Modern Micronutrient Use Considerations

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Essential Micronutrients

Formulae

- Those that solve the problem
- Shotgun vs. rifle
- Raw material vs. formulated vs. actual sale

Elements

- Zinc
- Boron
- Iron
- Manganese
- Copper
- Molybdenum
- Ni, Se, Si, Co, Cl?

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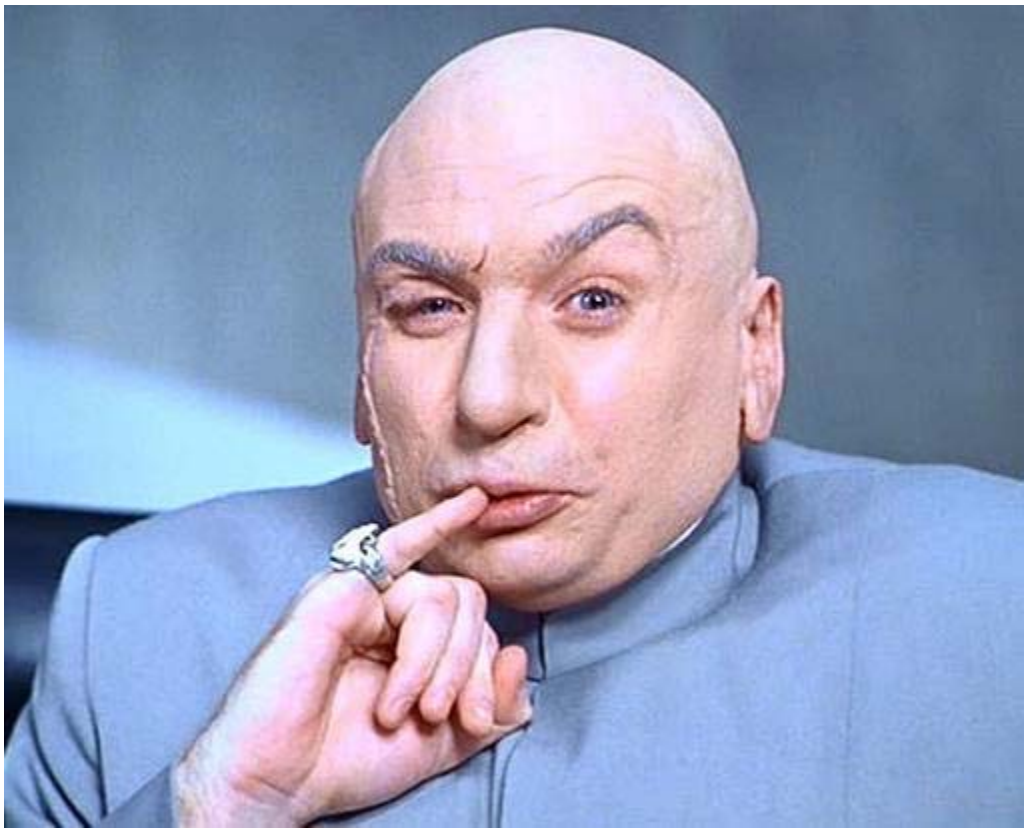
Industry Overview



