Developing testing protocols to assure the quality of fertilizer materials for organic agriculture

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Fertilizer Research and Education Program

Annual Conference

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ORGANIC.

CONSUMER DRIVEN. FARMER POWERED.

ORGANIC FOOD AND FARMING FUELS JOBS, RURAL ECONOMIES, AND CONSUMER CHOICE.

ORGANIC IS AN IMPORTANT PART OF THE DIVERSE U.S. AGRICULTURAL LANDSCAPE. THE ORGANIC TRADE ASSOCIATION REPRESENTS OVER 6,500 FARMERS, RANCHERS, HANDLERS, PROCESSORS, DISTRIBUTORS, AND RETAILERS ACROSS THE ORGANIC SUPPLY CHAIN.

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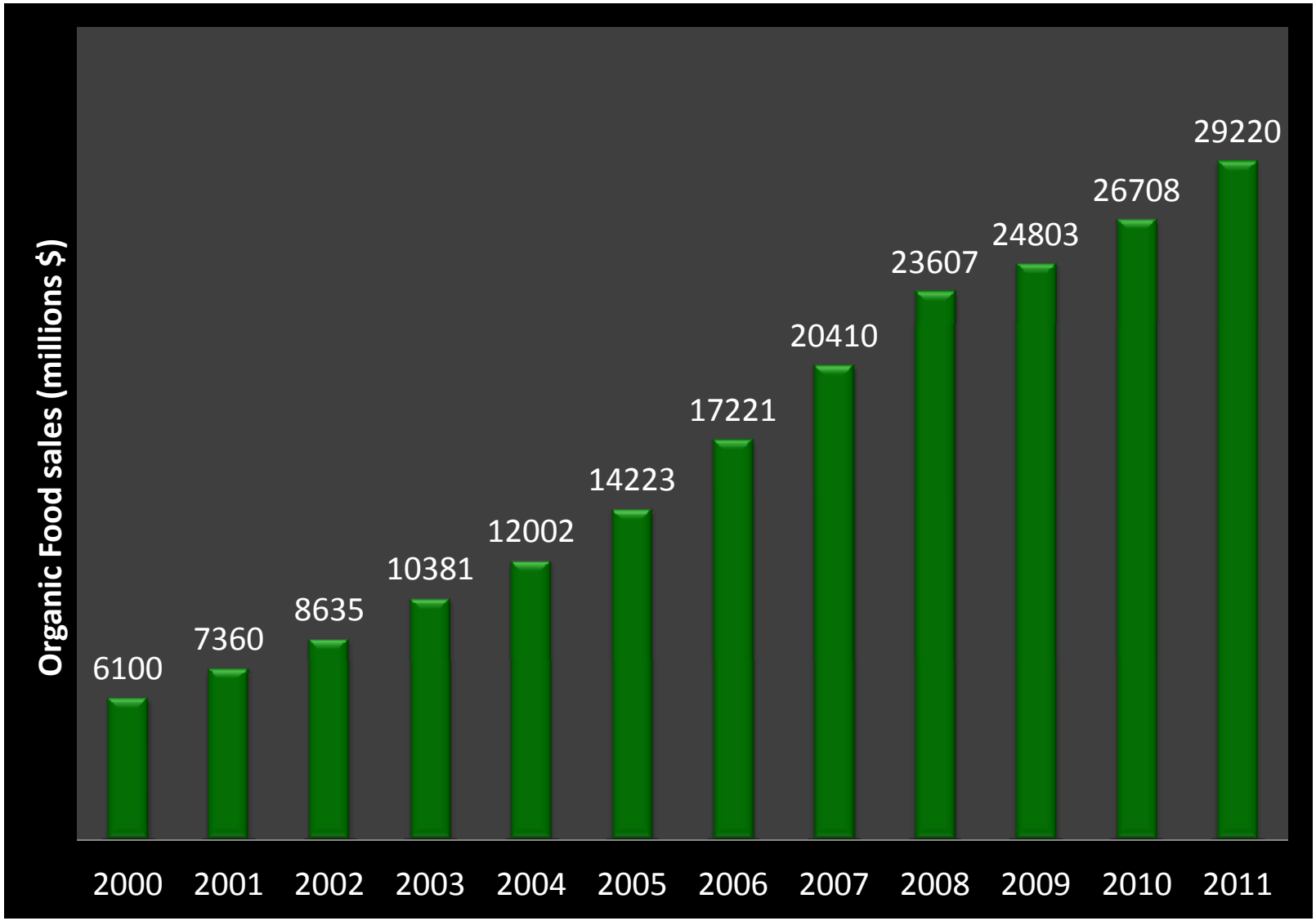
SINCE 1985 Organic trade association

Growth of US Organic Food Sector



Organic Trade Association's 2011 Organic Industry Survey

Organic Certification Requirements

- Annual certification inspections
- Detailed records of all practices
- Ecologically friendly methods and substances to improve soil conditions and control pests
- No conventional pesticides, artificial fertilizers, or harmful chemicals for at least 3 years

Converting to organic fertilizers
- Challenges -

- Fertilizers with variable nutrient contents
- Nutrient availability is inconsistent
- Nutrient demand is likely not met with seasonal amendments
- Limited availability of organic fertilizers with properties of conventional fertilizers

Fertigation Applications

Must be soluble like conventional fertilizers to take advantage of new technologies

Organic Farms Unknowingly Used Chemical Fertilizer

First Posted: 12-28-08 07:54 PM | Updated: 01-28-09 05:12 AM

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***Sacramento Bee*:**

For up to seven years, California Liquid Fertilizer sold what seemed to be an organic farmer's dream, brewed from fish and chicken feathers.

The company's fertilizer was effective, inexpensive and approved by organic regulators. By 2006, it held as much as a third of the market in California.

