

Presentation to the National Organic Standards Board Celery Panel

Andrew Milkowski

April 24, 2019



Outline

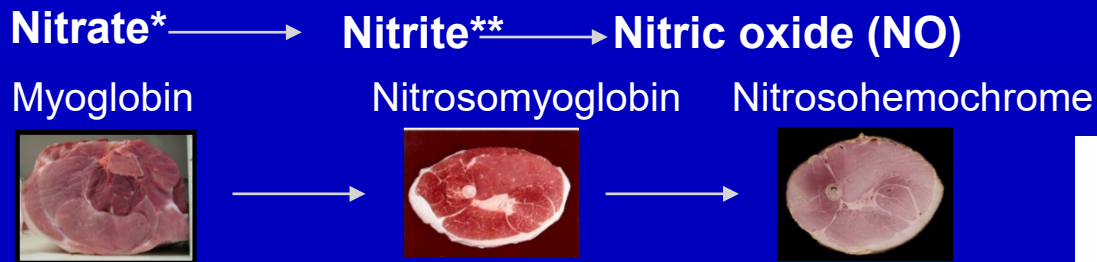
- **Response to questions of the National Organic Standards Board regarding celery as a curing ingredient in processed meats**
- **Discussion of human nitrogen oxide physiology**

1. Is nonorganic celery powder still essential for the production of processed meats?

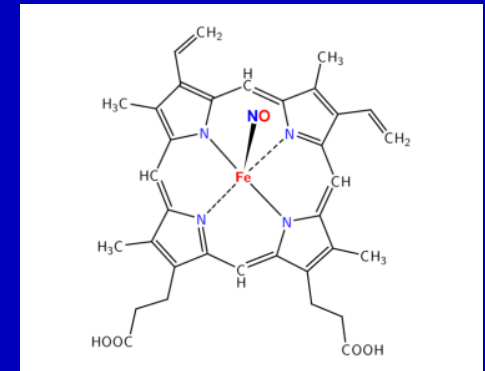
- I am unaware of any organic products containing high enough concentrations of nitrate or nitrite that would make them candidates to be a curing ingredient.
 - The minimal Nitrite concentration needed to cure processed meat for pathogen safety and color benefits is 80-200 ppm (based on weight of meat used)

Nitrite – The Multi-functional Food Additive

- **Development of cured meat color**



- **Cured meat flavor**
- **Functions as an antioxidant**
- **Antimicrobial** – *C. botulinum*, *C. perfringens*, *L. monocytogenes*



*Pure nitrate or celery powder

**Pure nitrite or cultured celery powder

4. Are there strategies to produce organic celery powder that is standardized to consistently meet safety and other requirements of the meat processing industry?

