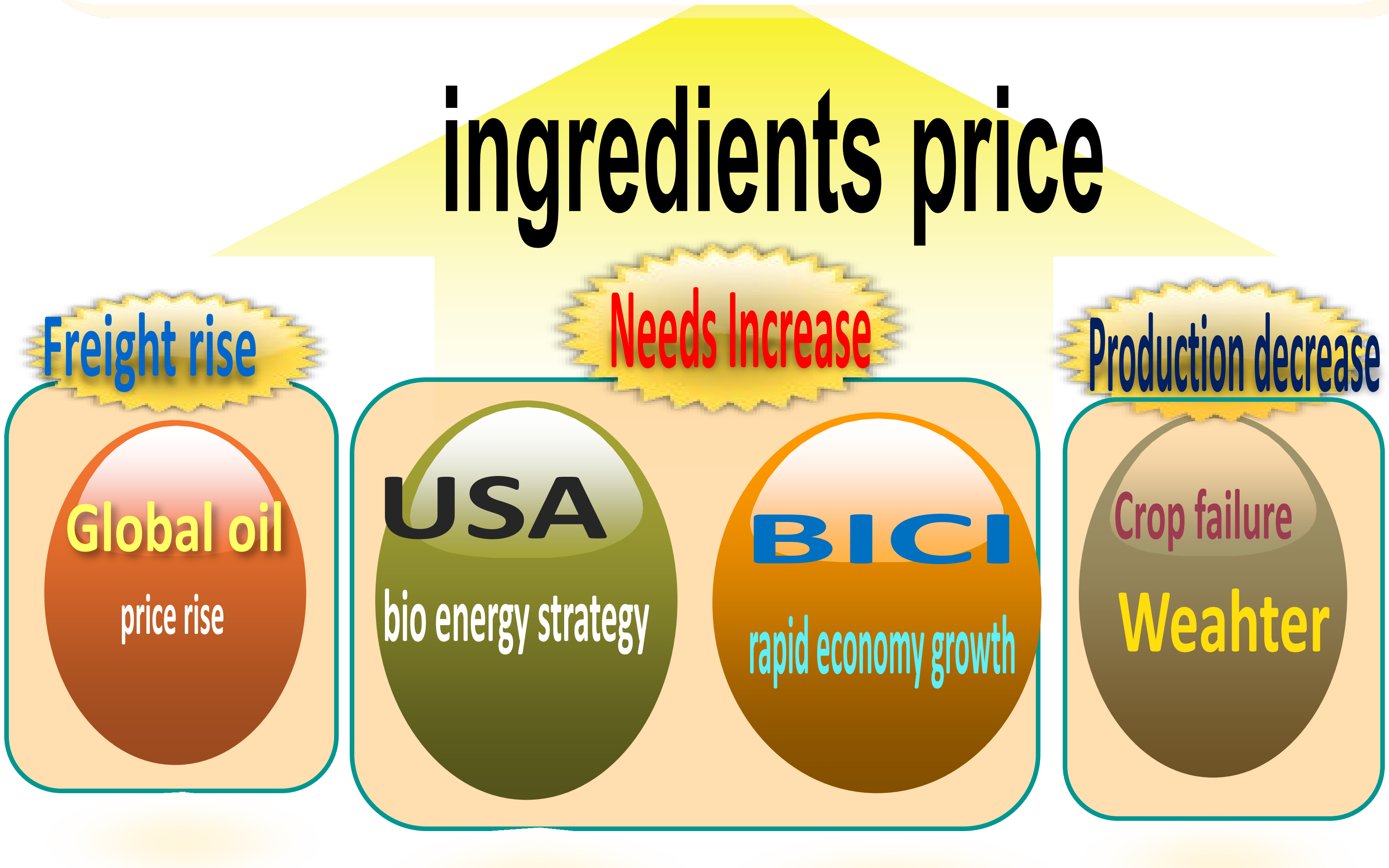
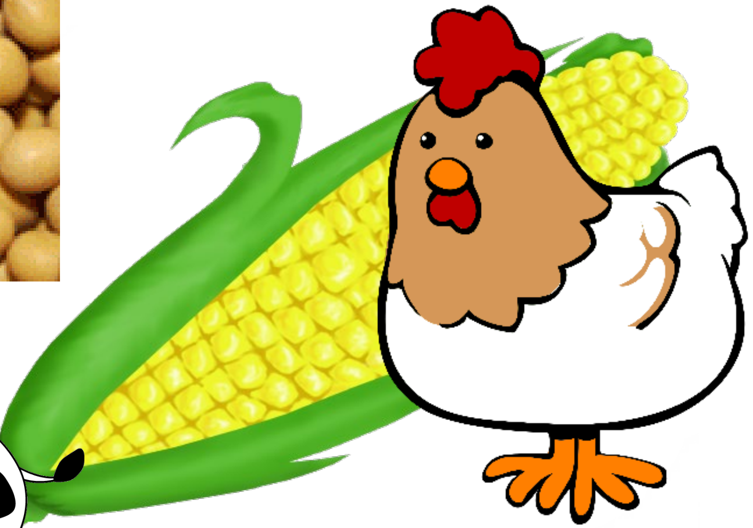
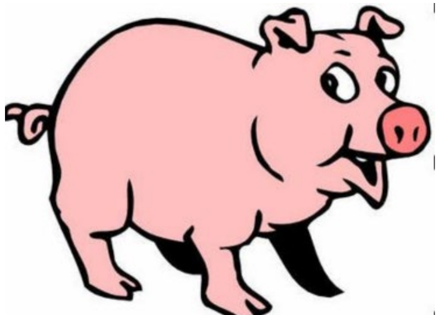
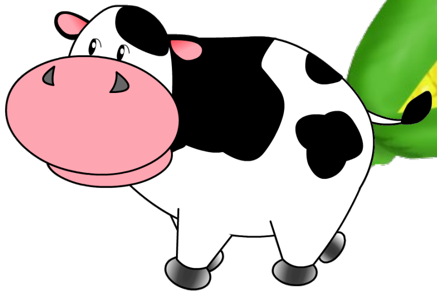
Maximizing Feed Nutrient Utilization



Corn and soybean







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Almond Hulls Processing:

Raw

Grinding

Extruding

Raw almond hulls

Nonpareil

Carmel

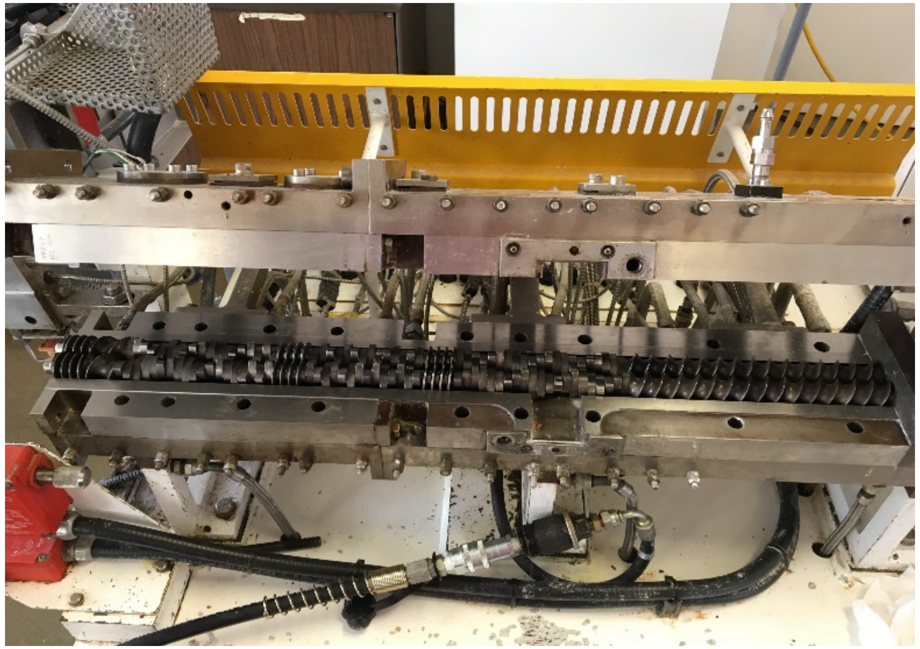
Nonpareil

Carmel

Extrusion:

- **Temperature: 120 °C**

- **Feeding rate: 190 g/min**



Nutrient profile: Rooster

Ground

Nonpareil

Carmel

Extruded

Nonpareil

Carmel

Roosters

Nutrient profile:

	Nonpareil		Carmel		Corn*
	Ground	Extruded	Ground	Extruded	Ground
ME, kcal/kg	1624	1447	1514	1375	3373
Fat, %	1.62	0.74	1.87	0.97	3.5
Crude fiber, %	13.11	11.03	26.35	24.82	1.90
Crude protein, %	4.80	4.41	5.01	4.60	7.5
Lys, %	0.15	0.12	0.14	0.11	0.24
Met, %	0.04	0.05	0.03	0.03	0.18

* Feedstuff, 2017 edition.

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Nutrient profile:

- **Extrusion:**
  Reduced the metabolizable energy
  Reduced fiber content

- **Future plans:**
  Extrusion cooking in lower temperatures

Broiler performance trial with ground almond hulls

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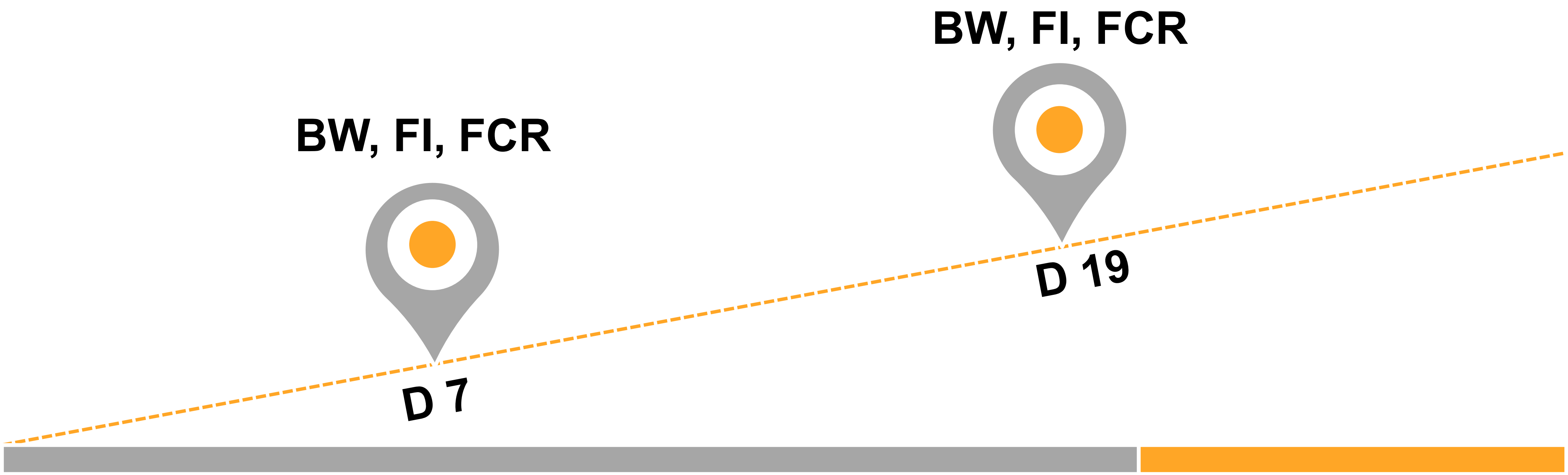
Experiment design:

1. Corn and SBM control (industry standard).
2. 3% Nonpareil.
3. 6% Nonpareil.
4. 9% Nonpareil.
5. 3% Carmel.
6. 6% Carmel.
7. 9% Carmel.