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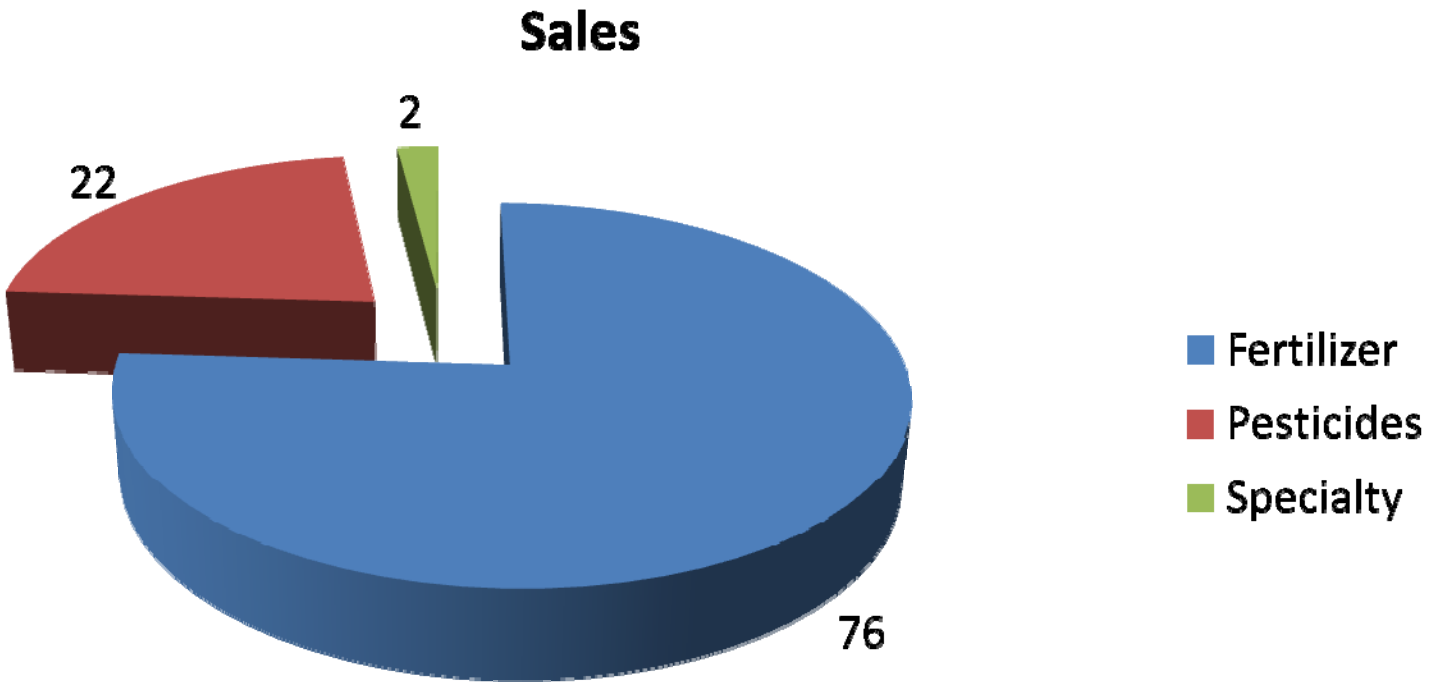
Total market for agricultural inputs, ~$150 billion



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North America

- 21% world market
  - ~$600 million
  - 4% of total fertilizer market

U.S. Market Ranking – reality?

- Zinc – 45%
- Iron – 25%
- Boron – 20%
- Manganese – 8%
- Copper – 2%

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Market Realities?

- Fertilizer distribution channels comfort zone is commodity trading and logistics
- Ag chem distribution used to jugs and “specialty” markets
- Neither model perhaps understands the nuances of “non-agricultural” commodities, raw materials, real life agronomics, metal markets etc……
- As a result, any guesstimate of the market is meaningless
  - Raw materials
  - Sales to distribution – double / triple count
  - Adjuvants / biologicals / others

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Issues

- Secondary nutrients (e.g. Ca, Mg) often dumped to "micros" – i.e. afterthought
- Agronomic "research"
  - Solution culture vs. soil
  - Curative (loser) vs. Preventative (there's a novelty)
  - Yield as the Holy Grail?
  - Nutritional / Quality – poor NPK practices?
    - Constitutive
    - Chemical
    - B, Mn, Ni classics
  - Genetics – you generally need a seed to grow a crop – *ignore at your peril*

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Genetics ahead

- Drought tolerance
- Nutritional
  - Constitution (Se)
  - Taste
  - Quality
- Nutrient use efficiency
- Non-conventional use e.g. B/N, Zn/Ca, Ni/Zn

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It is somewhat of a play-pen but there are rules.....