- **I am unaware of any, however this is not an area where I have expertise.**

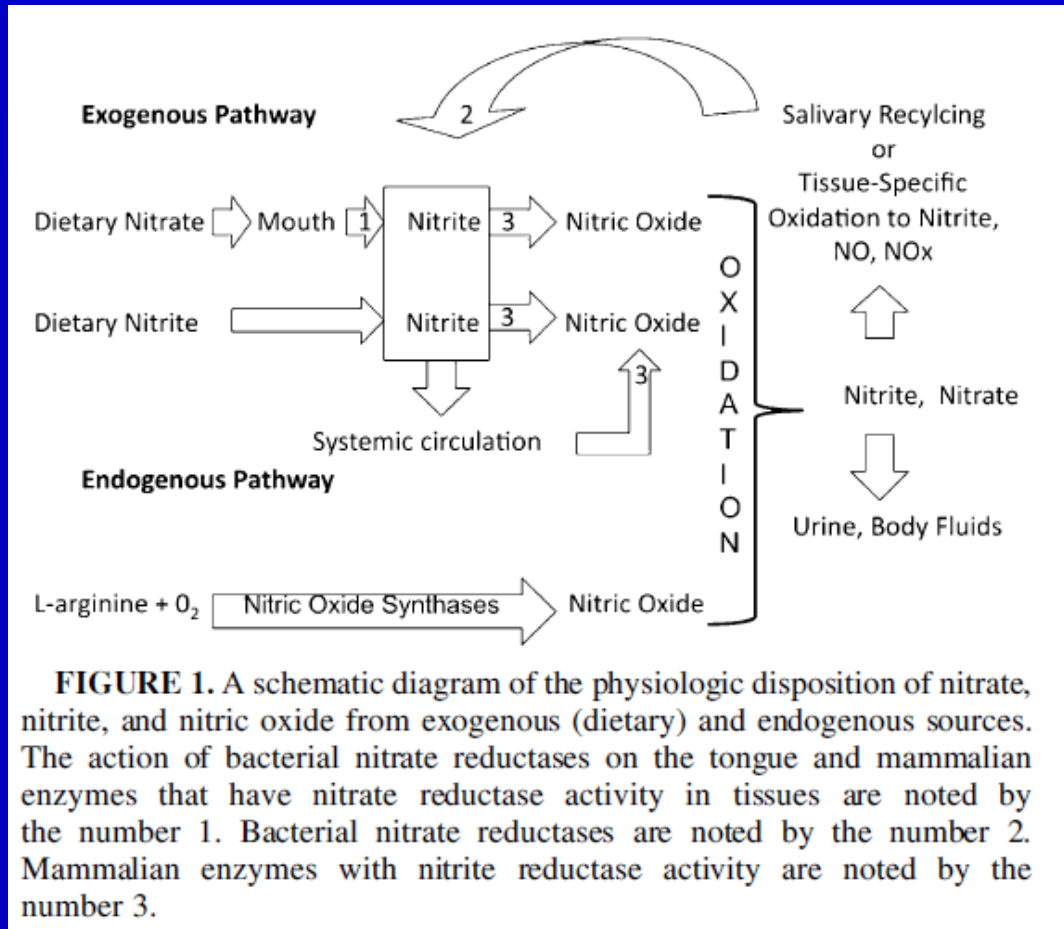
6. Are there commercially available agriculturally produced alternatives to celery powder? What is your experience with them? Are they organic? Does their use vary by application? Are they more effective in one application compared to another?

- There are vegetables and tubers (e.g. celeriac, Chinese cabbage, endive, fennel, kohlrabi, leek, parsley, celery, cress, chervil, lettuce, red beetroot, spinach) which have enough nitrate in them to be candidates, but they have flavors and colors which limit their use on a practical basis.**

7. What is the latest information on the human health risks of nitrate and nitrites present in processed meats from either synthetic or plant-based sources?

- IARC classifications of Nitrite & Nitrate (2006) and Processed Meats (2015)
- Important to note:
 - “IARC Monographs Programme evaluates cancer hazards but not the risks associated with exposure.” (<https://monographs.iarc.fr/>, Q&A link)
 - The 2015 working group noted that cured meats are a minor source of nitrate/nitrite in human physiology
 - There is no difference related to the source in how nitrate and nitrite are metabolized. As simple ions, naturally derived and synthetic nitrate and nitrite are physiologically identical.

Nitrogen Oxide Physiology



Hord, N. G., Y. Tang, et al. (2009). "Food sources of nitrates and nitrites: the physiologic context for potential health benefits." Am J Clin Nutr **90(1): 1-10.**

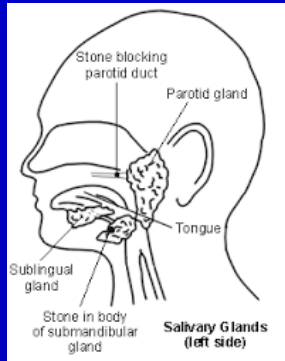
Sources of Nitrate, Nitrite and Nitric Oxide Exposure*