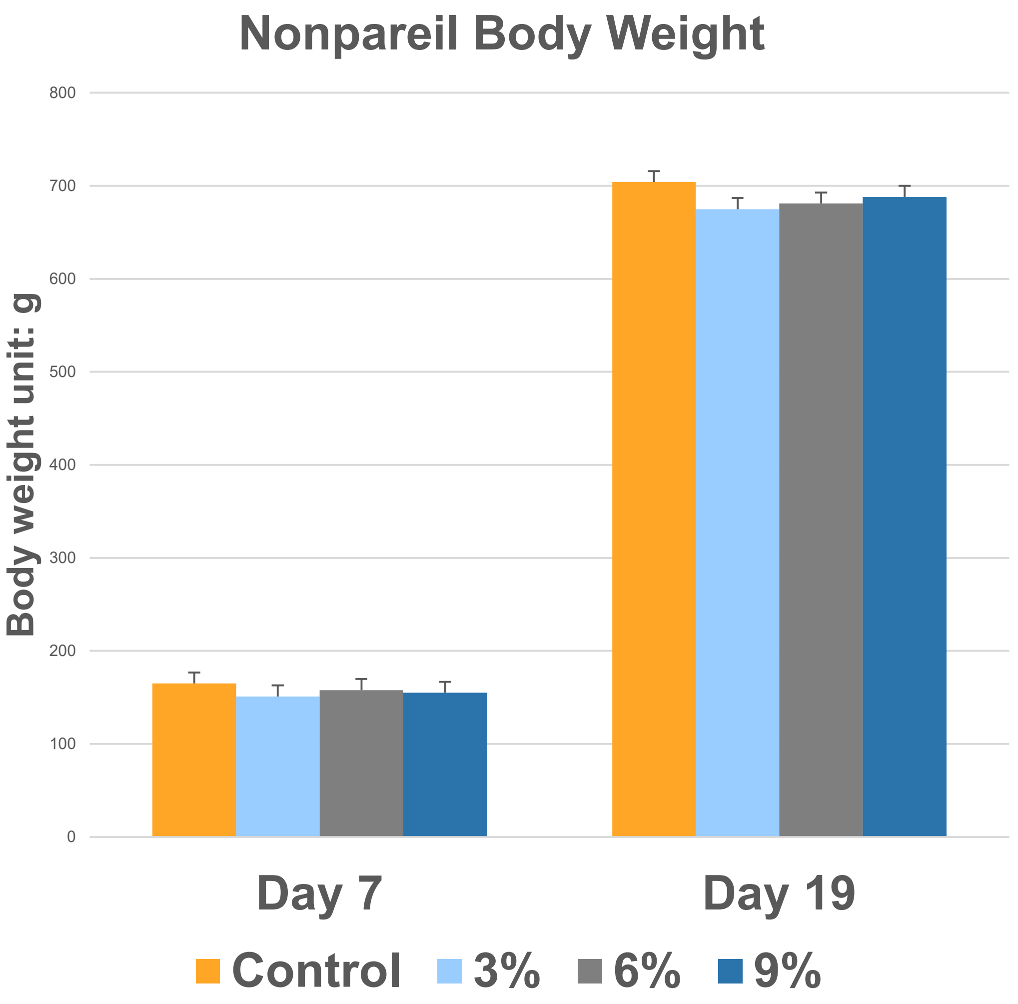
Material and Methods:

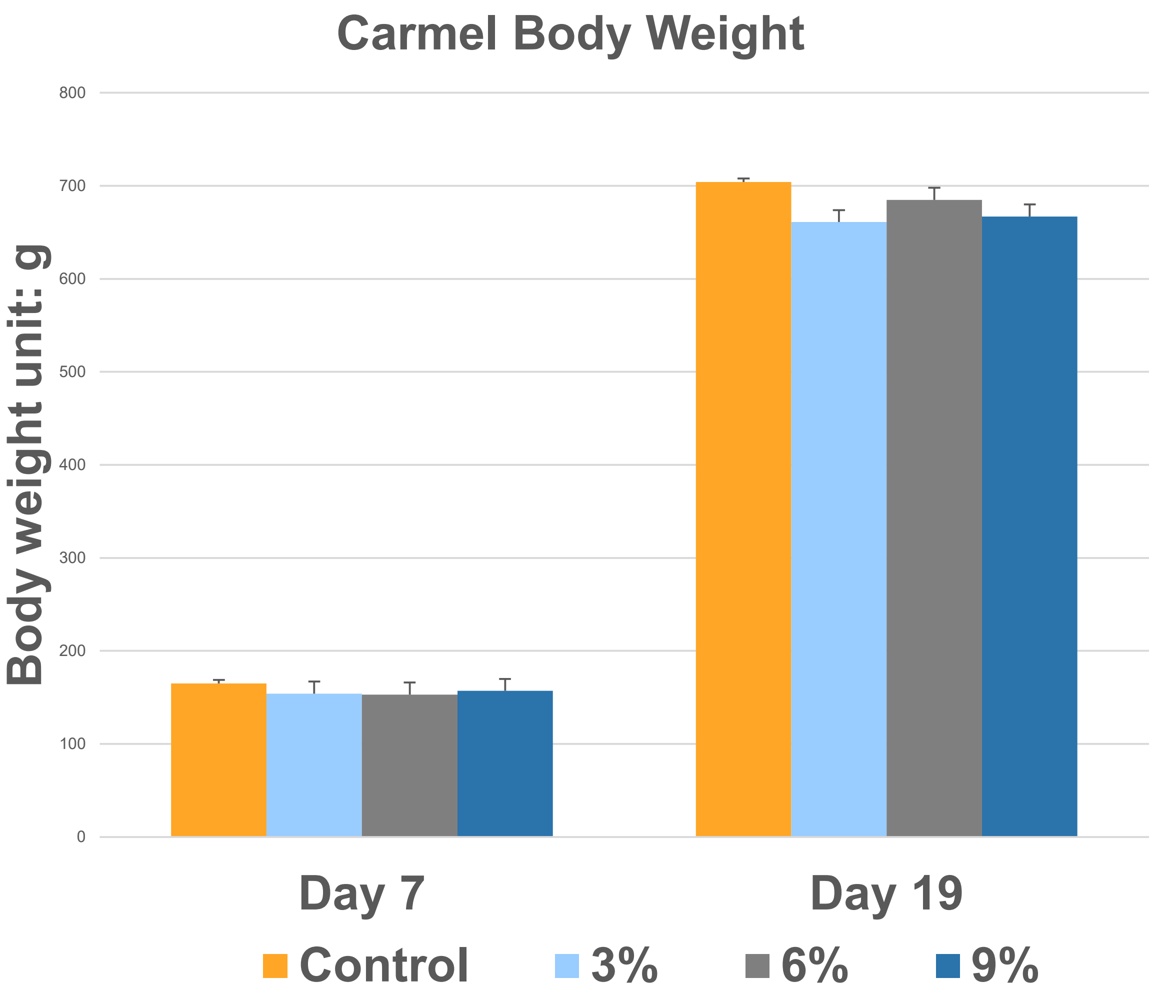
560 Cobb 500 male broiler chicks

- **7 treatments × 8 reps × 10 birds**



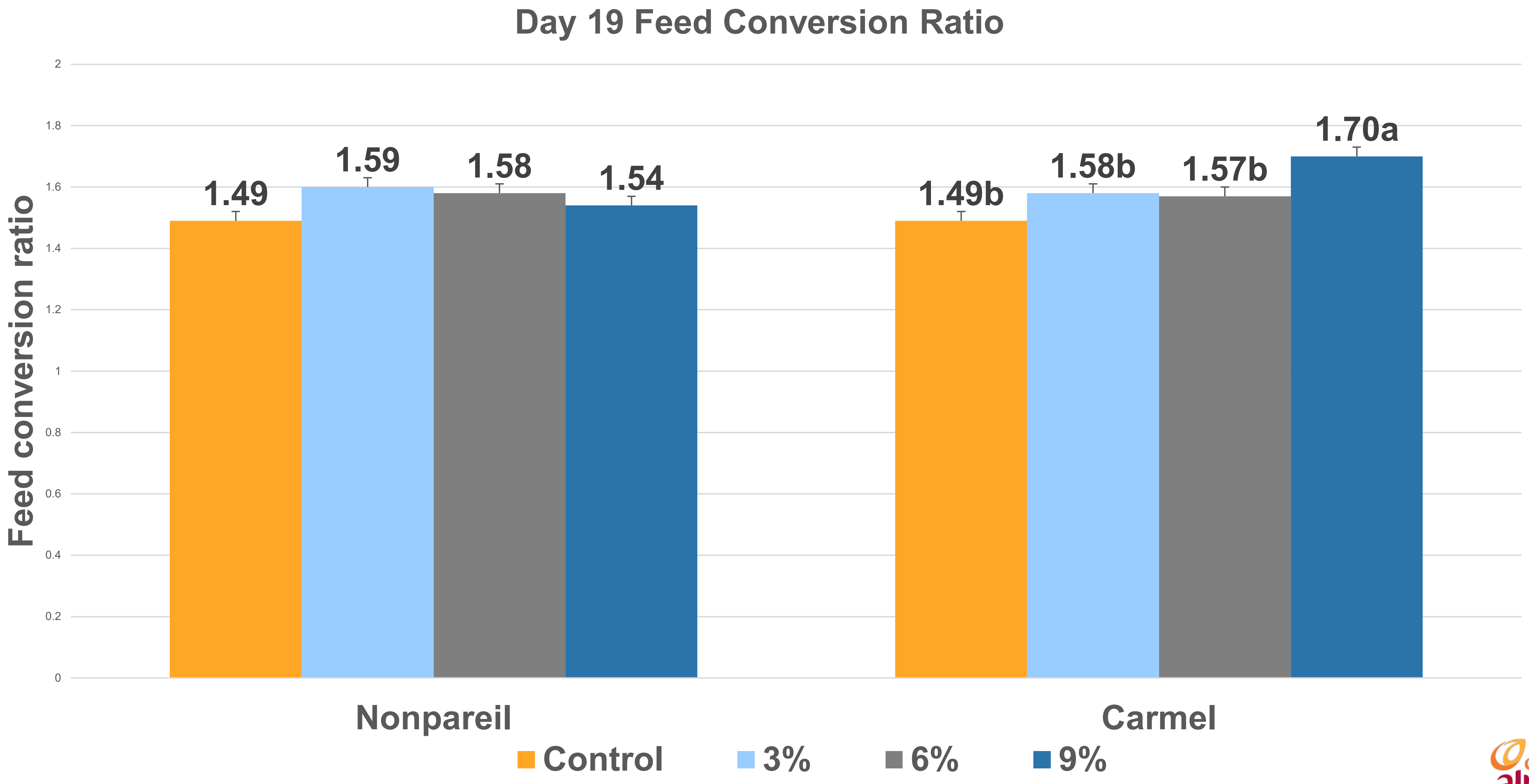
Body weight:


Nonpareil Body Weight
Body weight unit: g
0
100
200
300
400
500
600
700
800
Day 7
Day 19
Control
3%
6%
9%


Carmel Body Weight
Body weight unit: g
0
100
200
300
400
500
600
700
800
Day 7
Day 19
Control
3%
6%
9%

Feed conversion ratio: Feed intake/Body weight gain

$P_{Nonpareil} = 0.0606$
$P_{Carmel} = 0.0037$



Summary

- Nonpareil and carmeil contain considerable amount of sugar and carbohydrates to provide energy for poultry.
- Ground almond hulls have potential to become a good feed ingredient for poultry
- Chicken fed ground nonpareil upto 9% had similar growth performance compared to one fed control diet (corn and soybean meal).

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Future direction

- Identify better extrusion conditions: Test low temperature extrusion.
- Plan to use almond hulls as laying hen diets
- Plan to evaluate digestibility and digesting characteristics of almond hulls in poultry digestive track by an in vitro models

Thank you!

Questions?

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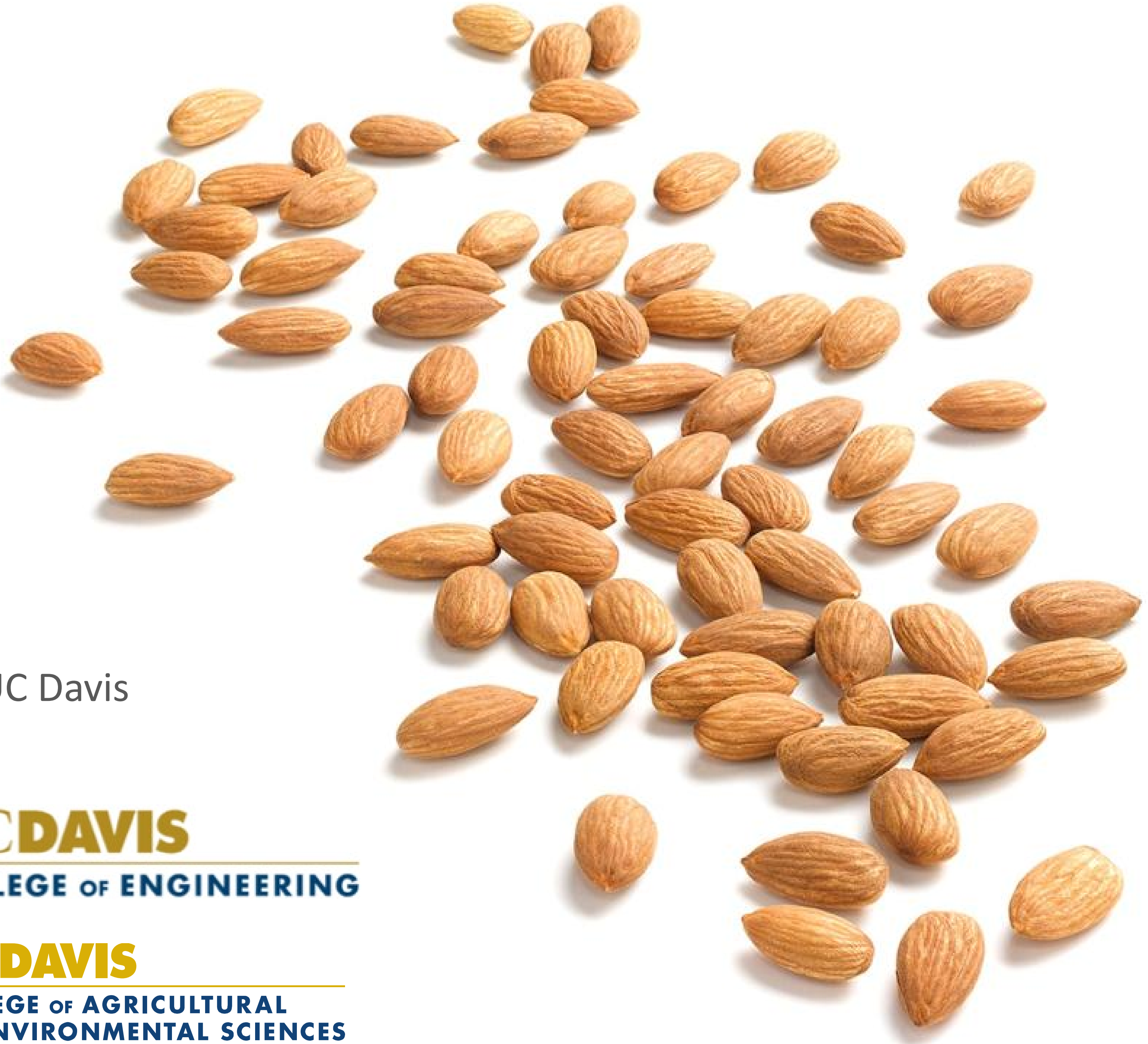
Performance of Black Soldier Fly Larvae on a Mediterranean Diet