Read the whole story: *Sacramento Bee*

http://www.huffingtonpost.com/2008/12/28/organic-farms-unknowingly_n_153827.html

Increasing concern

Known adulteration of organic fertilizers -

ammonium sulfate and urea

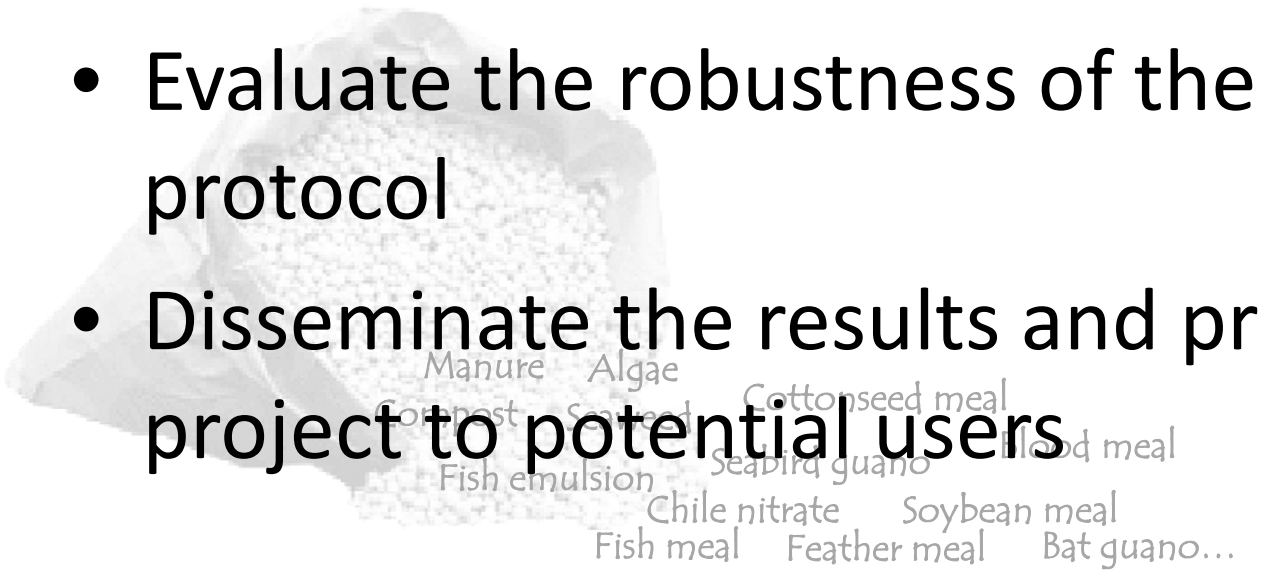
- Suspicion of manufacturers by certifiers, growers, Organic Materials Review Institute (OMRI), and CA Dept. of Food and Agriculture (CDFA)
- Public distrust
- Cost of watchfulness and enforcement of new policies (e.g., third party on-site inspections)
- Assembly Bill 856 passed January 2010

Challenges

- Authenticity and integrity of **organic** soil and crop amendments
- Restore trust in producers and confidence of consumers
- Provide simple, systematic and rapid methods for testing labs and regulatory agencies

Objectives

- Construct a database
- Establish natural ranges of properties for unadulterated materials
- Develop a stepwise protocol test to identify potentially adulterated organic fertilizers
- Evaluate the robustness of the above protocol
- Disseminate the results and products of the project to potential users



Task 1: Literature Review

- Collate existing data for
  - marketed products and raw materials, organic and synthetic (potential adulterants)
  - Ecological (e.g. raw fish, guano) or agronomic (e.g. compost, soybean meal)
- Dominated by data for carbon and nitrogen content and isotopic profile
- Used for comparison with experimental data

Status: Complete

Task 2: Analysis

Measured properties:

Total carbon

Total nitrogen

Carbon to nitrogen ratio

Total phosphorus

Surface functionality (FTIR and Raman Spectroscopy)

Carbon stable isotope ratio

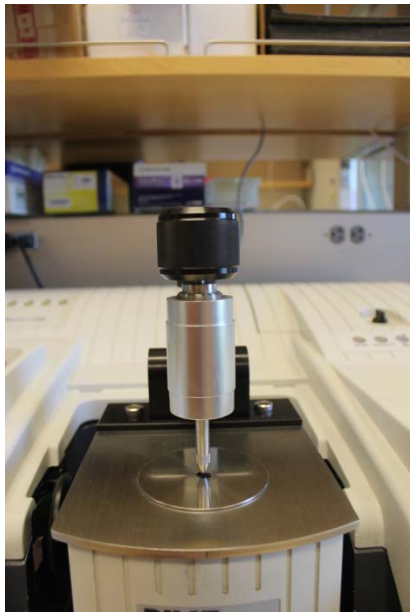
Nitrogen stable isotope ratio

Total solids

Dissolved organic carbon and nitrogen

Ammonium and nitrate

Approximately 200 samples currently characterized

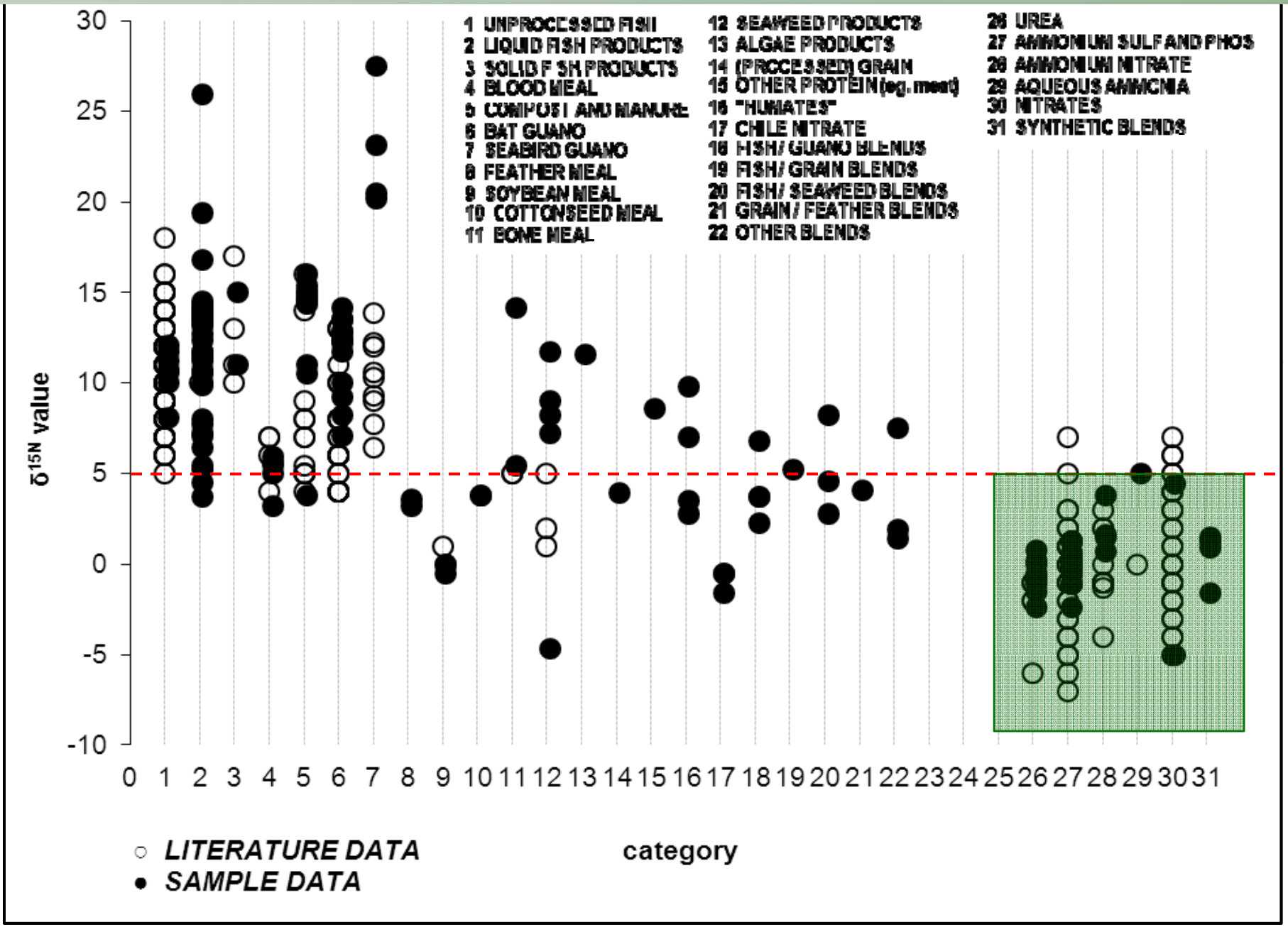


Key parameters:

- best help indicate presence of adulterants
- allow for comparison with existing data
- require minimal effort for a testing lab

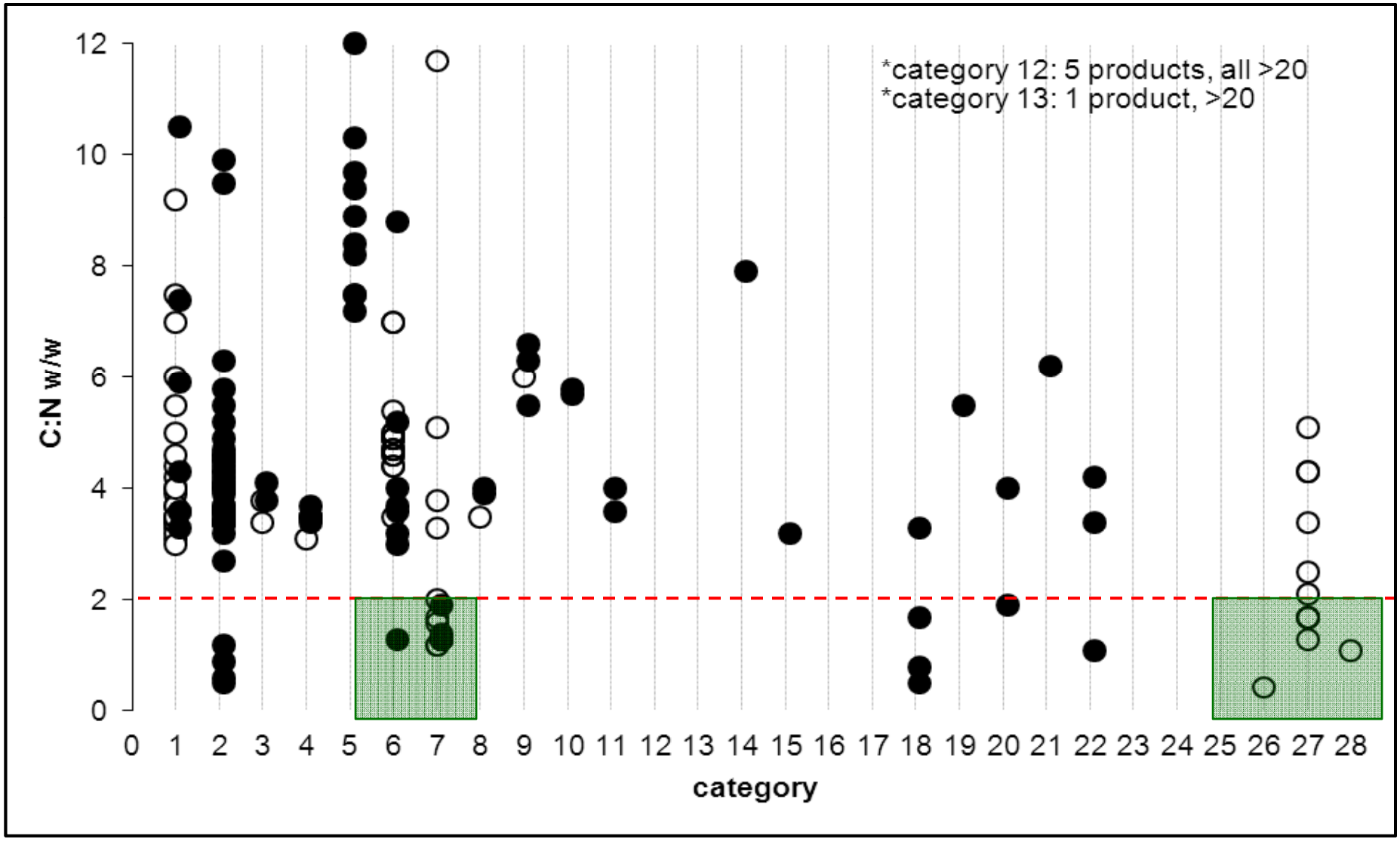
Status: Complete

Nitrogen stable isotope ratio database



$Total_{Carbon}$: $Total_{Nitrogen}$ Database

1 UNPROCESSED FISH
2 LIQUID FISH PRODUCTS
3 SOLID FISH PRODUCTS
4 BLOOD MEAL
5 COMPOST AND MANURE
6 BAT GUANO
7 SEABIRD GUANO
8 FEATHER MEAL
9 SOYBEAN MEAL
10 COTTONSEED MEAL
11 BONE MEAL
12 SEAWEED PRODUCTS
13 ALGAE PRODUCTS
14 (PROCESSED) GRAIN
15 OTHER PROTEIN (eg. meat)
16 "HUMATES"
17 CHILE NITRATE
18 FISH / GUANO BLENDS
19 FISH / GRAIN BLENDS
20 FISH / SEAWEED BLENDS
21 GRAIN/ FEATHER BLENDS
22 OTHER BLENDS
26 UREA
27 AMMONIUM SULF AND PHOS
28 AMMONIUM NITRATE
29 AQUEOUS AMMONIA
30 NITRATES
31 SYNTHETIC BLENDS



Spectral Database

- The spectral database currently consists of
  - 41 fish (liquid, solid and unprocessed)
  - 28 guano
  - 14 organic blends
  - 13 compost
  - 11 seaweed
  - 8 ammonia
  - 7 bloodmeal
  - 5 feathermeal
  - Also soy meal, urea and Chile nitrate