Source	Nitrate, NO ₃ ⁻	Nitrite, NO ₂ ⁻	Nitric Oxide, NO
Diet, ex cured meats	50 - 220	0 - 0.7	-
75g/d cured meats	1.5 - 6	0.05 - 0.6	-
Water	0 - 132	0 - 10	-
Saliva	>30 - 1000	5.2 - 8.6	-
Endogenous Synthesis	-	-	70

* mg/day/adult person

Source: Milkowski, A.L., (2017) Sources of Exposure to Nitrogen Oxides, in Nitrite and Nitrate in Human Health and Disease, 2nd edition, Edited by: N.S. Bryan, and J Loscalzo, ISBN: 978-3-319-46187-8, doi 10.1007/978-3-319-46189-2 Humana Press, New York, pp. 69-82

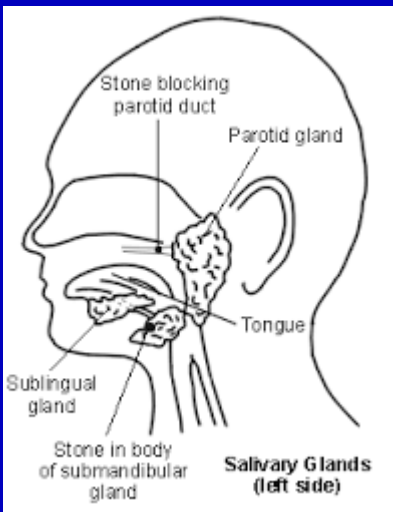
Nitrate is Secreted in Saliva



- **Salivary glands extract nitrate from the blood plasma** (25% of the nitrate you ingest from food or produce endogenously comes back into saliva)
- **Salivary nitrate is chemically reduced by bacteria on the tongue to nitrite** (20% of the nitrate in saliva)
 - Thus 5% of ingested and synthesized nitrate is recycled into ingested nitrite
- **Acidified salivary nitrite is protective against periodontal disease pathogens**
- **Salivary nitrite is swallowed and enters the acidic stomach**
- **Acidified gastric nitrite is bactericidal for a number of gastrointestinal pathogens and is thus a form of innate immunity**

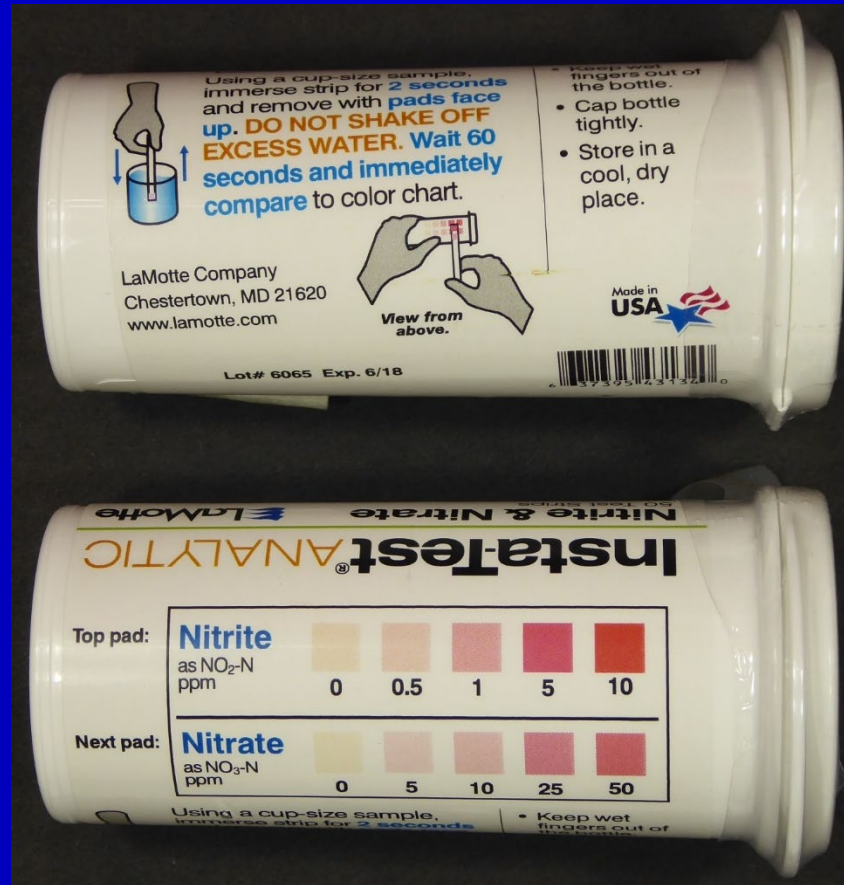
Time Permitting: Salivary Nitrate and Nitrite