Jean VanderGheynst, PhD

Lydia Palma and Jesus Fernandez-Bayo

Biological & Agricultural Engineering, UC Davis

December 6, 2018

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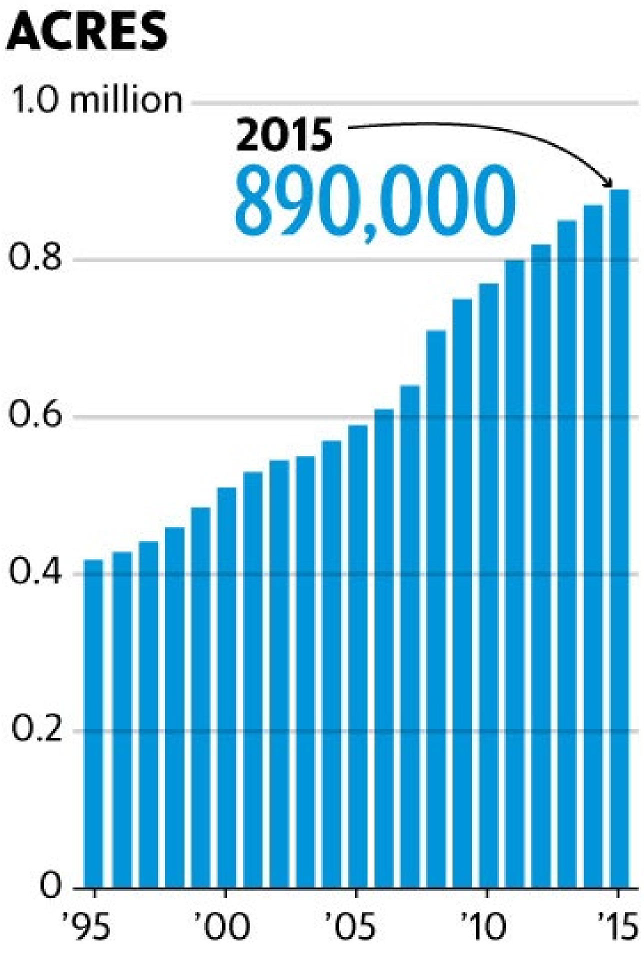
Growth in California Almond Production



Sources: U.S. Dept. of Agriculture, Merlo Farming Group

- Almond production acreage in the United States has increased by 62% in the last 10 years due in part to global consumer demands for plant-based food sources

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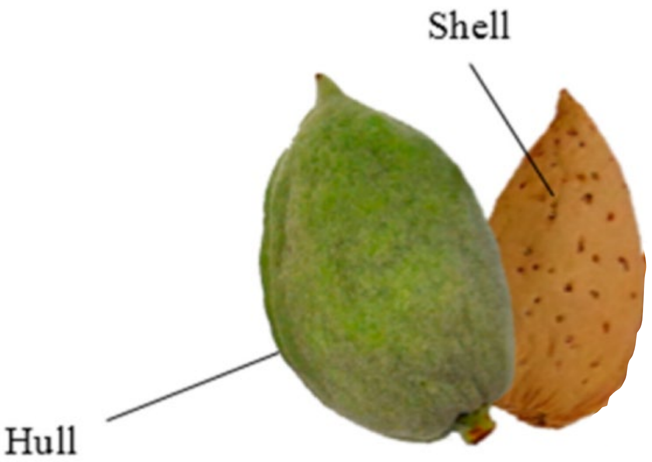
In 2016, the CA almond industry produced 1.53 MT of almond hulls and 0.61 MT of almond shells (CA Almond Board, 2017)



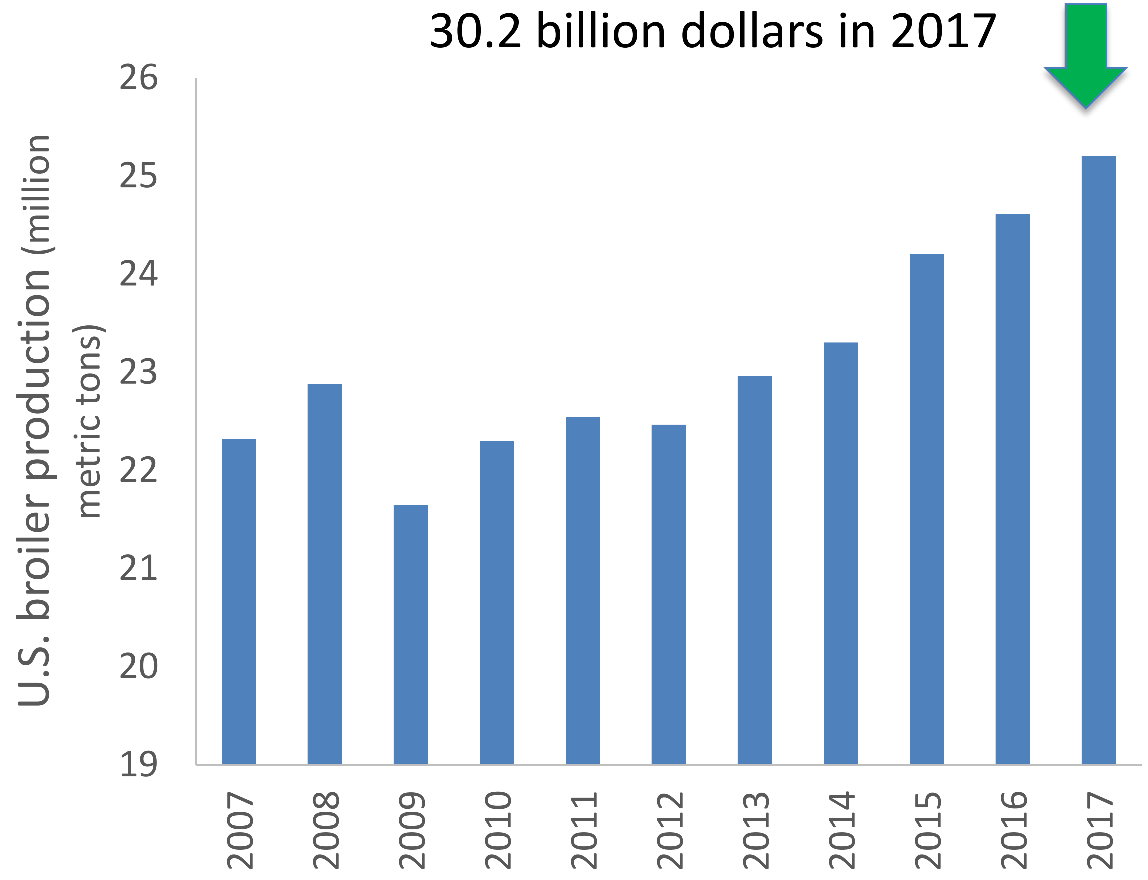
By-products from the almond industry require end uses

Composition*
21-25% fermentable sugars
9-16% cellulose/starch
7-10% hemicellulose
4-6% pectin
4-15% lignin
6-12% ash

*Holtmann et al. J. Agric. Food Chem., 2015, 63 (9)
Coffin et al. J. App Polymer Sci. 1994, 54 (9)

Growth in Poultry Products

Value of broiler production reached 30.2 billion dollars in 2017



USDA, N.A.S.S., *Poultry - Production and Value.* Summaries: 2007-2017

- Annual boiler production has grown nearly 11% in the past 6 years
- Annual egg production has grown over 14% in the past 10 years and 8.75% since 2015

Methionine is an essential amino acid required by poultry

- Methionine deficiencies lead to
  - Poor feed conversion
  - Broiler growth inhibition
  - Reduced egg production in layers

Amino Acid Sources and Challenges

- The percentage of synthetic methionine is restricted in organic poultry production
- Organic sources of methionine
  - Brazil nuts
  - Fish meal
  - Insects including black soldier fly larvae

Oscar Martinez, fourth year animal science major feeds hens that are part of UC Davis pastured poultry project and insect feeding trial. (Trina Wood/ UC Davis)

- Last year we demonstrated black soldier fly larvae production on almond hulls and shells

- We showed significant impacts of oxygen supply and water content on growth

Journal of The Science of Food and Agriculture: http://dx.doi.org/10.1002/jsfa.9252

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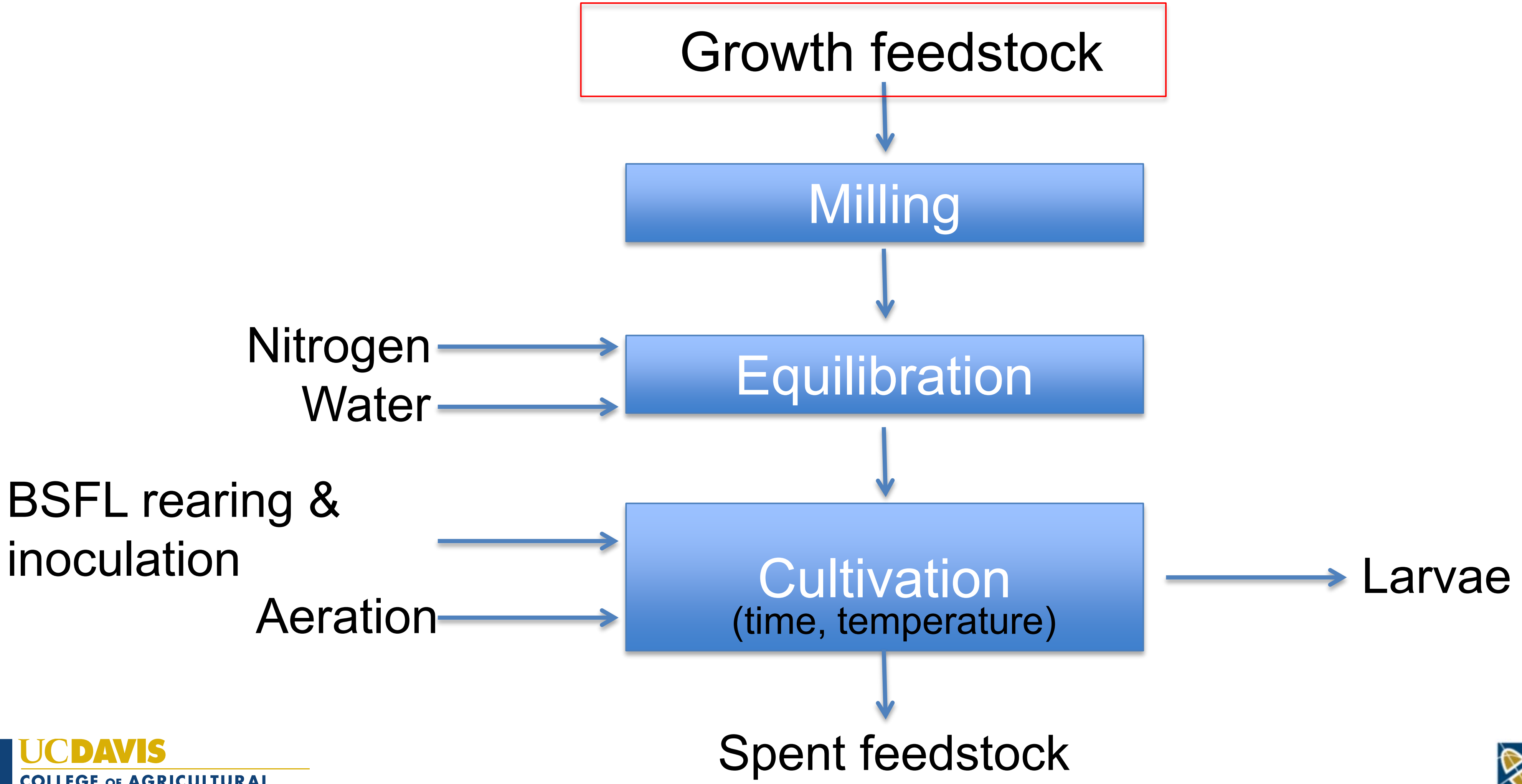
Current Research Questions

- What is the impact of almond by-product composition on larvae production and quality?

- What is the impact of nitrogen amendment source on larvae production and quality?

- What is the fate of hull pesticide residue during larvae cultivation?

