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

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ORGANIC.
CONSUMER DRIVEN. FARMER POWERED.

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

78% OF U.S. FAMILIES ARE BUYING ORGANIC

94% OF ORGANIC OPERATIONS NATIONWIDE ARE PLANNING TO MAINTAIN OR INCREASE EMPLOYMENT IN 2012

40% OF THE ORGANIC MARKET IS FRUITS AND VEGETABLES

THE ORGANIC INDUSTRY GENERATES OVER $31 BILLION PER YEAR

17,600 CERTIFIED ORGANIC FARMS, RANCHES AND BUSINESSES NATIONWIDE

4.6 MILLION ACRES OF ORGANIC FARMLAND ACROSS THE U.S.

ORGANIC FARMS ARE 35% MORE PROFITABLE THAN THE AVERAGE FARM

MORE THAN HALF OF PARENTS HAVE A HIGH LEVEL OF TRUST FOR ORGANIC PRODUCTS

ORGANIC IS NOT JUST FOOD. OVER $2 BILLION WORTH OF ORGANIC FIBER, COSMETIC, AND HOUSEHOLD PRODUCTS WERE SOLD LAST YEAR

IN 2011, THE ORGANIC INDUSTRY GREW BY 9%

THE NATIONAL AVERAGE

6% OF ALL DAIRY PRODUCTS SOLD TO U.S. CONSUMERS ARE ORGANIC

THE ORGANIC INDUSTRY IS CREATING JOBS 4 TIMES THE NATIONAL AVERAGE

THERE ARE ORGANIC FARMS IN ALL 50 STATES

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.

LEARN MORE AT WWW.OTA.COM
Growth of US Organic Food Sector

Organic Food sales (millions $)


6100 7360 8635 10381 12002 14223 17221 20410 23607 24803 26708 29220

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

Read More: California Liquid Fertilizer, Capay Organic, Organic Chemical, Organic Farm Chemicals, Organic Fertilizer, Green News

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

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


○ LITERATURE DATA  □ SAMPLE DATA

The graph shows a scatter plot of δ15N values for various nitrogen sources, with distinct clusters for each category.
Total Carbon : Total Nitrogen Database

*category 12: 5 products, all >20
*category 13: 1 product, >20
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

<table>
<thead>
<tr>
<th>ATR-FTIR</th>
<th>FT-Raman</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Higher sample throughput due to shorter analysis time per sample</td>
<td>• Less post analysis processing</td>
</tr>
<tr>
<td>• Less sample preparation</td>
<td>• Easier detection of the potential adulterants.</td>
</tr>
<tr>
<td>• Handles solid and liquid samples</td>
<td>• Scattering resulting in longer analysis times to reduce the signal to noise (S/N) ratio</td>
</tr>
<tr>
<td>• Cheaper</td>
<td></td>
</tr>
</tbody>
</table>

• Techniques provided **qualitative** information on the presence of these adulterants
Feathermeal Compost

Aliphatic \( \text{CH}_2 \text{ and } \text{CH}_3 \)

Primary amine \( \text{N-H} \)

Amide \( \text{C-O} \)

Sample # 70
Sample #73
Sample #67
Sample #71
Sample #66
Sample #40
Sample #71
Sample #30
Sample #34
Sample #32
Sample #29
Sample #19
Sample #27
Samples #35
Samples #36
Samples #26
Sample #26
Ammonium Sulfate

Absorbance

Wavenumber (cm\(^{-1}\))

Sample #121
Sample #115
Sample #61
Sample #58
Sample #57
Sample #56
Sample #55
Sample #54
Sample #53
Sample #52
Ammonium Sulfate

Urea

Absorbance

Wavenumber (cm\(^{-1}\))
ATR-FTIR Spectra

Seaweed

1% urea
1% (NH₄)₂SO₄
undoped

Absorbance

Wavenumbers (cm⁻¹)

4000 3000 1600 1200 800 400
1% (NH₄)₂SO₄
1% urea

ATR‐FTIR Spectra

Undoped

Liquid fish

Wavenumbers (cm⁻¹)

Absorbance
FT-Raman Spectra

Bloodmeal

Feathermeal

Wavenumbers (cm$^{-1}$)

Urea

Ammonium sulfate

(1% urea)

(1% (NH$_4$)$_2$SO$_4$)

34

1% urea)

19 (1% (NH$_4$)$_2$SO$_4$)

19

32 (1% urea)

32 (1% (NH$_4$)$_2$SO$_4$)

32
Solid Fish

Compost

Wavenumbers (cm\(^{-1}\))
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.

<table>
<thead>
<tr>
<th></th>
<th>Sample #</th>
<th>Total Carbon (%)</th>
<th>Total Nitrogen (%)</th>
<th>C:N Ratio</th>
<th>NH$_4$-N (%)</th>
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<tbody>
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<td><strong>Lab A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1</td>
<td>1</td>
<td>15.2</td>
<td>4.8</td>
<td>3.15</td>
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<tr>
<td>2</td>
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<td>5.2</td>
<td>2.67</td>
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Status: Ongoing
Task 5: Dissemination

Presentations:


Publications:

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
Acknowledgements

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