Comparison of Spectroscopic Analysis Techniques

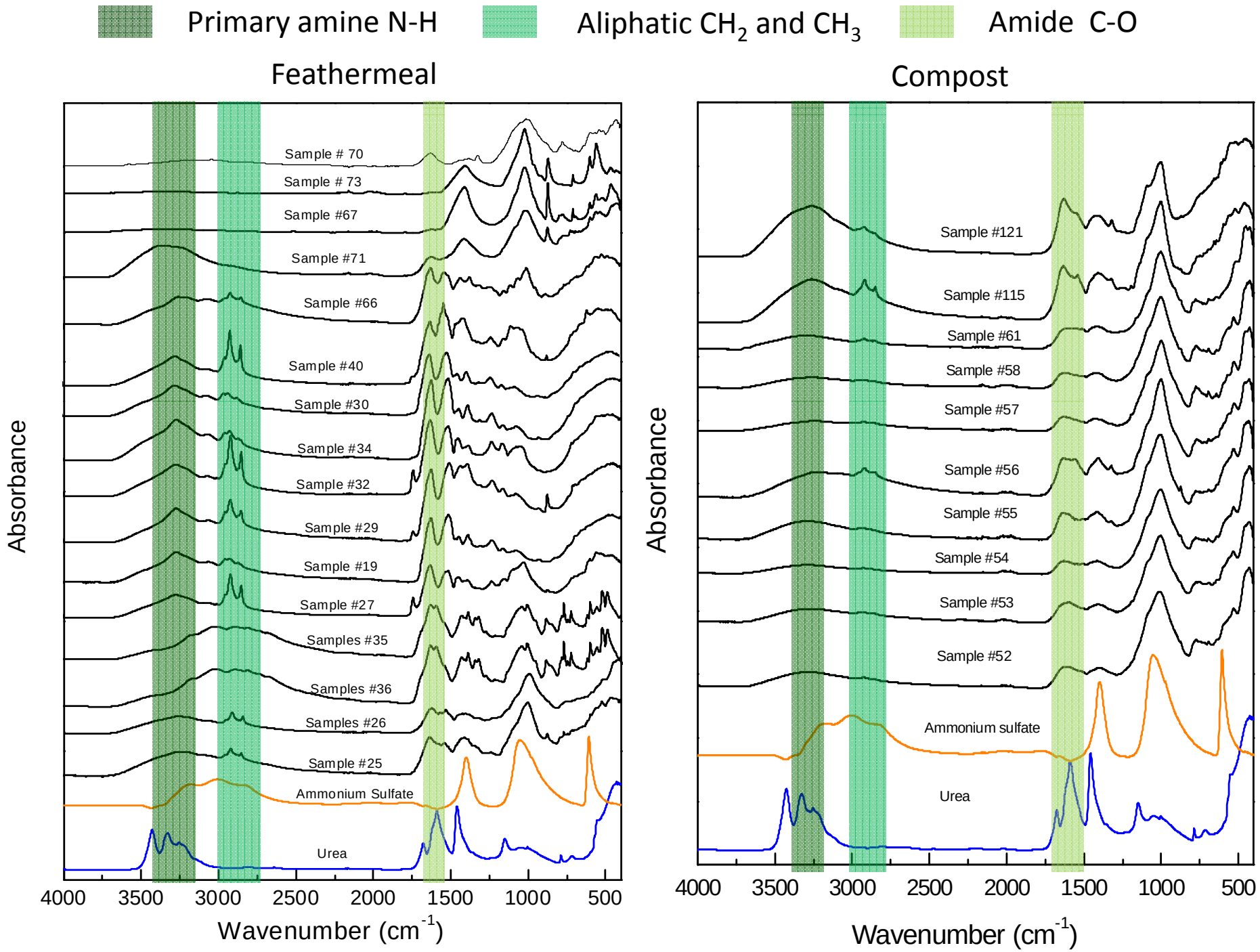
ATR-FTIR

- Higher sample throughput due to shorter analysis time per sample
- Less sample preparation
- Handles solid and liquid samples
- Cheaper