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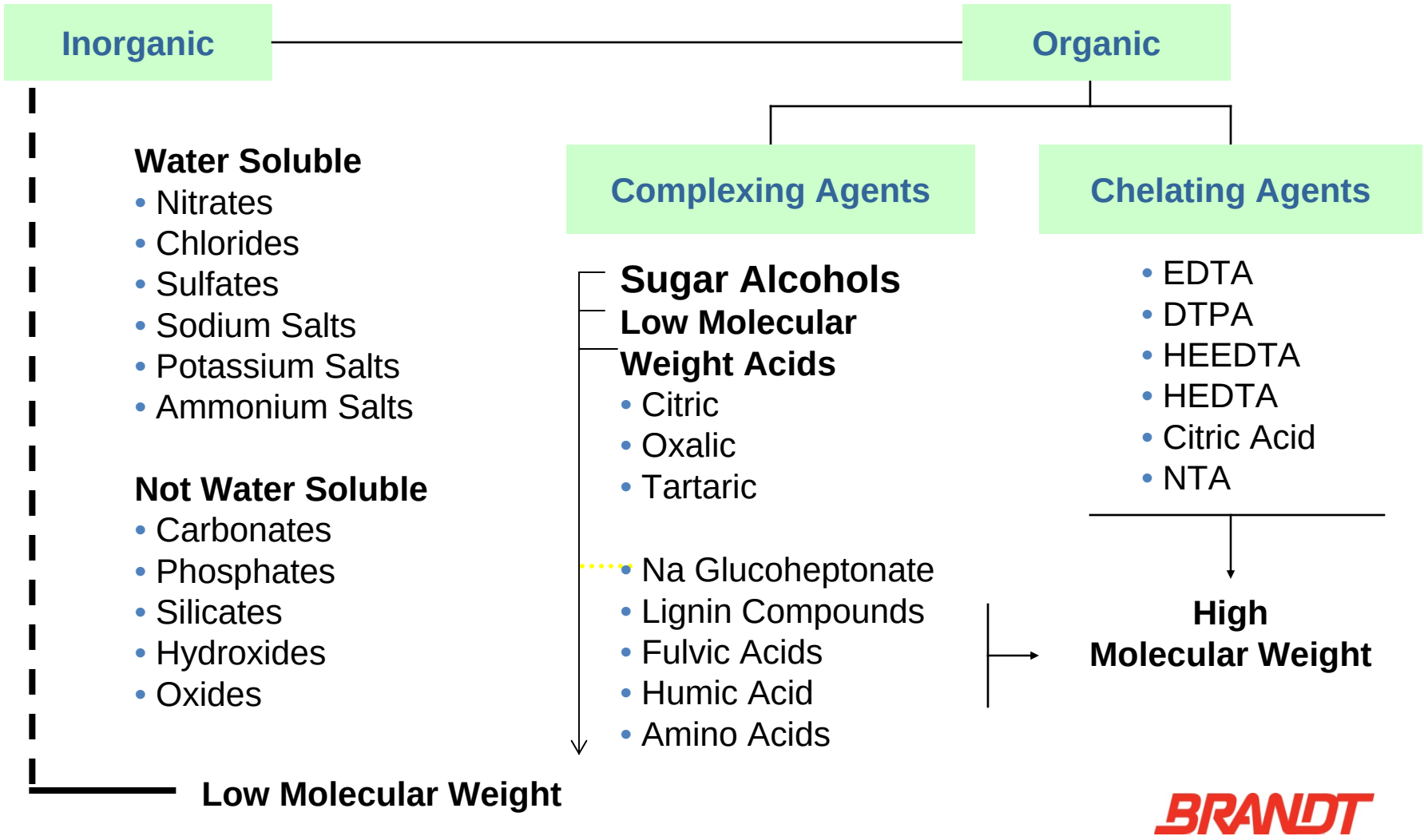
Here's the playpen



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Solutions

- Inorganic vs. Organic
- Complexes vs. Chelates vs. Salts
- Stability constant
- Role of pH and soil type
- Organic matter
- Solubility and plant availability

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Considerations

- Molecular weight, size, dimension
- Soil or foliar? Both?
- In plant mobility?
- Biodegradable / environmental compatibility
- Chemical compatibility
- Phytotoxicity
- Stability constant

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Agronomic considerations – try not to forget the plant…

- Micronutrients usually applied in amounts of less than 10 lb metal /ac
- Problems?
  - Uniformity of soil application – surface activity
  - Liquid vs. dry
  - Are the combinations plant available?
    - Biological / chemical - glyphosate
  - Can you get it out of the spray tank?
  - Crop safety issues – timing (pollenation)
  - Predicting the problem

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Soil applications

- Strong chelate
- Compatible with fertilizer
- Plant mobility not an issue, chemical stability is....
- Local market / custom usually dictates
  - Liquid / dry
  - Chelate vs. salt (starter vs. fall blend)
  - Cost per lb / vs. cost per acre

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% Zn remaining after 4 minutes mixing with a 1-2-0 ortho P

- ZnEDTA 100
- ZnPhenolic 11
- ZnCitrate 8
- ZnSO4-NH3 complex 8
- ZnSO4 4

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Foliar applications

- Much maligned in “conventional” circles
  - Cure all vs. agronomic proven supplement
  - Muck and mystery vs. proven solutions
  - Ignorance at “research” level is a hurdle (disparate disciplines)
- Multiple ride opportunities?
  - Glyphosate / herbicide
  - Fungicide
  - Corrective / compensatory / additive aspects

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Foliar needs

- Weak complex
- Low molecular weight
- High water solubility
- Low phytotoxicity
- Plant analog
- In-plant mobility