Processing steps for larvae production on almond hulls



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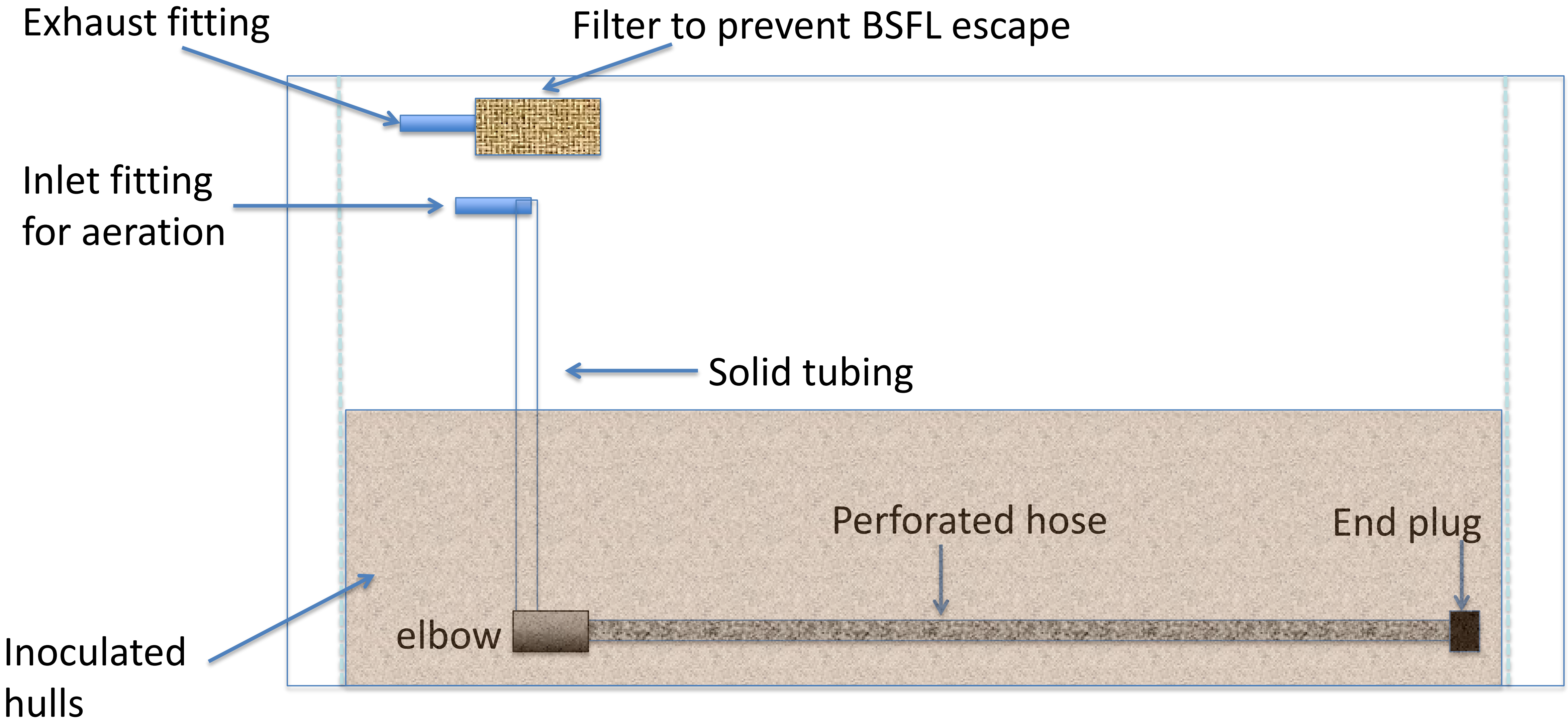
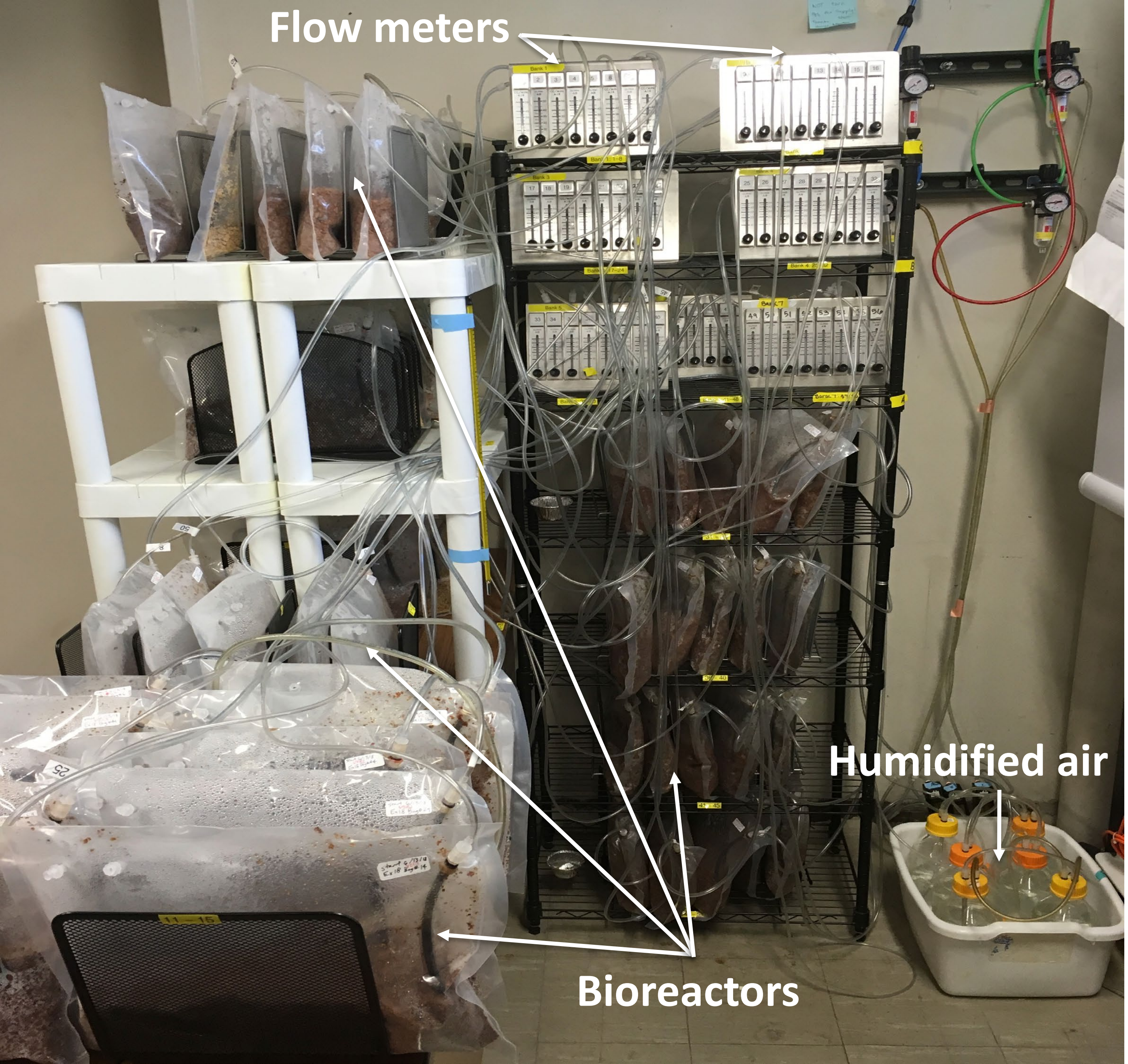
Black Soldier Fly Larvae Cultivation Bioreactors





Larvae cultivation system with 54 bioreactors

Measurements

- Average larvae harvest dry weight, yield, growth
- Larvae composition (fat, protein, carbohydrate and amino acid content)
- Composition and quality of the initial hulls and spent residue

Composition of Hulls and Shells Investigated

Hull ID	Description	Harvest Year	Composition of feedstock								
			Fat (%)	Protein (%)		Acid detergent fiber (%)	Neutral detergent fiber (%)	Acid detergent lignin (%)	Starch (%)	Sugar (%)	C/N Ratio
1	Pollinator Hulls	2016	3.10	4.01		25.9	35.8	6.7	7.6	15.3	72.7
2	Nonpareil Hulls	2017	2.05	4.63		17.9	26.4	4.4	11.4	24.4	60.4
3	Pollinator Hulls	2017	2.48	4.10		22.1	31.9	5.7	8.4	17.8	69.7
4	Nonpareil Hulls	2017	2.23	5.53		17.5	25.3	3.5	10.8	29.1	69.5
5	Monterey Hulls	2017	2.65	6.77		28.6	40.4	7.5	5.0	11.9	42.2
6	Pollinator Hulls	2017	2.29	4.06		25.6	35.9	6.4	8.2	20.2	50.4
7	Mixed Shells	2017	1.46	4.26		52.8	75.0	15.9	1.9	5.3	70.6

Composition of Hulls and Shells Investigated

Hull ID	Description	Harvest Year
1	Pollinator Hulls	2016
2	Nonpareil Hulls	2017
3	Pollinator Hulls	2017
4	Nonpareil Hulls	2017
5	Monterey Hulls	2017
6	Pollinator Hulls	2017
7	Mixed Shells	2017

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Composition of Hulls and Shells Investigated

Hull ID	Description	Fat (%)
1	Pollinator Hulls	3.10
2	Nonpareil Hulls	2.05
3	Pollinator Hulls	2.48
4	Nonpareil Hulls	2.23
5	Monterey Hulls	2.65
6	Pollinator Hulls	2.29
7	Mixed Shells	1.46

Composition of Hulls and Shells Investigated

Hull ID	Description	Protein (%)
1	Pollinator Hulls	4.01
2	Nonpareil Hulls	4.63
3	Pollinator Hulls	4.10
4	Nonpareil Hulls	5.53
5	Monterey Hulls	6.77
6	Pollinator Hulls	4.06
7	Mixed Shells	4.26

Composition of Hulls and Shells Investigated

Hull ID	Description	Co
		Acid detergent fiber (%)
1	Pollinator Hulls	25.9
2	Nonpareil Hulls	17.9
3	Pollinator Hulls	22.1
4	Nonpareil Hulls	17.5
5	Monterey Hulls	28.6
6	Pollinator Hulls	25.6
7	Mixed Shells	52.8

Composition of Hulls and Shells Investigated

Hull ID	Description	mposition of fee
		Neutral detergent fiber (%)
1	Pollinator Hulls	35.8
2	Nonpareil Hulls	26.4
3	Pollinator Hulls	31.9
4	Nonpareil Hulls	25.3
5	Monterey Hulls	40.4
6	Pollinator Hulls	35.9
7	Mixed Shells	75.0

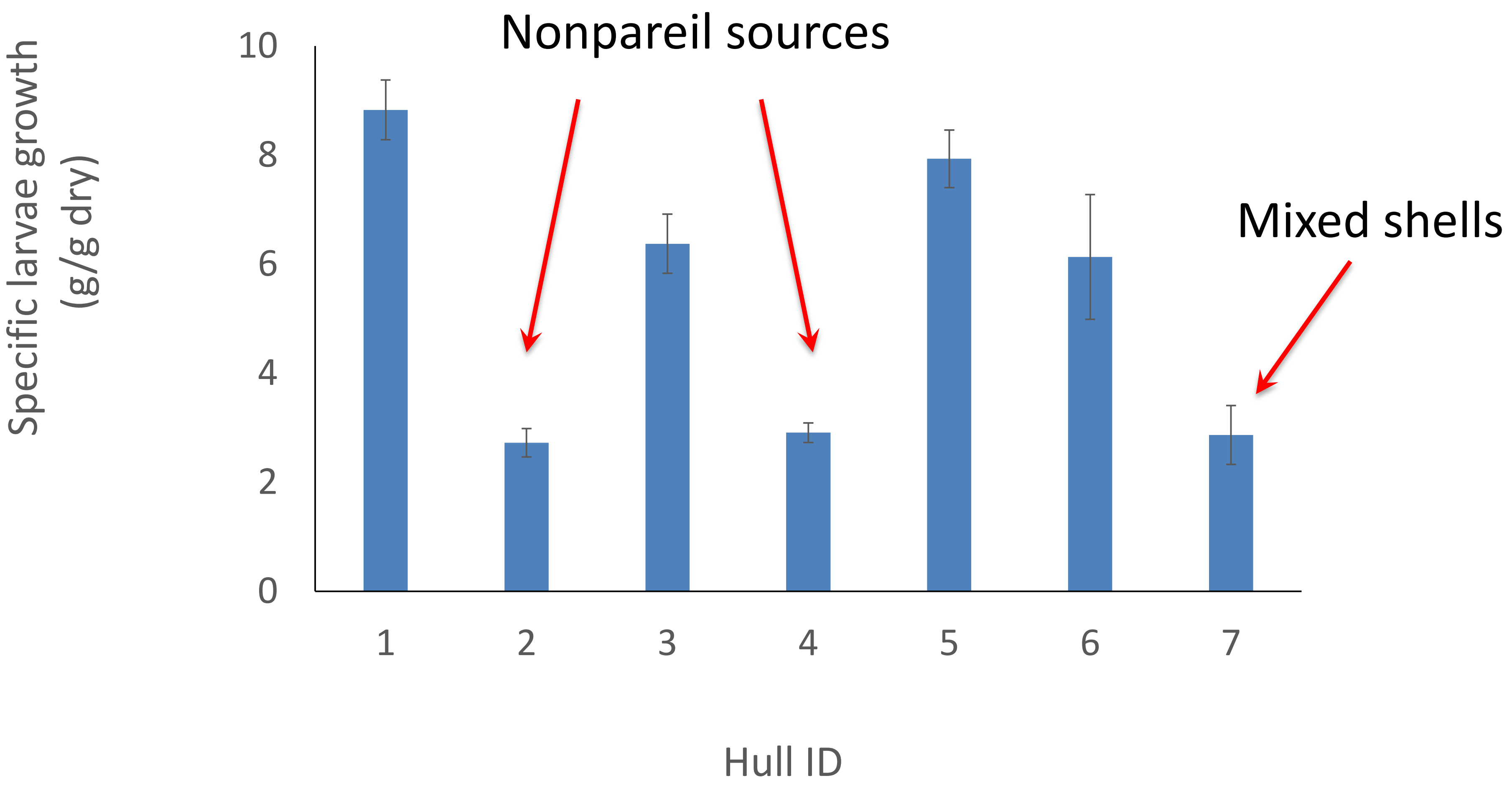
Composition of Hulls and Shells Investigated