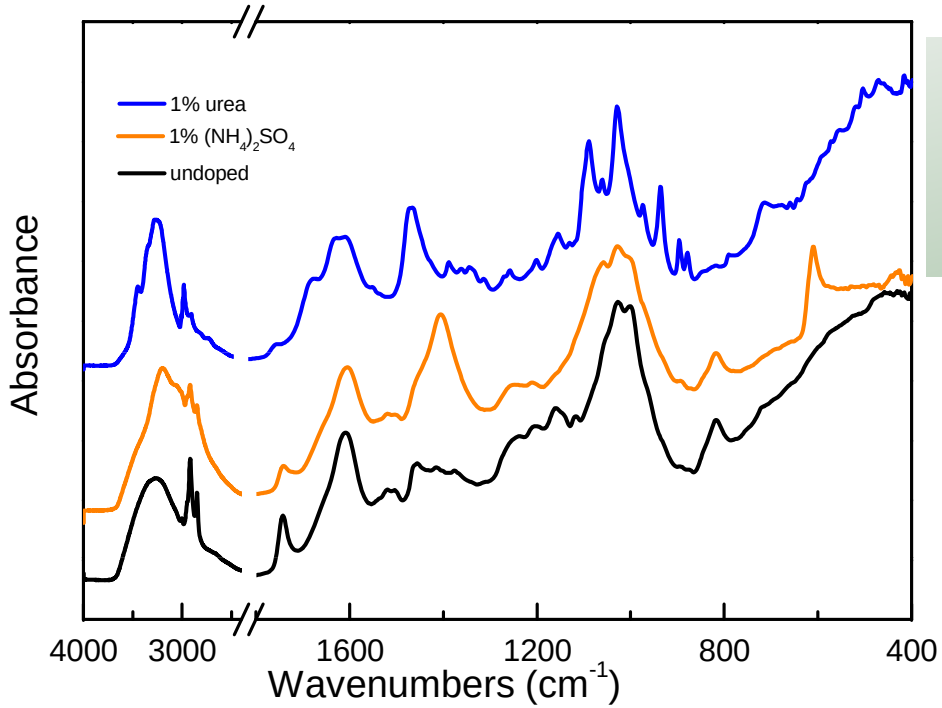
FT-Raman

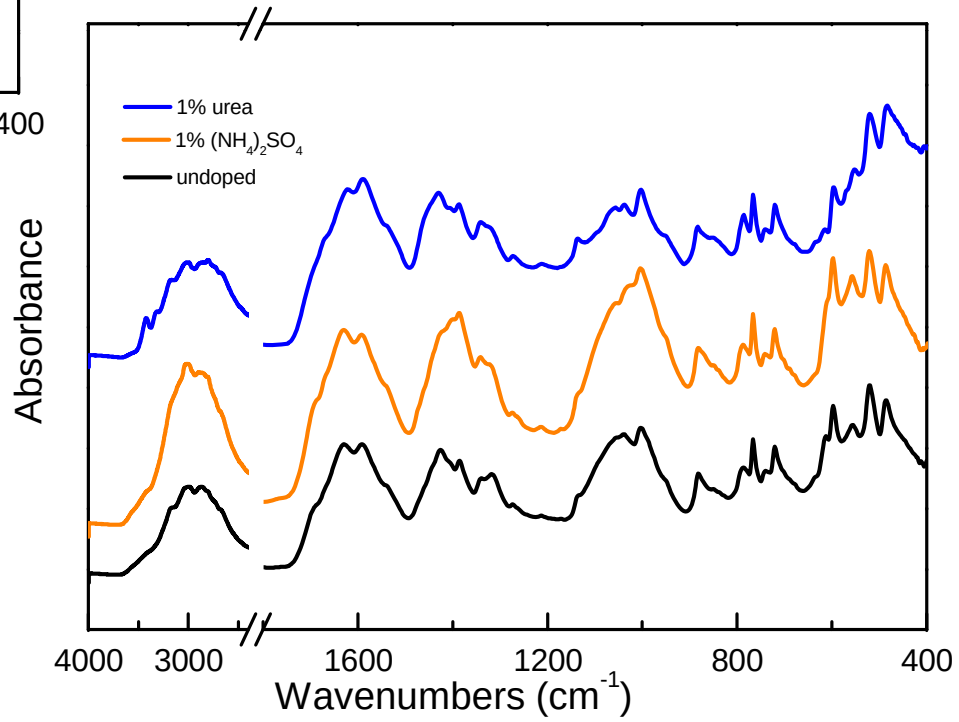
- Less post analysis processing
- Easier detection of the potential adulterants.
- Scattering resulting in longer analysis times to reduce the signal to noise (S/N) ratio

- Techniques provided qualitative information on the presence of these adulterants

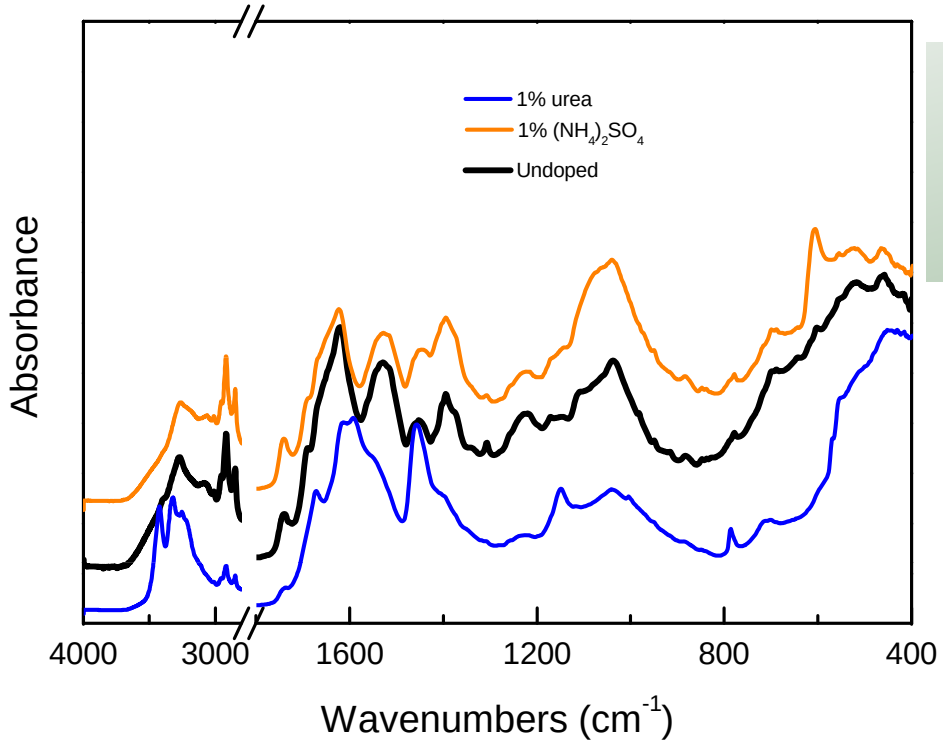

Primary amine N-H
Aliphatic CH_2 and CH_3
Amide C-O
Feathermeal
Compost
Absorbance
Wavenumber (cm^{-1})
Sample # 70
Sample # 73
Sample #67
Sample #71
Sample #66
Sample #40
Sample #30
Sample #34
Sample #32
Sample #29
Sample #19
Sample #27
Samples #35
Samples #36
Samples #26
Sample #25
Ammonium Sulfate
Urea
Sample #121
Sample #115
Sample #61
Sample #58
Sample #57
Sample #56
Sample #55
Sample #54
Sample #53
Sample #52
Ammonium sulfate
Urea
4000
3500
3000
2500
2000
1500
1000
500

