EVOLUTION & FUTURE OF BIOCONTROL

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DunhamTrimmer LLC
Overview

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• Bio Companies
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• Macro Drivers

• Market Drivers
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• The Unexpected
• Market Growth
• Closing
Introduction

2011—Co-Founded DunhamTrimmer LLC
- Premier Biological Industries Market Research Firm
- Clients: Multinational CPC; Bio Companies; Investors; NGO’s
- Due Diligence, Multi-client market data, Single client studies

2013—Launched 2BMonthly
- The Global Biocontrol & Biostimulant E-Newsletter
- Joint effort New Ag Int’l & DunhamTrimmer
- Subscribers: Companies, individuals interested in biological industries
### Biological Market Overview

**Introduction—Product Types**

#### Biological Products

- **Biofertilizers**
  - Microbials used to enhance plant nutrient uptake from soil
  - Nitrogen fixing bacteria make up largest group
  - Others include mobilizers of specific nutrients (zinc, sulfur) and mycorrhizal fungi
  - Biofertilizers regulated under country/state fertilizer regulations

- **BioStimulants**
  - Seaweed Extracts make up the largest segment in this group
  - Microbials, primarily bacteria, often used as seed or soil treatment to aid in nutrient assimilation
  - Organic acids are humic and fulvic acids used as soil amendments, formed by the microbial degradation of plant matter.
  - Definition and regulation of biostimulants is still under development in most parts of the world

- **Biostimulants**
  - Amino Acids
  - Microbials
  - Plant Extracts
  - Organic Acids
  - Seaweed Extracts

- **Biochemicals**
  - Plant Extracts; Minerals & Others; PGRs; Semiochemicals; Organic Acids
  - Plant Extracts make up the largest segment in this group
  - Semiochemicals (pheromones) has the largest actual number of products
  - Largest challenge for Plant Extracts is manufacturing and consistent quality in the active ingredient(s)

- **Biochemicals**
  - N Fixing
  - K Mobilizers
  - Others
  - Amino Acids
  - Microbials
  - Plant Extracts
  - Organic Acids

- **Biopesticides**
  - Biopesticides are derived from natural materials, such as plants, bacteria and certain minerals. Biopesticides target specific pests and are inherently less toxic than synthetic pesticides.

- **Biopesticides**
  - Bacteria; Fungi; Virus; Protozoa; Yeasts
  - Bacteria, followed by Fungi make up the largest groups commercially (>90%)
  - Biopesticides are the largest market of biopesticides at US$1.3 Bn.
  - Biggest challenges for microbials are formulation related: 1) Shelf-life; 2) Stability; 3) Performance enhancement

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- **Macroorganisms**
  - Insects; Mites; Nematodes
  - Insects followed by mites makeup the largest groups
  - Unique in that the live organism in the form of eggs, larvae, pupae or adult is used.
  - Most important challenge for Macros is logistics—shipping live organisms that have to have special care to survive
  - Normally not classified as a Biopesticide—only as Biological Control Products

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Source: DunhamTrimmer LLC
• 17th Century
  – Nicotine used to control plum beetles
• 1835
  – Agostine Bassi demonstrated that white-muscadine fungus (*Beauveria bassiana*) could be used to cause an infectious disease in silkworm
• 19th Century
  – mineral oils as plant protectants
• 1901
  – Bt was isolated from a diseased silkworm by Japanese biologist Shigetane Ishiwata
• 1911
  – Ernst Berliner in Thuringen, Germany, rediscovered Bt
  – classified as type species *Bacillus thuringiensis*
• Early 1920s
  – French growers began to use Bt as a biological insecticide
• 1938
  – first commercially available Bt product, Sporeine, appeared in France
• 1950’s
  – In USA, widespread use of biopesticides began to take hold as a host of research on Bt efficacy was published

*Sources: BPIA website & Willem Ravenburg’s book, “A Roadmap to the successful Dev & Comm of Microbial Pest Control...”*
Stepping Back—Where it all started

- **1956**
  - Pacific Yeast Product Company developed an industrial process known as submerged fermentation, which allowed production of Bt on a large scale

- **1973**
  - *Heliothis* NPV was granted exemption from tolerance and the first viral insecticide Elcar received a label in 1975

- **1977**
  - *Bacillus thuringiensis* var. *israelensis* (toxic to flies) was discovered

- **1979**
  - U.S. EPA registered the first insect pheromone for use in mass trapping of Japanese beetles

- **1983**
  - The Bt strain *tenebrionis* (toxic to beetles) was discovered

*Sources: BPIA website & Willem Ravenburg’s book, “A Roadmap to the successful Dev & Comm of Microbial Pest Control...”*
Founding Members IBMA 14-9-1995
- Abbott
- Agrisense
- BCP
- Biobest
- BioTop
- Ciba Bunting
- ESA
- Koppert
- Novo Nordisk
- NPP

Source: DunhamTrimmer Company Database / IBMA
Global BioControl Market Benchmark Values (USD)

- 1993: $US 250 Million
- 1999: $US 100 Million
- 2005: $US 1,000 Million
- 2009: $US 1,500 Million
- 2012: $US 2,000 Million
- 2014: $US 3,000 Million
- 2016: $US 4,000 Million
- 2020: $US 5,000 Million

Source: BioMarket Database DunhamTrimmer LLC
Biocontrol Market Stats

2015 Biocontrol Market

Microorganisms
Macroorganisms
Pheromones
Plant Extracts

2015 Biopesticide Market

BioInsecticides
BioFungicides
BioNematicides
BioHerbicides
Others
ROW
Asia/Pac
USA/Can
Europe
LatAm
Biopesticides - Registered Products