Hull ID	Description	Starch (%)
1	Pollinator Hulls	7.6
2	Nonpareil Hulls	11.4
3	Pollinator Hulls	8.4
4	Nonpareil Hulls	10.8
5	Monterey Hulls	5.0
6	Pollinator Hulls	8.2
7	Mixed Shells	1.9

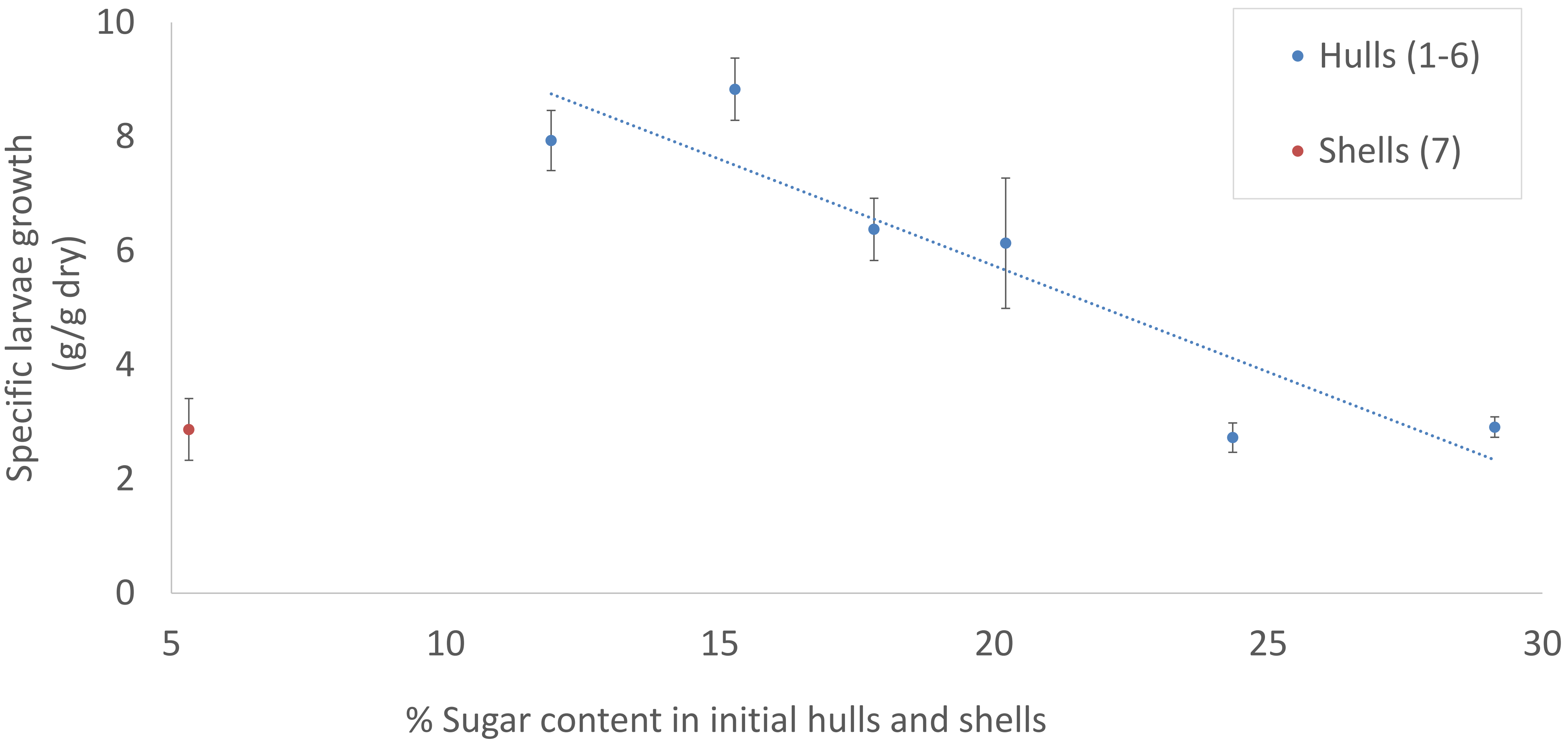
Composition of Hulls and Shells Investigated

Hull ID	Description	Sugar (%)
1	Pollinator Hulls	15.3
2	Nonpareil Hulls	24.4
3	Pollinator Hulls	17.8
4	Nonpareil Hulls	29.1
5	Monterey Hulls	11.9
6	Pollinator Hulls	20.2
7	Mixed Shells	5.3

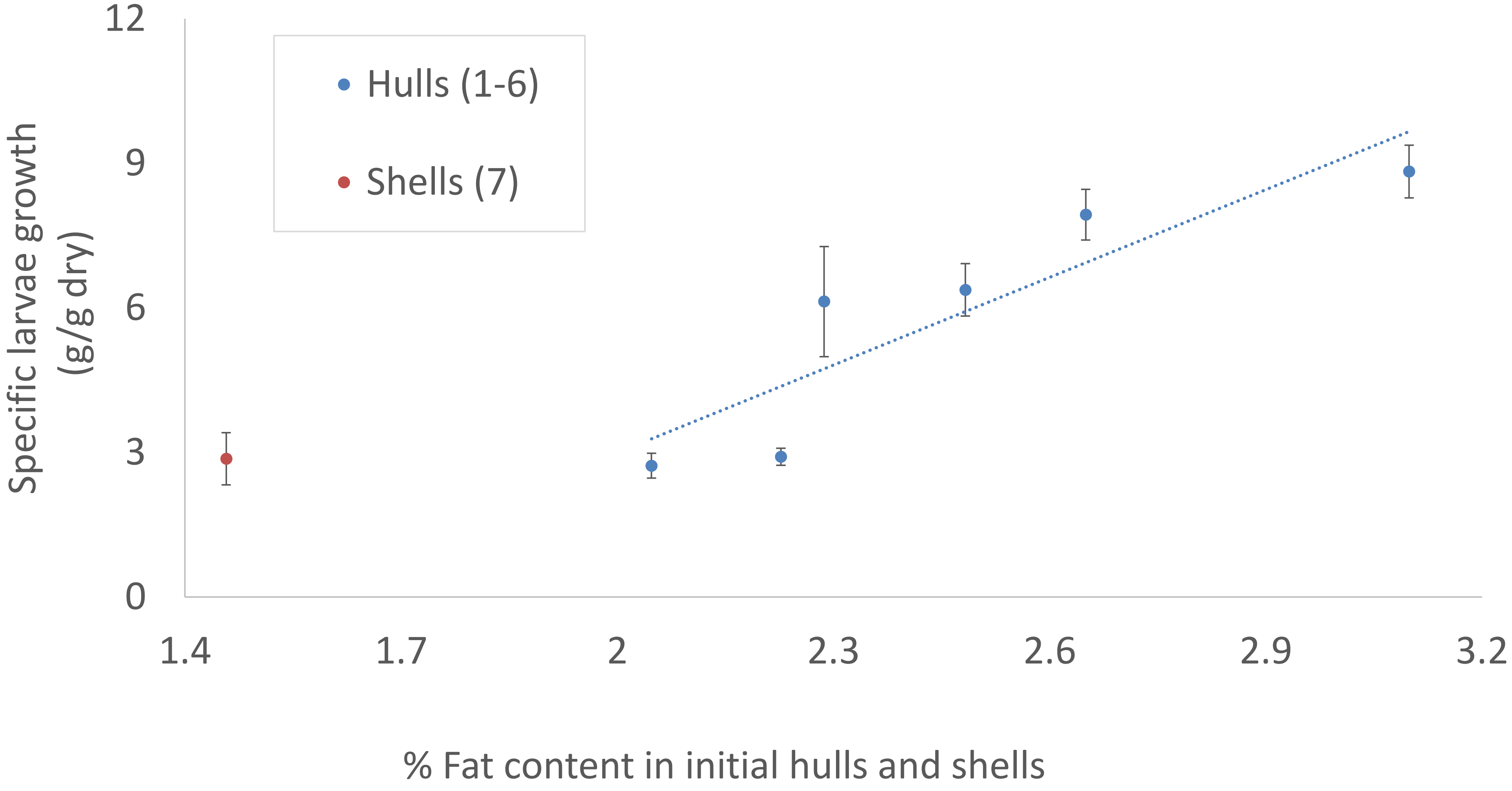
Larvae specific growth varies with hull type



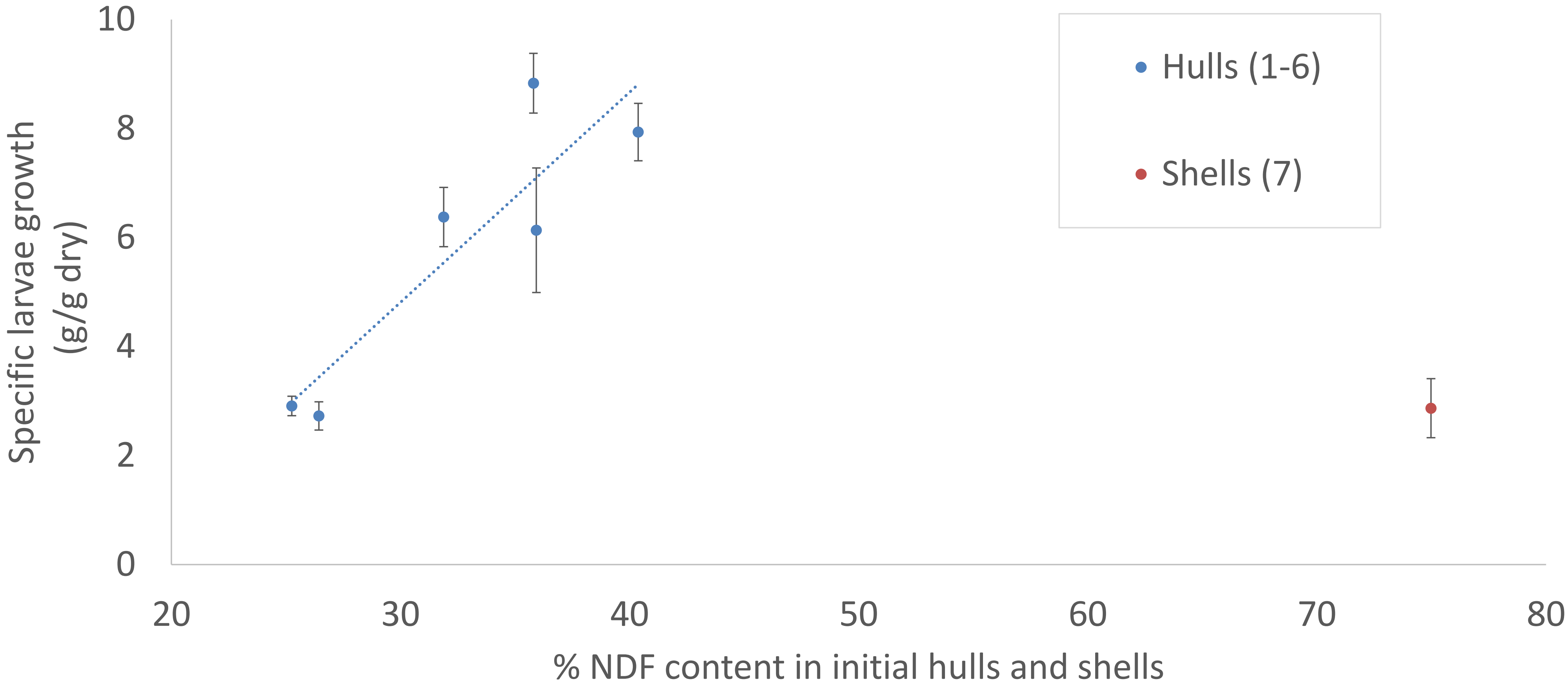
Larvae specific growth decreases as hull sugar content increases