Let's check Nitrate and Nitrite in our own saliva



Salivary Nitrate and Nitrite

1. Wet the tip of your finger with saliva
2. Transfer saliva to each pad on the test strip and get it thoroughly moistened
3. Wait a couple of minutes
4. Hold the test strip with the pads up
5. Compare to the scale on the screen





Celery Powder

Industry perspectives on re-listing & constraints



An essential ingredient

- Celery Powder remains an essential curing agent for organic cured meats
- Only option currently available to comply with FSIS food safety requirements
- Cured meat products represent nearly 25% of Organic Meat Company's gross revenue annually



Numerous Constraints

- Varietal differences
- Fertility/regional variation
- Nitrate to Nitrite conversion performance
- Sensory panel approval
 - Taste
 - Color
 - Shelf-life



Market dynamics

Why isn't the market just innovating and developing the product?

- Financial risk to the farmers
- Financial risk to the processors
- Product is used in small amounts
- Potential gain for processors and farmers is limited



Environmental impacts

- Is use of synthetic nitrogen increased in conventional celery production for powder?
- Largely speculative
 - Contracted growers (conventional) have been very unwilling to share in-field practices of their production systems.



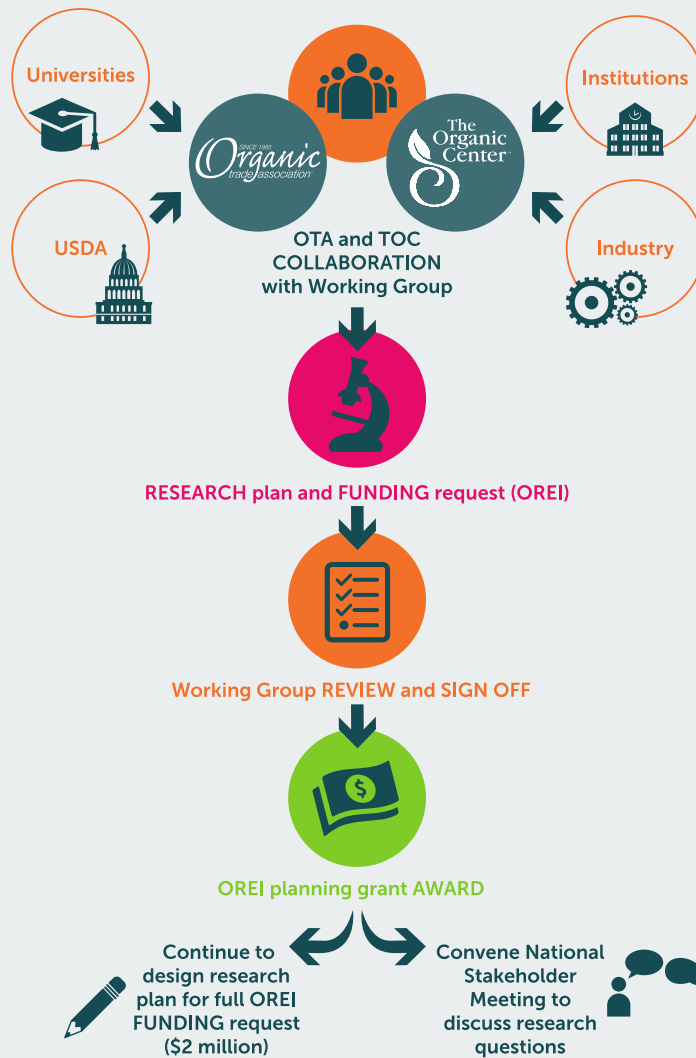
Celery Powder – NOSB Panel

A close-up photograph of a hand holding the handle of a brown paper shopping bag. The background is a soft, out-of-focus green, suggesting an outdoor setting like a farm or market. The lighting is bright and natural, highlighting the texture of the paper and the skin of the hand.

Dr. Erin Silva
University of Wisconsin-Madison