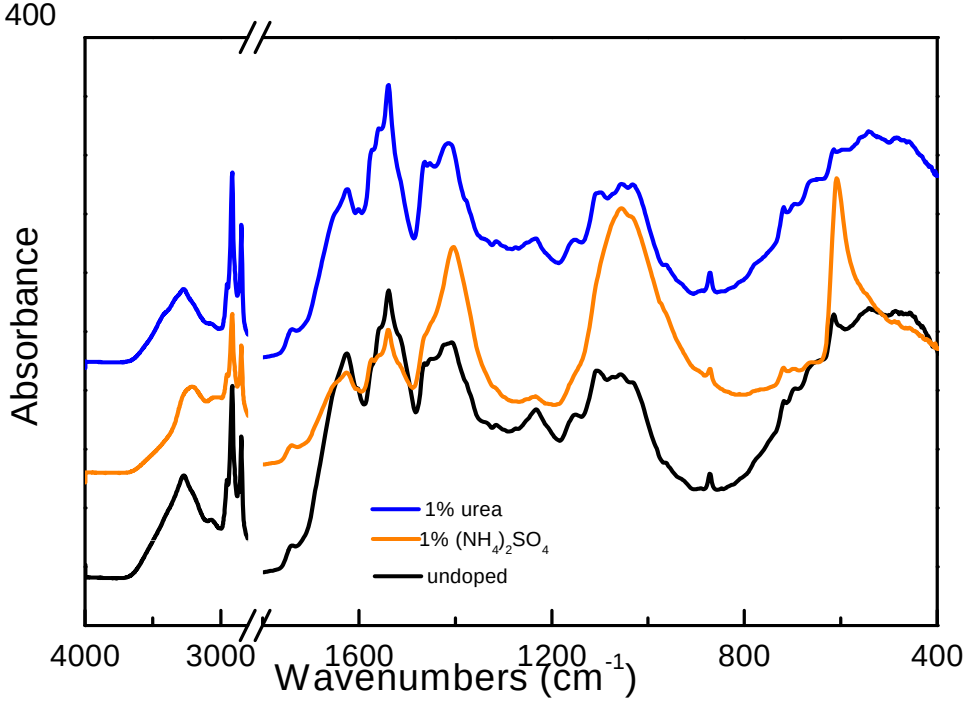
ATR-FTIR Spectra Seaweed



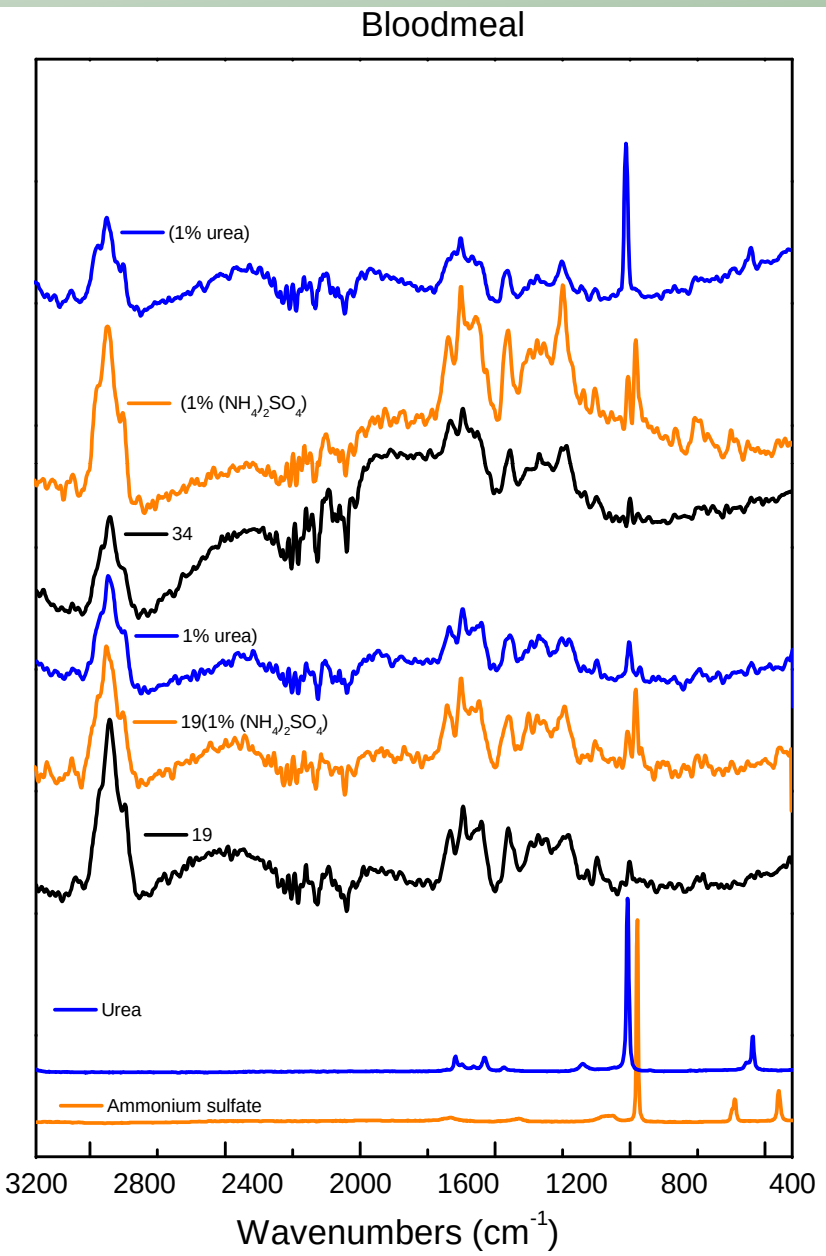


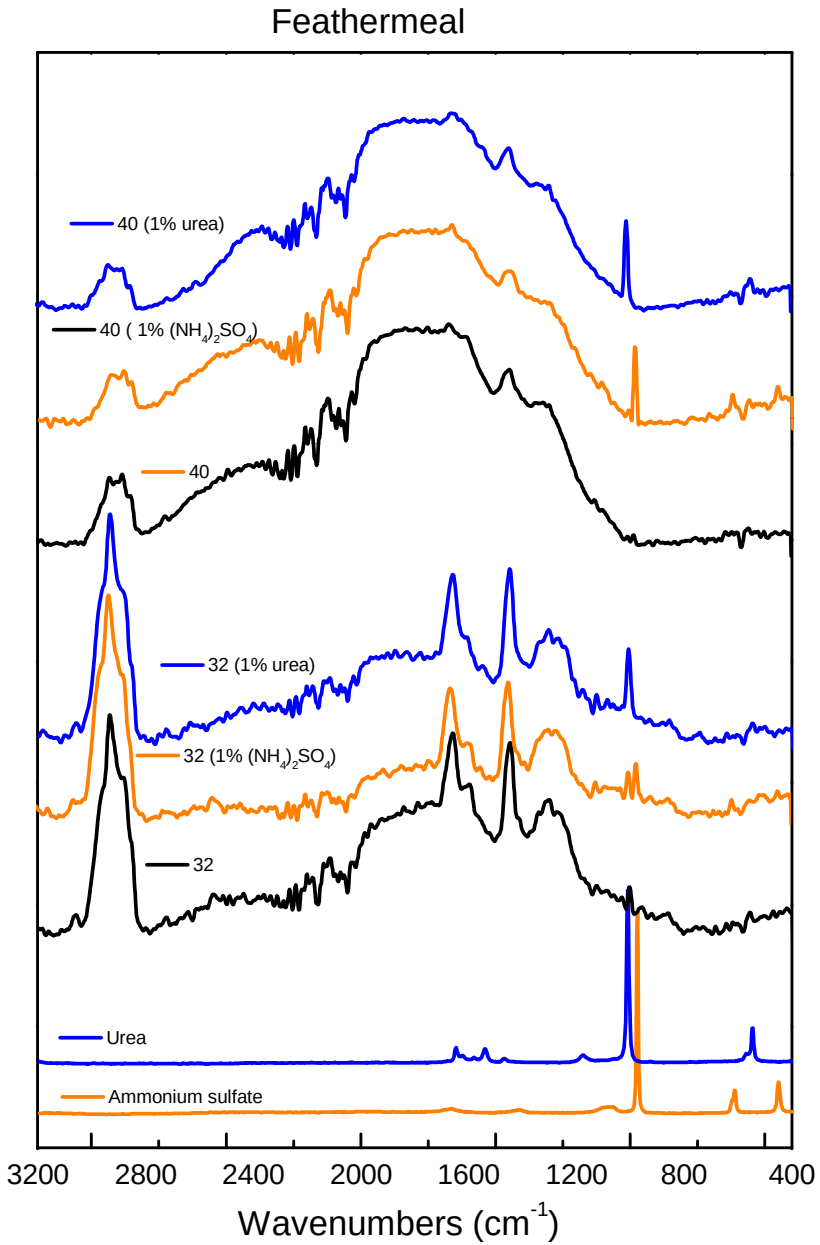
ATR-FTIR Spectra
Liquid fish



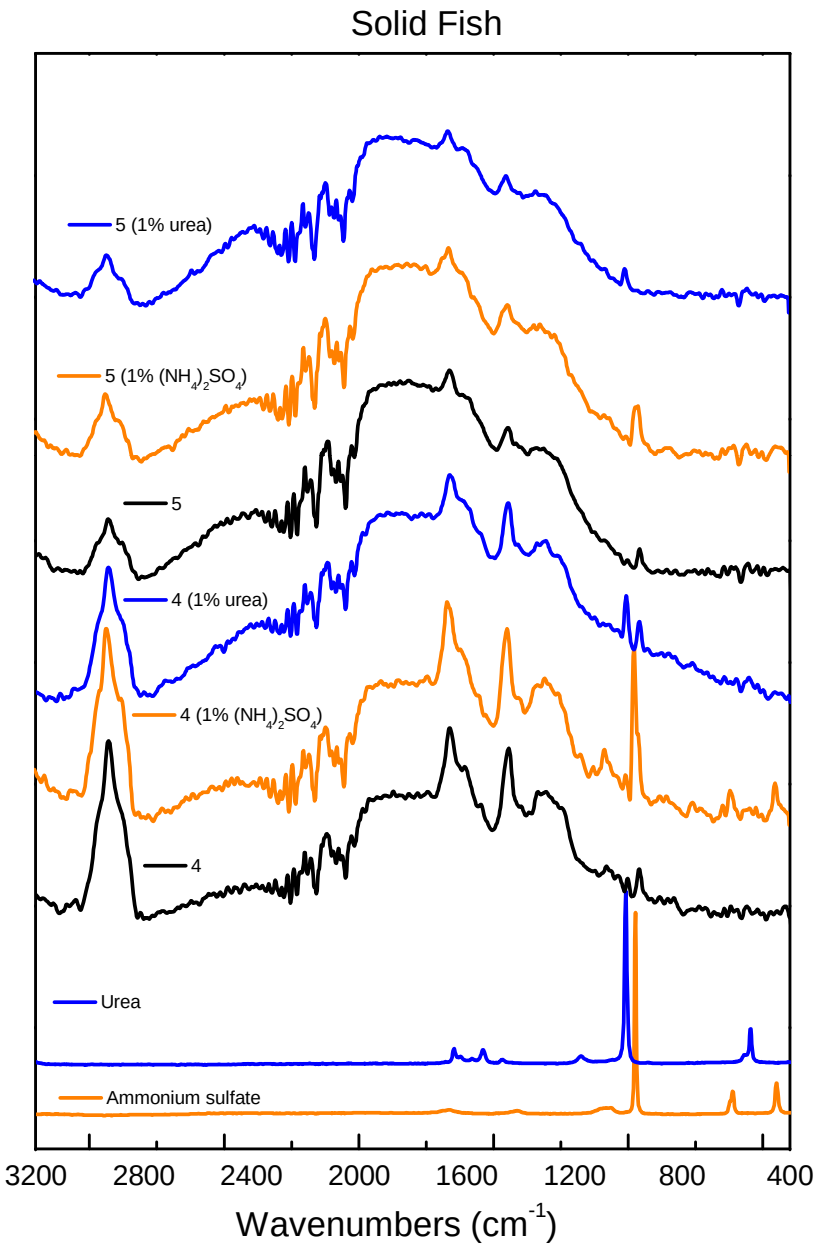


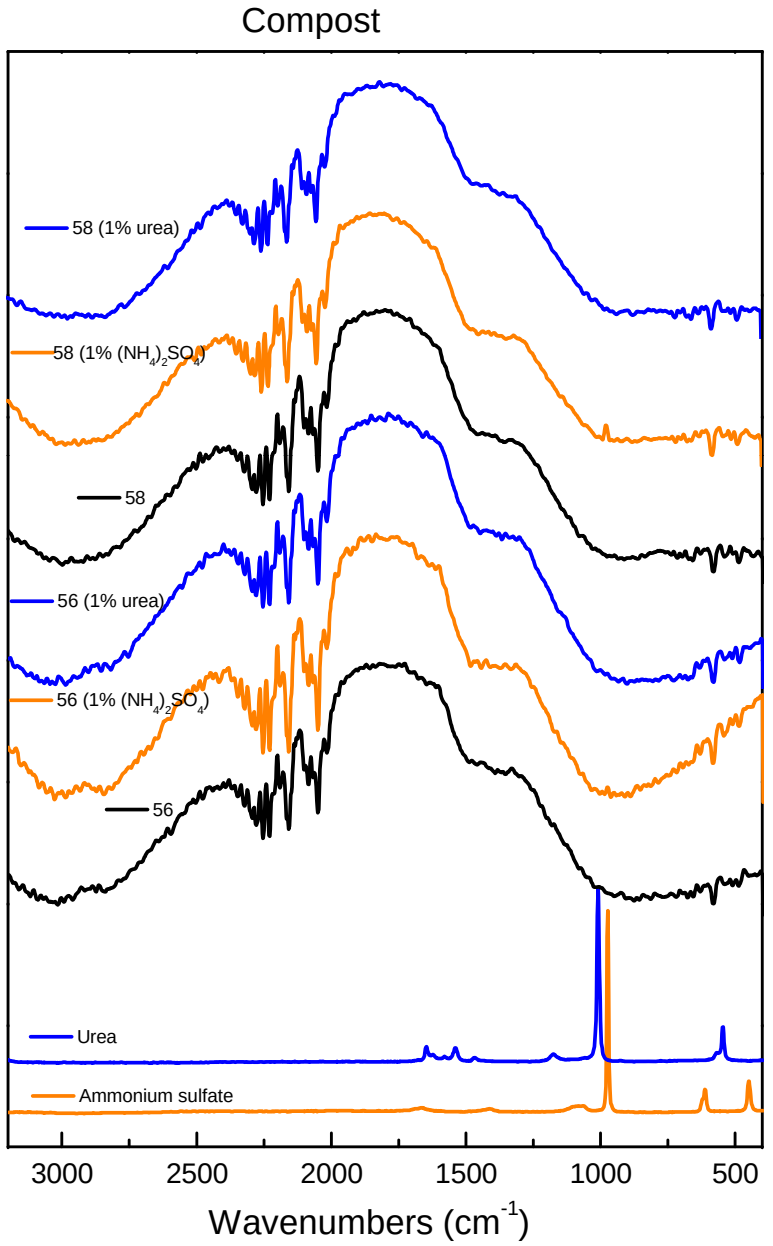
FT-Raman Spectra





FT-Raman Spectra





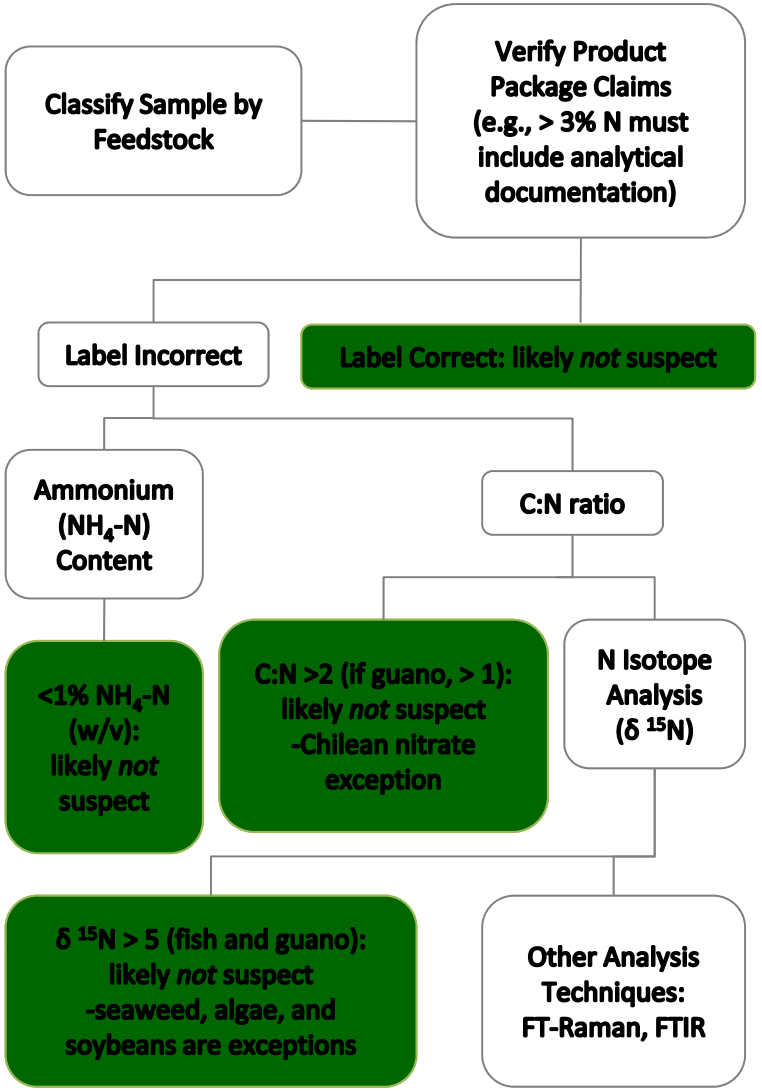
Task 3: Develop protocol

Guide

- Simple
- Systematic
- Rapid
- Ranges of values for certain parameters
- Threshold values for certain parameters

… to reach a tentative conclusion concerning a product's integrity

Status: Ongoing



Task 4: Independent tests

- Collaborating laboratories analyzing pure and doped samples using protocol tests.