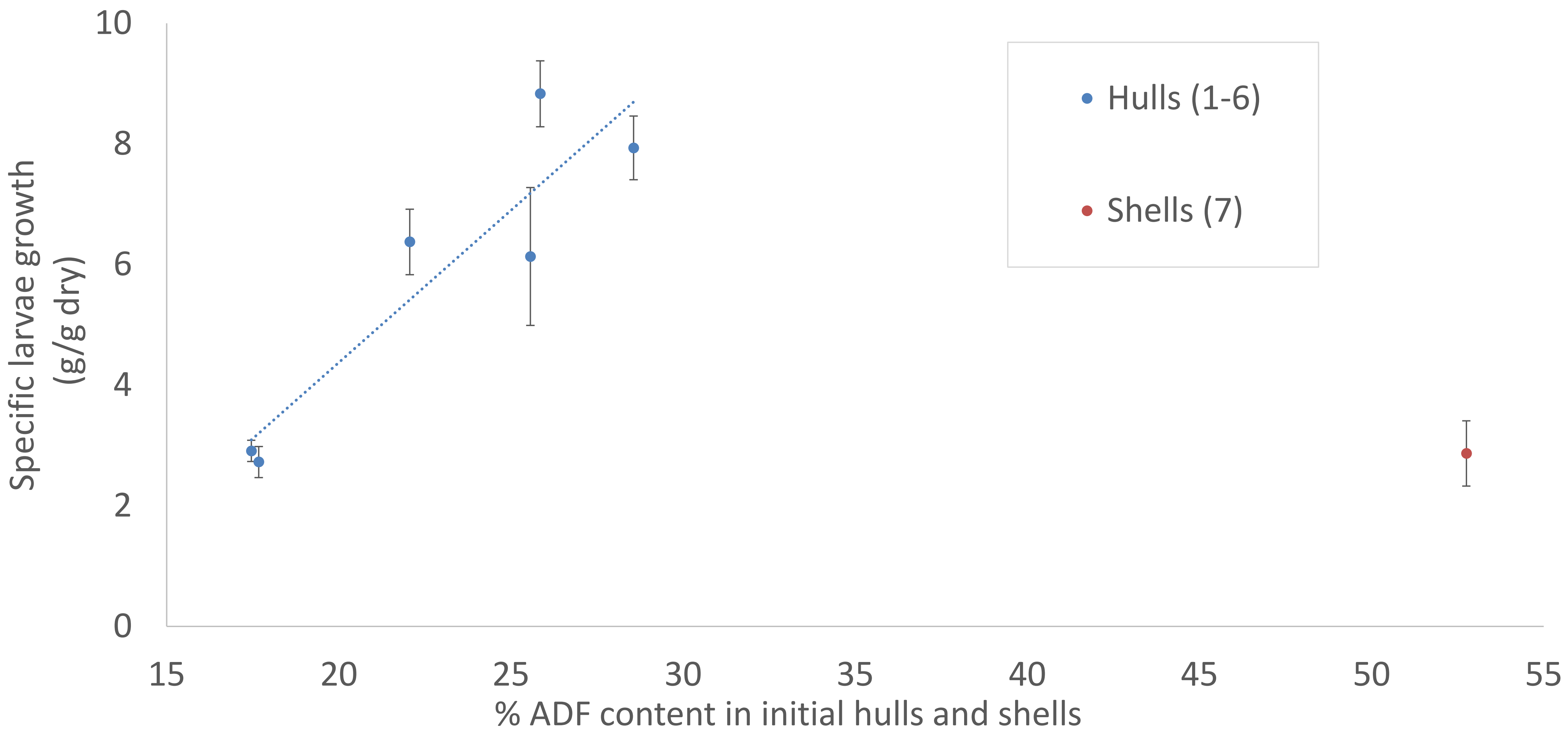
Larvae specific growth increases as hull fat content increases



Larvae specific growth increases as hull neutral detergent fiber content increases



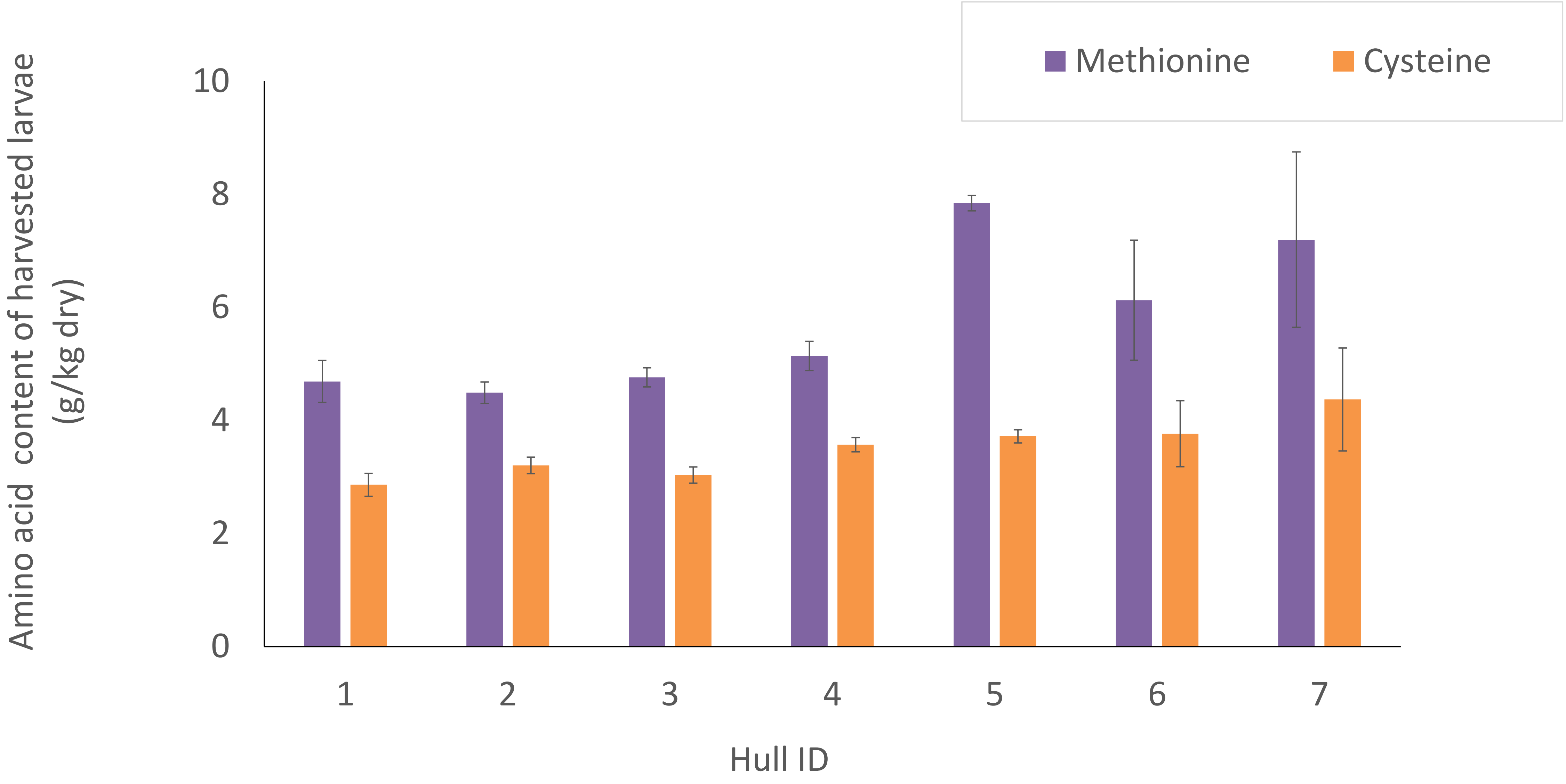
Larvae specific growth increases as hull acid detergent fiber content increases



Black solider fly larvae grow best on diets with high fat, high fiber and low sugar (i.e. a Mediterranean Diet)

Black solider fly larvae grow better on pollinator hulls compared to Nonpareil hulls

Larvae amino acid content is affected by hull type



Impact of Hull Composition on Amino Acid Content

- There was not a significant effect of hull sugar or fat content on larvae methionine content

- Methionine content in larvae increased with fiber content in the hulls

Future Research Needs:

Hull Quality Post Larvae Cultivation

- As much as 75% of the initial hull biomass can remain after larvae cultivation
- There is a need to identify uses of the spent hull biomass

Future Research Needs: Pesticide Residues

- All hull varieties investigated contained pesticide residues
- Fate of residues needs to be considered if larvae are to be used as an “organic” feed source

Future Research Needs:

Impact of cultivation time on amino acid profile

- Published research has shown that amino acid content varies with the stage of larvae growth
- Studies need to be completed to select optimum cultivation time and hull composition for desired amino acid content

Acknowledgements

- BSFL production team
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  - Ferisca Putri
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  - Kylie Bodie
  - Heather Bischel

- Financial support
  - CA Almond Board

Thank you!