Organic Production Specialist

Developing an ORGANIC ALTERNATIVE TO CELERY POWDER

AN OTA WORKING GROUP PROGRESS UPDATE



Question #2

- Compared with growing celery for vegetable production, is increased use of synthetic nitrogen fertilizers required to produce source plants with enough nitrate for celery power production?

Answer

- It is Dr. Sindelar's understanding that there are specific recommendations for the production of celery for juicing as a meat curing agent, but we were not able to ascertain these recommendations

Question #3

- Since 2015, what progress has been made on the production of organic celery for powder production?

Current Grant Funding

- USDA Organic Research and Extension Initiative Planning Grant
 - Applied March 2016, awarded June 2016
 - Led by the University of Wisconsin-Madison
- Organic Valley's Farmers Advocating for Organics Fund

Experimental Approach

- Variety selection
- Fertility management strategies
- Farm environment
- Harvest date
- Yellow and white beets as alternative plant source

Experimental Approach

- Core experiment conducted at certified organic land at the UW West Madison Agricultural Experiment Station
 - Certified organic 10+ years
 - Under a vegetable rotation with extensive cover cropping
 - 3.5% organic matter, silt loam soil
 - Fertilized annually with pelletized poultry manure (aiming for 120 lbs/N per acre, estimating 50% availability in given year)

Experimental Approach

- Three replications, split plot design
 - Whole plot factor: variety
 - Split plot factor: fertility treatment (foliar feed versus sidedressing)
- Planted as 8 week old transplants in June
- Drip irrigated as needed
- Harvested in late September