BIOPESTICIDE REGISTRATIONS

- Brazil: 100
- EU: 125
- USA: 420

Biopesticide Registrations
Biopesticide – Active Ingredients

Number of Actives

- Semiochemicals
- Plant extracts
- Minerals
- Bacteria
- Fungi
- Viruses
- PGRs
- Organic acids
- Protozoans
- Yeasts

> 250 active ingredients total

Source: DunhamTrimmer BioPesticide Industry Overview: Products
Biopesticide – Use Patterns

Number of Products

- Insecticide: 831
- Fungicide: 164
- PGR: 16
- Nematicide: 12
- Molluscicide: 8
- Herbicide: 1
- Rodenticide: 1

> 1000 products total

Source: DunhamTrimmer BioPesticide Industry Overview: Products
Global Population Growth

- 1990: 5 billion
- 2010: 7 billion
- 2030: 8 billion
- 2050: 9 billion

Sustainable Agriculture

70% more food by 2050, using.....

- Less land
- Less water
- Less Fertilizer
- Fewer pesticides

To produce......?

- 1 Slice Bread—40 liters
- 1 bag Chips—190 liters
- 1 Hamburger—2400 liters
- 1 Steak—7000 liters

According to the UN Food & Agriculture Organization the world needs to produce more food between 2000 and 2050 than was produced during the previous 10,000 years.

Source: Dr Jack Bobo Sr Advisor for Biotechnology US State Dept
Climate Change

Climate Change Impacts Crops Through:
- Increased CO$_2$ concentration
- Higher temperatures
- Altered, more variable precipitation patterns

Climate Change will alter pest problems:
- Potential magnitude is uncertain
- Some weeds benefit more from higher CO$_2$ than crops
- Higher temperatures can increase or reduce plant disease & insect pressure
- The range of pests attacking crops or people will change

Extreme weather events will be more common:
- Heat waves, droughts, freezing, floods........
- Timing & location of these events during crop development can greatly influence the impact

Source: US EPA
## “Snake Oil” to Science

### “Snake Oil”
- Biological “enthusiasts”
- Non-scientific, non-replicated data
- Promoted marginal activities
- “Over Promised—Under Delivered”

### Science
- Scientific designed replicated trials
- Scientific data
- Improved fermentation technology
- Understanding of “Mode of Action”
- Deliver on promised results
BioControl Companies

>300 Bio Companies*
>200 Biocontrol Companies*
>100 Biostimulant Companies*
*(outside of India/China)

- 98% of Bio Companies are Privately Held
- ~5 Biocontrol Companies have > $100 Mn AR
- 75% of Biocontrol companies have < $10 Mn AR
- Biocontrol Companies are Found WorldWide

- Founded by Research individuals
- Most apparent weakness is Market Access—lack resources
- Generally lack funding for rapid market growth

- Crop Protection Market Characteristics
  - “Manufacturers create demand”
  - “Distributors take orders”
  - A typical multinational in US has >300 field personnel
  - A Typical Biocontrol Company in the US has 5-10 field personnel
Bio Market Drivers

• Regulatory
  – Lower cost & shorter timeline

• Pest Resistance
  – Multiple MOA (Mode of Action)

• Portfolio Mgmt Tools
  – Full Program Offer

• Food Marketers/Consumer Demand
  – Reduced chemical residues

• Worker safety/flexibility

• Sustainability

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<th>Manufacturers</th>
<th>Growers</th>
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<td>Regulatory</td>
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<td>Worker safety/flexibility</td>
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<tr>
<td>Sustainability</td>
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Acquisitions

2BMonthly Reported Intercompany Activity

M & A / JVs / Investments
✓ 2014 – 24 Major Agreements
✓ 2013 – 16 Major Agreements

Distribution—Market Access
✓ 2014 – 22 Major Agreements
✓ 2013 – 14 Major Agreements

R & D / Manufacturing
✓ 2014 – 16 Major Agreements
✓ 2013 – 9 Major Agreements

Acquisitions by "Major Six" CPM Companies

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<th>Chemical</th>
<th>Seed</th>
<th>Biopesticides</th>
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<tr>
<td>Syngenta</td>
<td>46</td>
<td>19*</td>
<td>5**</td>
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<td>Bayer</td>
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<tr>
<td>DuPont</td>
<td>3</td>
<td>5 / 6</td>
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<tr>
<td>TOTAL</td>
<td>101</td>
<td>143 / 34</td>
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* Acquisitions (direct & indirect)

** Partial Ownership

*** >$US 2 Bn
Case Study-Brazil 2014

**Pest** – Corn earworm (*Helicoverpa armigera*)

**Background**

- Widespread in Old World, first found in Brazil in 2012
- Quarantine pest, likely arrived by import
- Voracious feeder in many crops – corn, cotton, soybeans, many vegetable crops
- BT crops do not control; no registered insecticides
- “Perfect Storm” due to continuous cropping & tropical climate
- 2013 crop losses estimated 5 to 10 billion Real

**Biocontrol**

- Regulatory system delays
- Government approved biocontrol products (baculoviruses) under emergency provisions
- Biocontrol products are main viable control option available
- Changing mindset of growers to biocontrol solutions

**Market Growth**

- Biocontrol Market Grew by over $100 Mn in 2014
- Growth for the total CPM
Biocontrol Market Growth

Biocontrol Market Growth (Bn USD)

Year 2010
Year 2015
Year 2020
Year 2025
Closing

• Biological Ag Industries—Sustainable Growth-12%-17%
  – **Biocontrol** / Biostimulants / Biofertilizers
• Green technology / Sustainable technology
• More efficient use of resources
  – Pesticides / Fertilizers / Inputs
• Rapidly growing entrepreneurial companies
• Consolidation – Market Access
THANK-YOU FOR YOUR ATTENTION

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