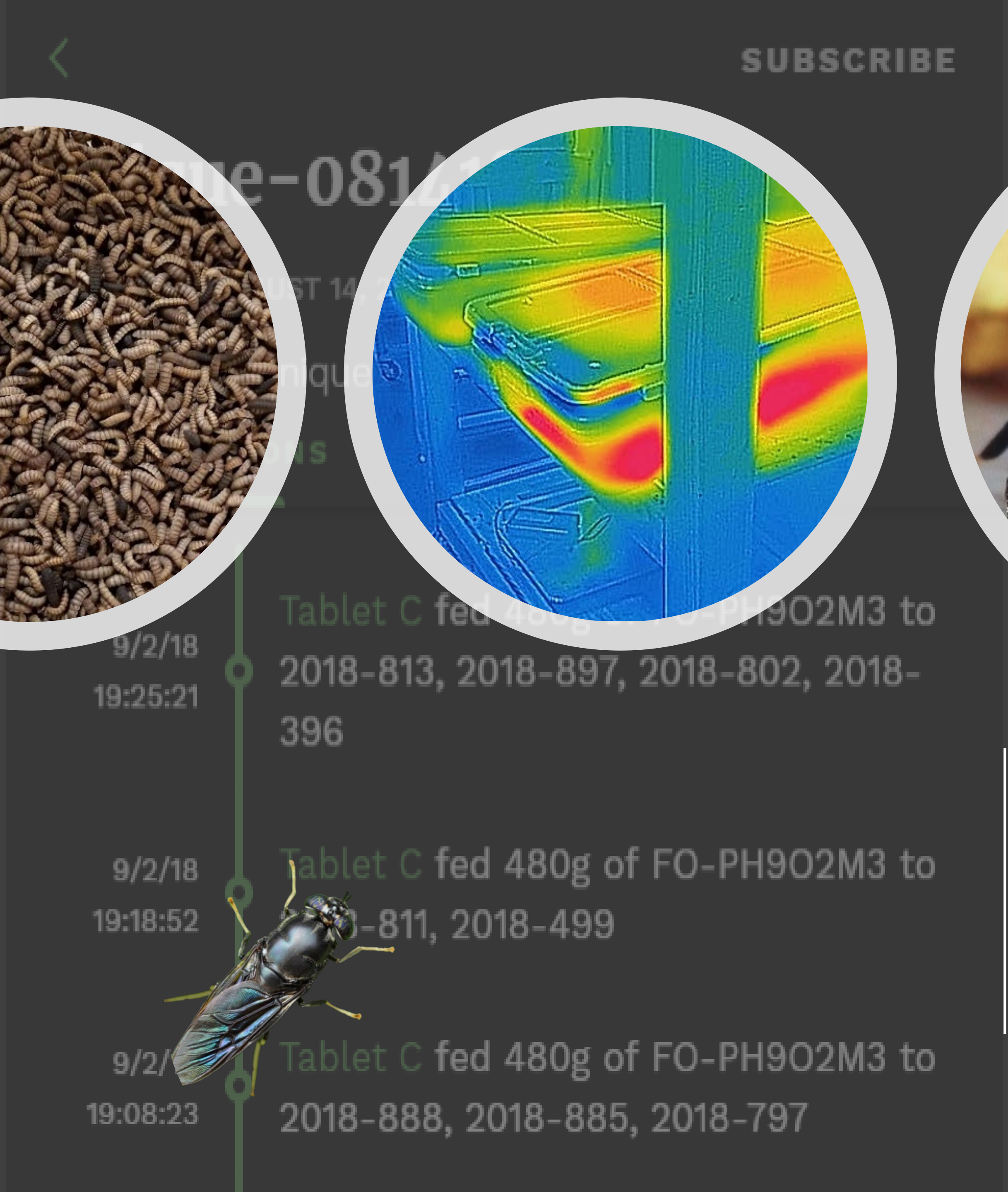
Almond Board of California

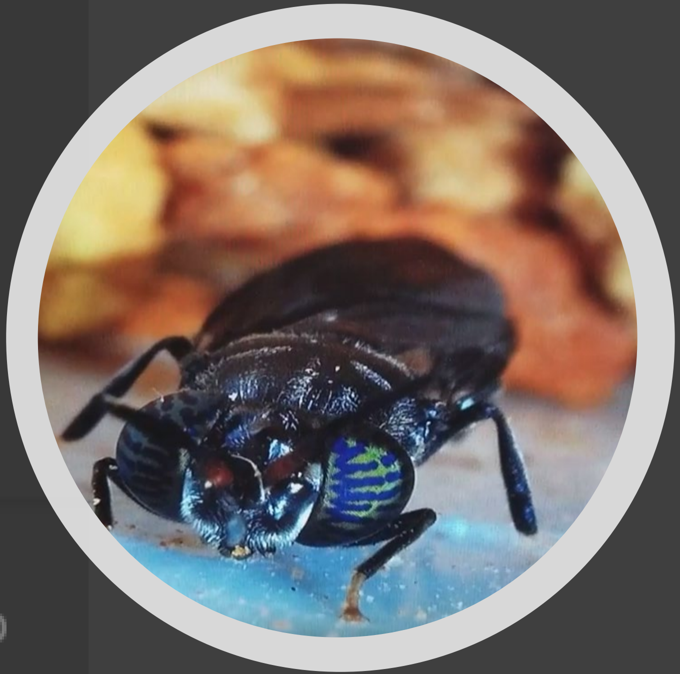
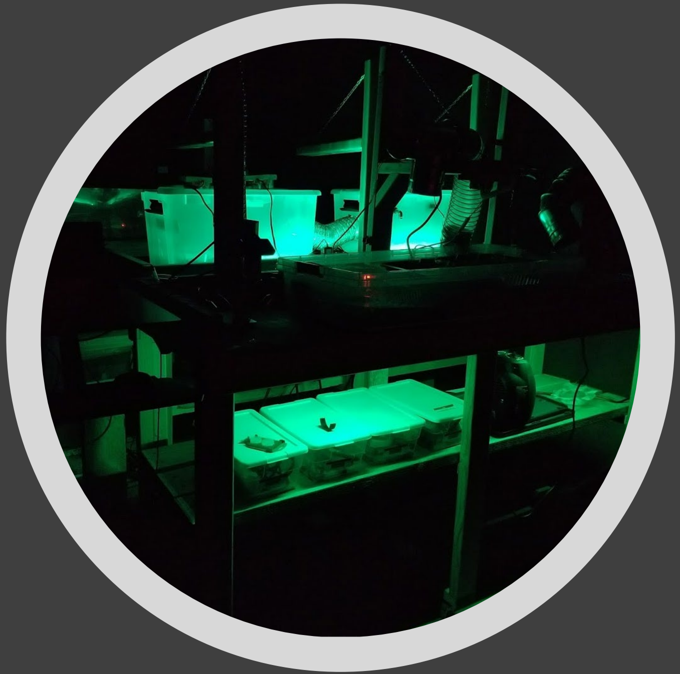
Commercial-Scale Rearing of Black Soldier Flies using Almond Hulls: Insights

Eric Tilton, C.T.O. HermetiaPro, Inc.

Why BSF? Poultry and Aquaculture markets

- Poultry feed (globally) will reach $252B in 2018
- Aquafeed was $107B in 2017, growing to $172B by 2022
- Insect protein can theoretically produce as much protein in **one** acre of land as **2,000** acres of soy
- Almond hulls are an attractive natural and clean feedstock for Black Soldier Flies
- California has a geographic advantage for this feedstock

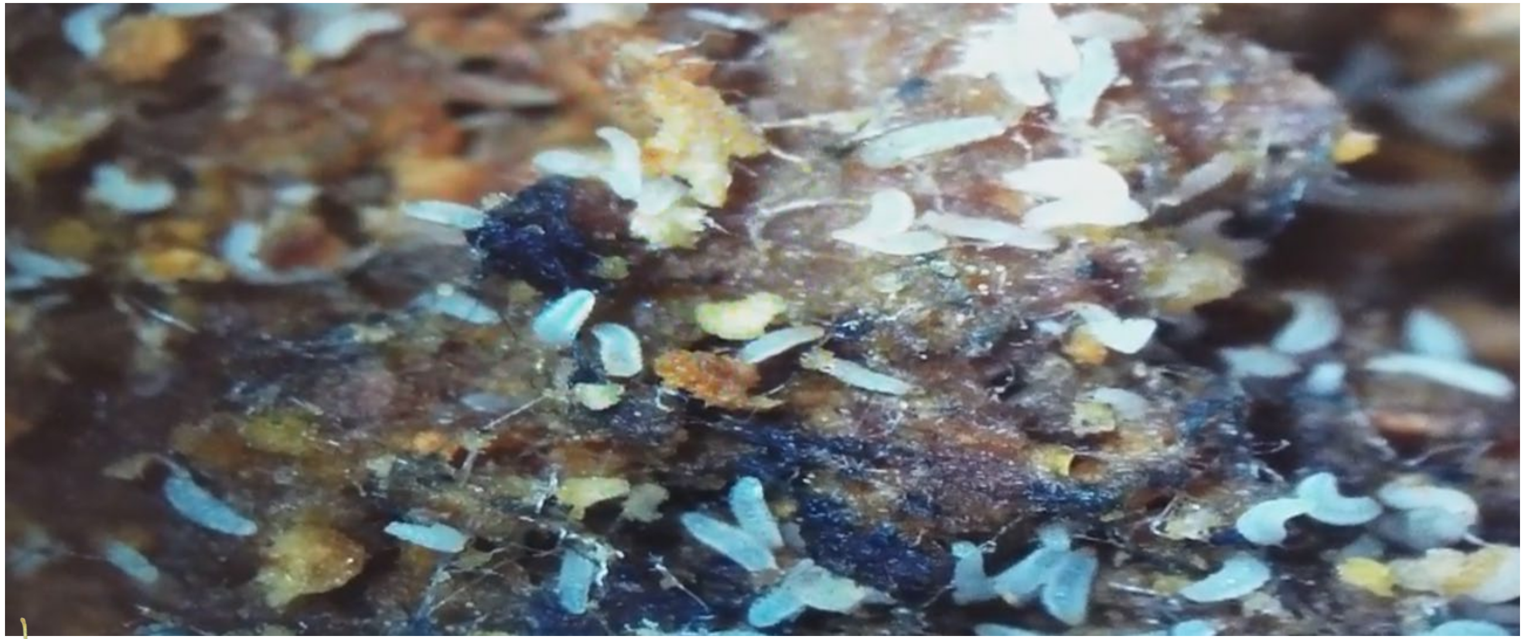


About Us

HermetiaPro is an advanced sustainable-agriculture firm, specializing in biomass conversion of almond hulls using Black Soldier Flies, which results in the production of insect-derived animal feed products and coproducts.

We master the entire lifecycle: breeding to harvestable adult. We also develop the machinery and software for full factory automation and traceability.

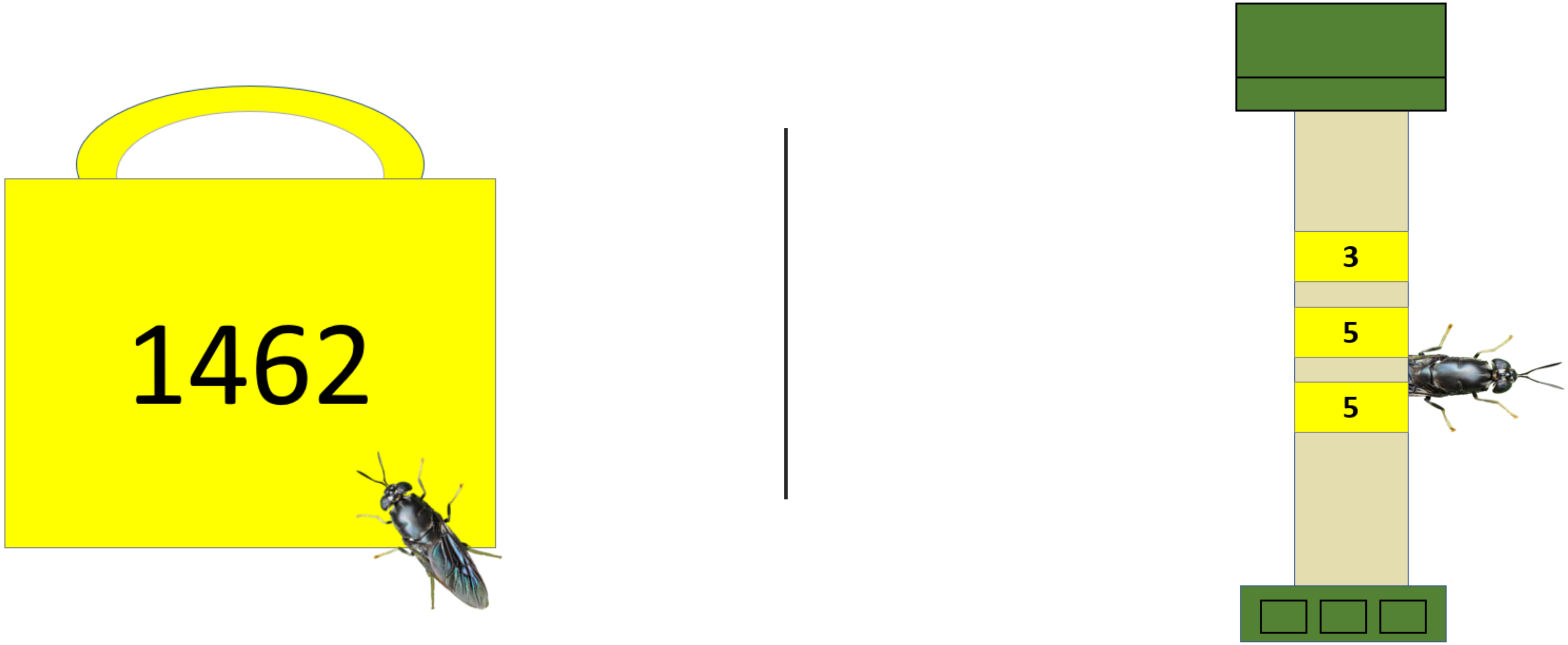


When we started testing hulls, the learning curve was steep.

Insects can be viewed as “Mini Livestock” – “Entoculture?”

- Rearing insects commercially for feed has many challenges in common with traditional livestock
- Nutrition, rearing conditions, disease and health management, genetic diversity, vigor, selection for optimal traits

We briefly looked at ear tags and radio collars for use with black soldier flies



But they didn’t fit very well.
So we gave up on that.

Feed Lot Analogy

For commercial scale, we need to produce the highest possible protein **density** in a fixed volume, in the **shortest** possible time, with the **least** amount of feedstock and water

(Just like a feedlot for beef or poultry)

A few of our successes:
Potential for industry-leading results

01

Duration:

Egg to harvestable adult larva in just 10-12 days (200mg typical weight)

02

Amazing Larvae/Soil Ratios:

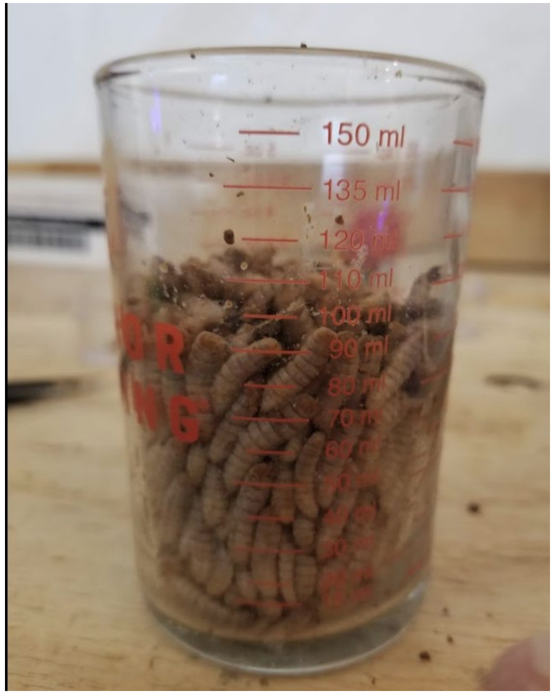
52% larvae by weight, 40% by volume

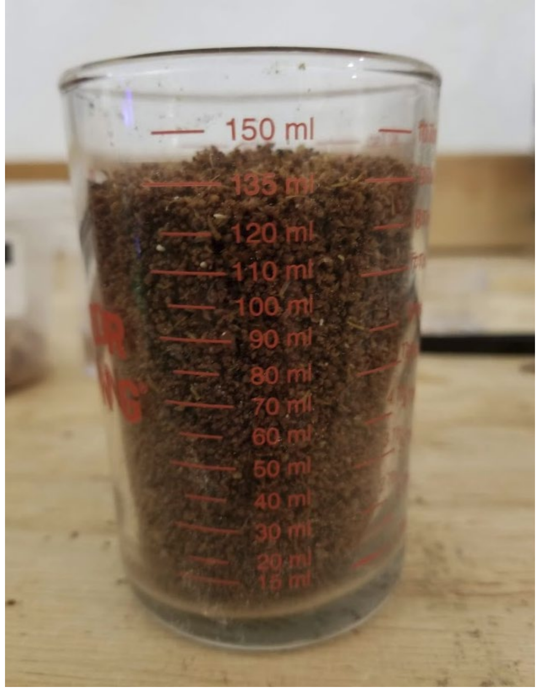
03

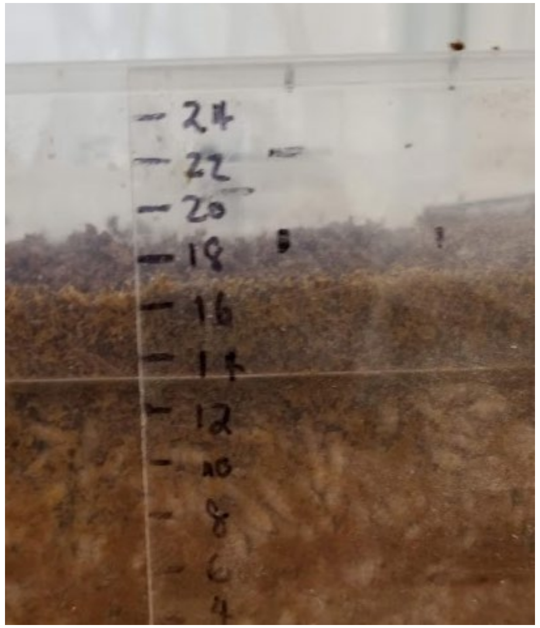
High Yield Weight:

Max larval weights 240 – 304mg in just 11 days

- Typical is 100 – 220mg in 15-18 days
- 380mg in 8 days, 410mg in 12 days







Recent Example:
Batch 11/9/2018, 10 days post hatch

In one cup volume, well mixed:

Larvae 65g (52.7% of total wt.)
Soil 58.5g (47.3% of total)
Larvae volume to total: 40%
Soil volume to total: 60%

Sample weight: 10 larvae @ 1.20 g ->120mg avg.