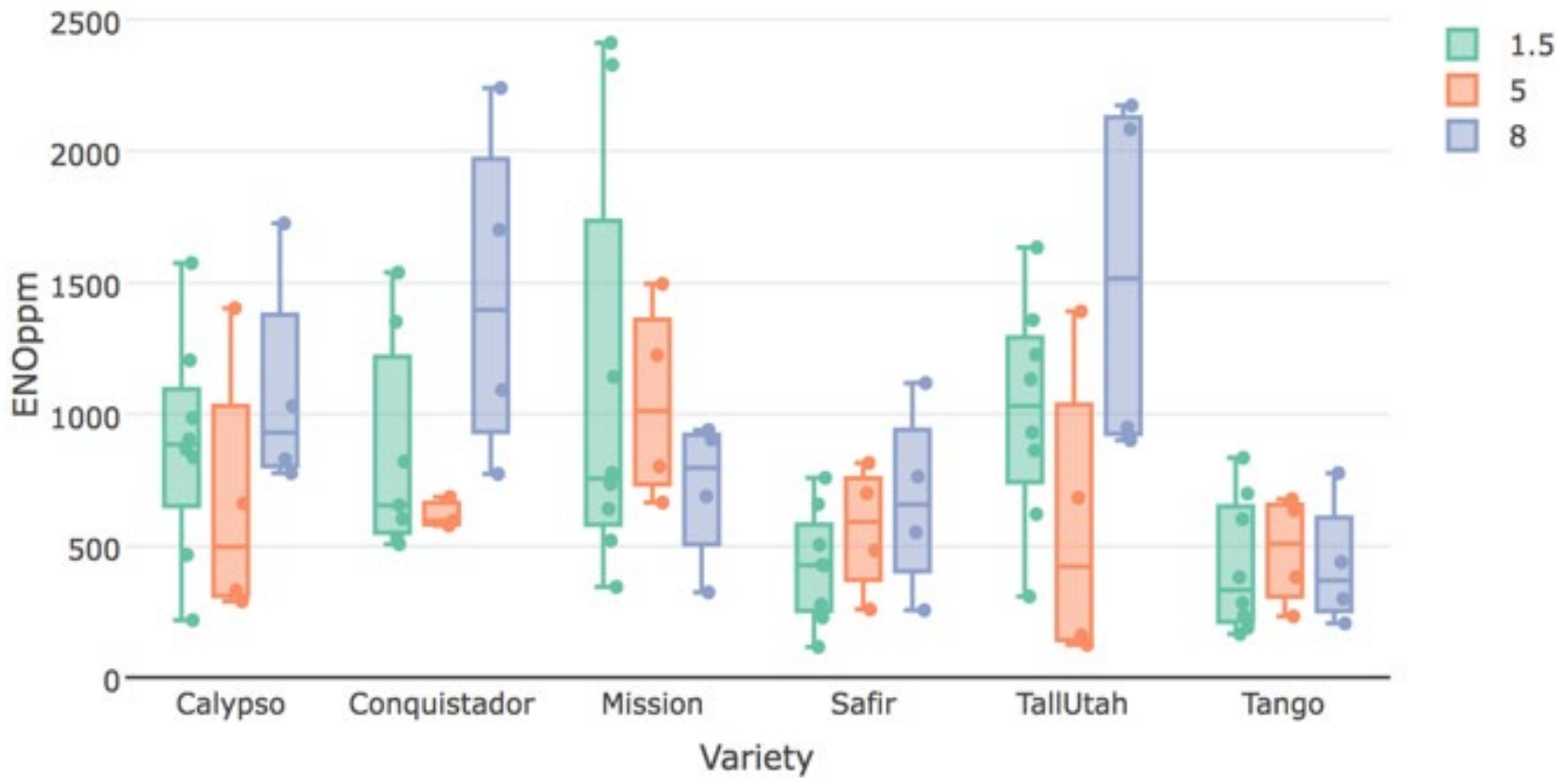
Experimental Approach

- Samples were juiced and frozen at UW Madison
 - Aimed for within 24 hours of receiving samples, which were kept refrigerated
- Samples sent to Kerry Ingredients for further testing