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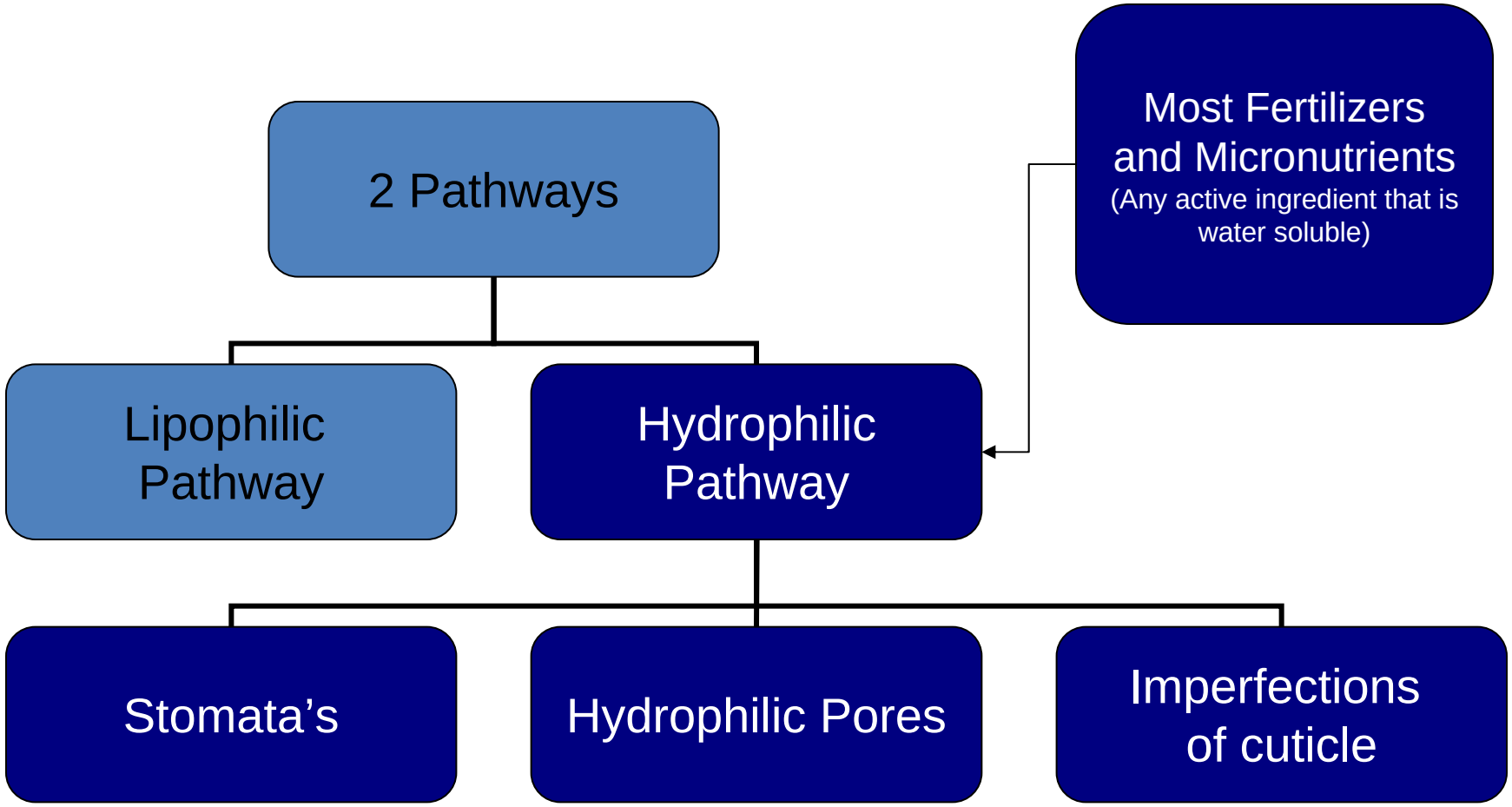
Foliar Applied Ingredients

2 Pathways



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Leaf Penetration (Cuticle)

- Lipophylic
  - Non-electrolytes – organic molecules
    - Agrochemicals
- Hydrophylic
  - Polar / Aqueous pathways
  - Hydrated ionic compounds (sugars, inorganic ions)
  - Pores – 0.45 – 1.18 nm

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Factors influencing permeability of inorganic ions and charged molecules across plant cuticles

- E.g. – Ca2+, glyphosate, precipitation at pore (Fe)
  - Humidity
    - 2-3 x greater as RH approaches 100%
    - Sorption of water to polar domains
    - = swelling of cutin polymer
    - = increased penetration of ionic compounds
  - Temperature
    - No effect (except humidity)
  - Light
    - Rates of salt penetration 2-fold lower in dark
  - Molecular weight
    - Reduced 3-10x as Ca salt increases from 100 – 500 gmol

In summary – the crop or end-user that counts?

- In 2015 Zn will still be Zinc but gene expression, traits etc might have shifted…
- Operational vs. agronomic service
  - Just another SKU or a business necessity?
- Prescription vs. insurance
  - Re-birth of real agronomists
- Chemistry vs. price
  - Sophisticated products in a singularly unsophisticated market
- Soil vs. foliar
- Yield vs. quality
- Nutritional value of the crop

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Sometimes it helps to stay quiet and look inconspicuous……

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