Based on sample, 65g contains:
544 larvae est., -> density 544 larvae / cup vol.

6 quart container:
2200 g = larvae + soil weight
17 cups total contents volume

=> 9.3K – 9.6K total larvae in container

Challenges in BSF Rearing at Commercial Scale

- Egg availability, hatch rate
- Larval density requirements
- Cannibalism minimization
- Water/Feed prep and delivery mechanics
- Optimizing nutrition, yield (Machine Learning)
- Disease, pest insect mitigation
- Genetic diversity (many generations per year - inbreeding)
- Selective Breeding (e.g., Chihuahua vs Great Dane)
- Separation of larvae from spent feed
- Traceability





Egg Production

Larvae grow 20,000% over a few weeks as they tear through food like a football team ripping through a dozen pizza boxes. In order to sustain full-cycle commercial production, we've had to master breeding and egg production.

Shorter rearing time implies more egg demand.

We've done things that others said couldn't be done.

Neonate Production

Creating the conditions for breeding, egg collection, and hatching requires careful attention to the environmental conditions needed for optimal growth: temperature, humidity, and light.

Light spectrum, duration of light to mimic day/night, and angle all matter.

Still testing the Barry White Music. Might help, not sure.

Larval Density

If you're squeamish, look away: we've figured out how to achieve extremely high larval density as we raise the neonates.

You're looking at about 80,000 larvae just a few days after hatching.

Feed Prep

We are evaluating a variety of feedstock particle sizes and ration compositions.

In our R&D Facility, we need an easy way to separate larvae from the compost they create; mechanical sifting is most efficient

Feed Trials

Similar to other livestock, its important to evaluate the benefits of including other nutritional elements in a ration.

For Black Soldier Flies, almond hulls are great … but selectively blending in other feed components in small amounts lets us boost growth rates and potentially improve the amino acid profile of the harvested larvae.

Rearing

- In our R&D facility, we’ve created space efficient final rearing modules with purposeful design elements for humidity and heat management.
- We’ve also pioneered some strategies for “self-separation” of adult larvae from soil.
- We’ve also gone through tons of almond hulls.

Separation Methods

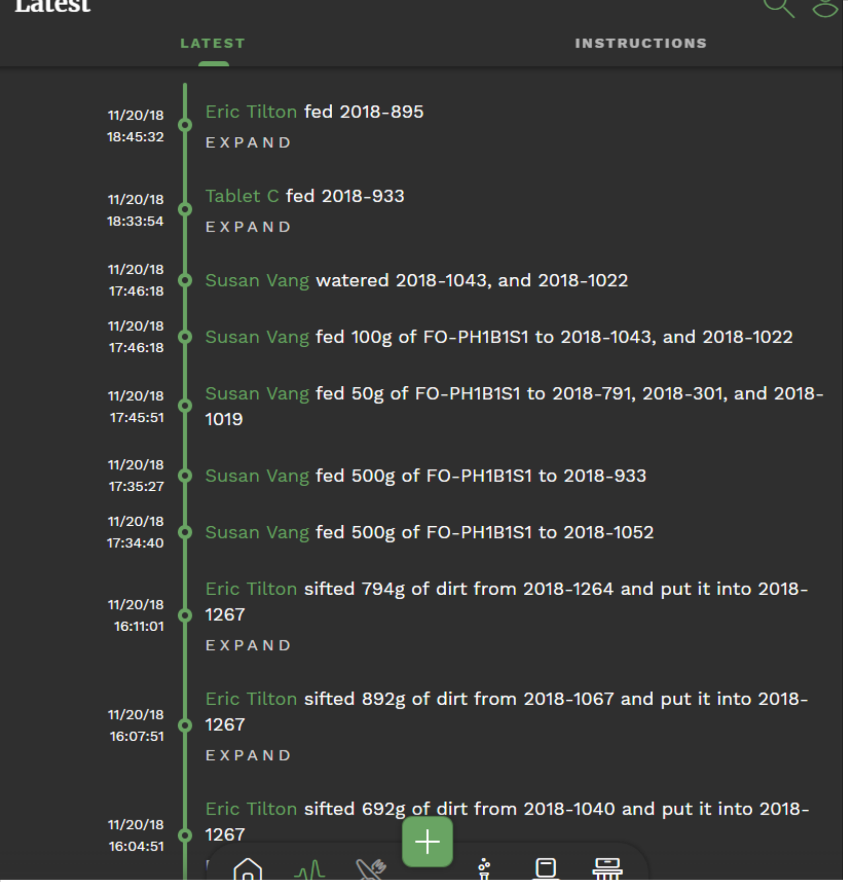
There are two valuable outputs of a Black Soldier Fly rearing facility: the larvae themselves, and the rich soil they create. Efficiently separating the two is critically important.

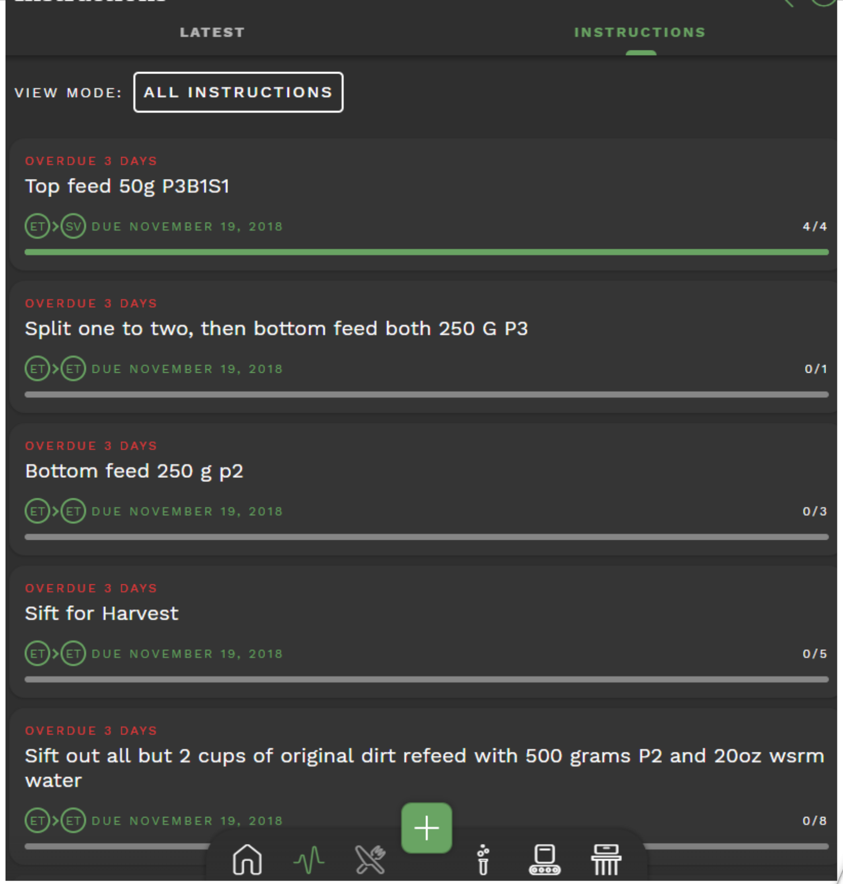
Feed type, viscosity, cycle of feeding and water addition affects the quality and separability of the soil.

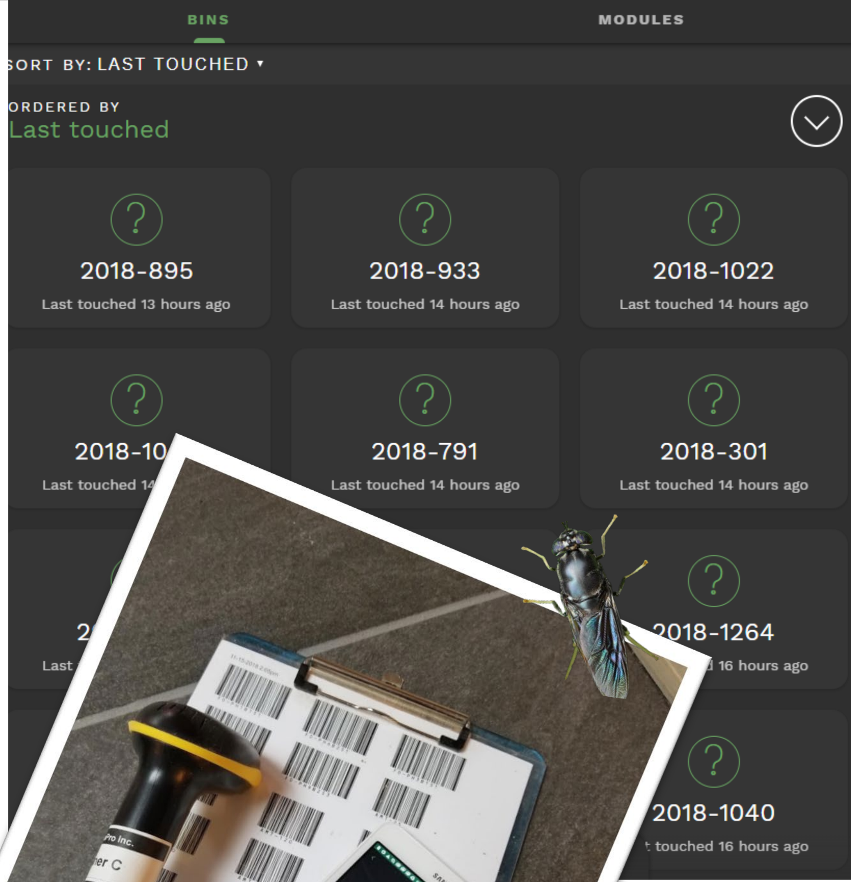
Chicks Dig It

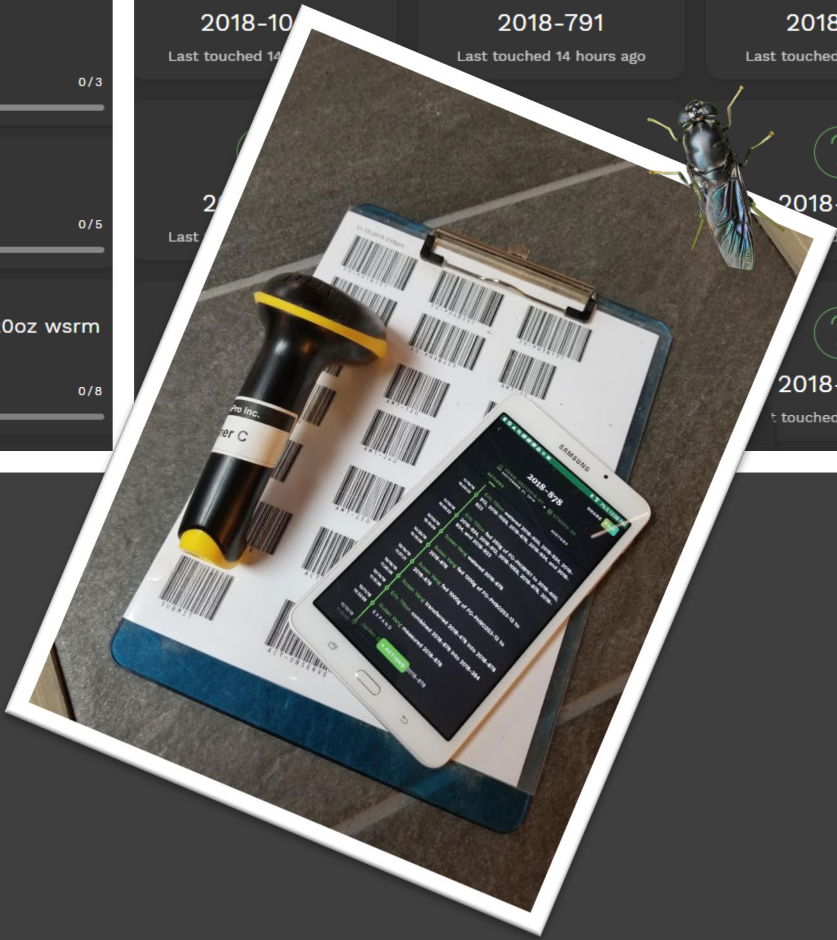
After we collect the larvae, we have to beat the chickens, ducks and turkeys back with a stick.

Poultry loves this stuff!









Traceability

End to end traceability – eggs to flies, flies to neonates, feed components + larvae to harvest and compost – requires detailed traceability, particularly if BSF will be used as a feedstock.

We made an app for that!

HermetiaPro Team