	Sample #	Total Carbon (%)	Total Nitrogen (%)	C:N Ratio	NH_4-N (%)
Lab A	1	15.2	4.8	3.15	0.67
	2	14.0	5.2	2.67	1.99
	3	10.9	2.9	3.70	0.14
	4	2.6	4.4	0.59	3.31
Lab B	1	15.4	4.5	3.46	0.04
	2	14.6	5.0	2.94	0.12
	3	10.7	2.8	3.84	0.02
	4	5.30	6.1	0.87	0.55

Status: Ongoing

Task 5: Dissemination

Presentations:

Horwath, W.H. *The authenticity of organic fertilizers*. Russell Ranch Sustainable Agriculture Field Day, Thursday May 31, 2012; Davis CA.

Mukome, F.N.D., T.A. Doane, W.H. Horwath, and S.J. Parikh. *The use of ATR-FTIR and FT-Raman in the investigation of potential organic fertilizer adulteration*. Western Soil Science Society Meeting, Tuesday June 26, 2012; Davis CA.

Horwath, W.H., T.A. Doane , Mukome, F.N.D., and S.J. Parikh. *Developing testing protocols to ensure the authenticity of fertilizers for organic agriculture*. Western Soil Science Society Meeting, Tuesday June 26, 2012; Davis CA.

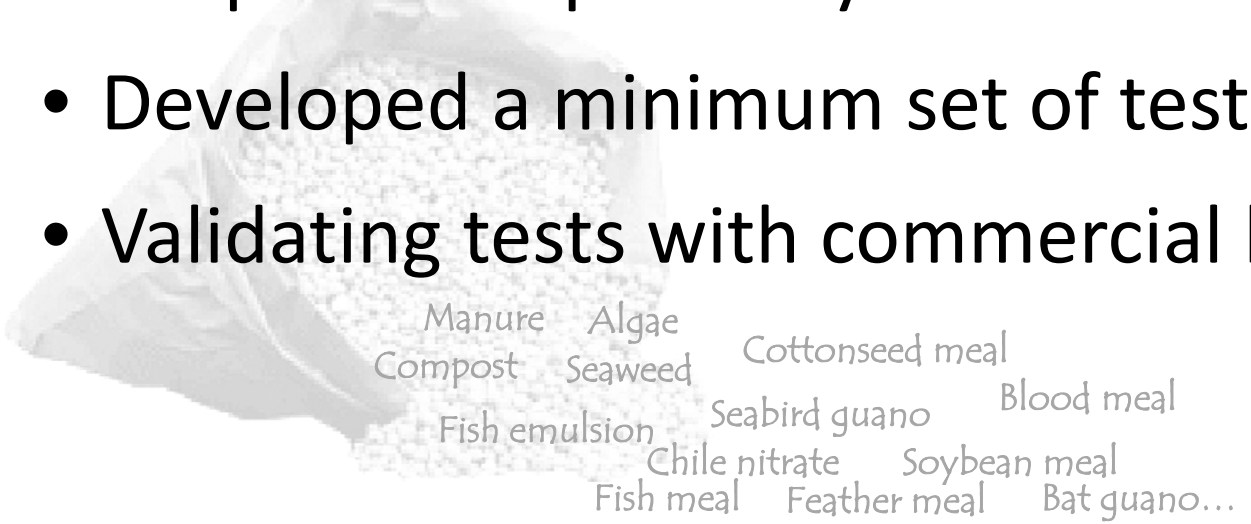
Publications:

Mukome, F.N.D., T.A. Doane , S.J. Parikh, and Horwath, W.H. *Developing testing protocols to ensure the authenticity of fertilizers for organic agriculture*. (submitted).

Status: Ongoing

Summary

- Analysis is showing detectable differences of types and sources of fertilizer
  - Stable isotopes
  - Traditional analysis (ammonia)
  - Spectroscopic analysis
- Developed a minimum set of tests
- Validating tests with commercial labs



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