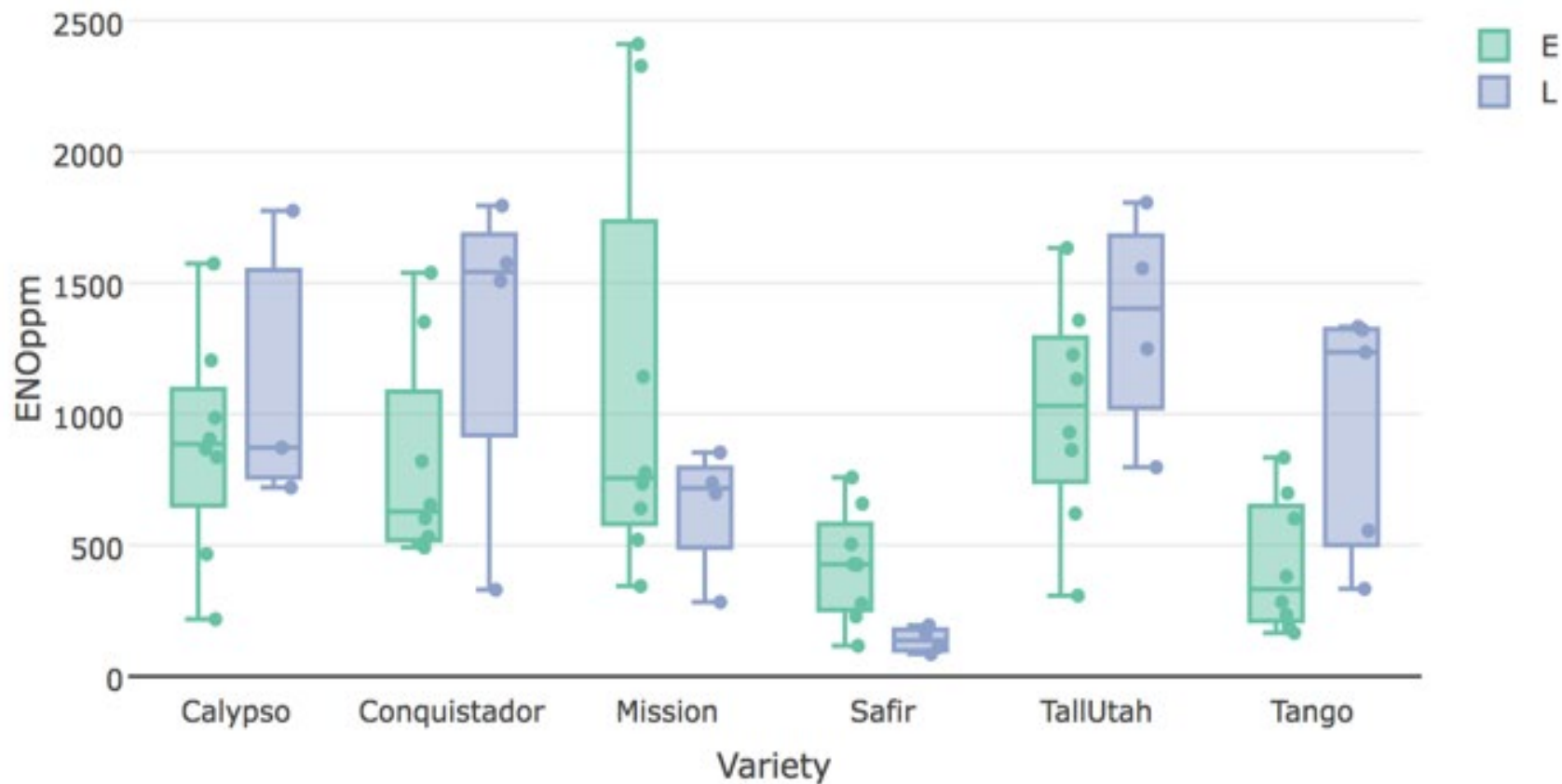
Nitrate Concentrations of Organic Celery Samples by Variety

	Nitrate (ppm) 2016	Nitrate (ppm) 2017
Calypso	1618	882
Conquistador	1869	811
Tall Utah	2197	1009
Tango	1322	442
Mission		1112
Safir		424
P-value	0.2701	0.0004

Effect of Time to Juicing on Nitrate Concentrations



Effect of Early (145 days) and Late (171 days) Harvests on Nitrate Concentrations of Celery



Impact of Supplemental Fertility on Nitrate Levels in Organic Celery

2016	Foliar Feeds	Unfertilized
Nitrate (ppm)	1549	1743

2017	Sidedressed	No Sidedress
Nitrate (ppm)	827	726

Nitrate Concentrations of Organic Celery Samples Across Farms

		Nitrate (ppm)	Nitrate (ppm)	Notes
Wisconsin	West Madison ARS	1731	795	
	Equinox	190		
	Park Ridge Organics	997	410	CPM; Conquistador
	Scotch Hill Farm	221		
	Blue Moon		450	CPM; Tango
	Tipi Produce		207	CPM before and as sidedress; Tango
	Squashington		102	Cover crop; Tango
California		488		741
	P-value	<0.0001	0.05	

Question #6

- Are there commercially available agriculturally produced alternatives to celery powder? What is our experience with them? Are they organic? Does their use vary by application? Are they more effective in one application compared to another?

Nitrate Concentrations of Organic Beet Samples by Variety

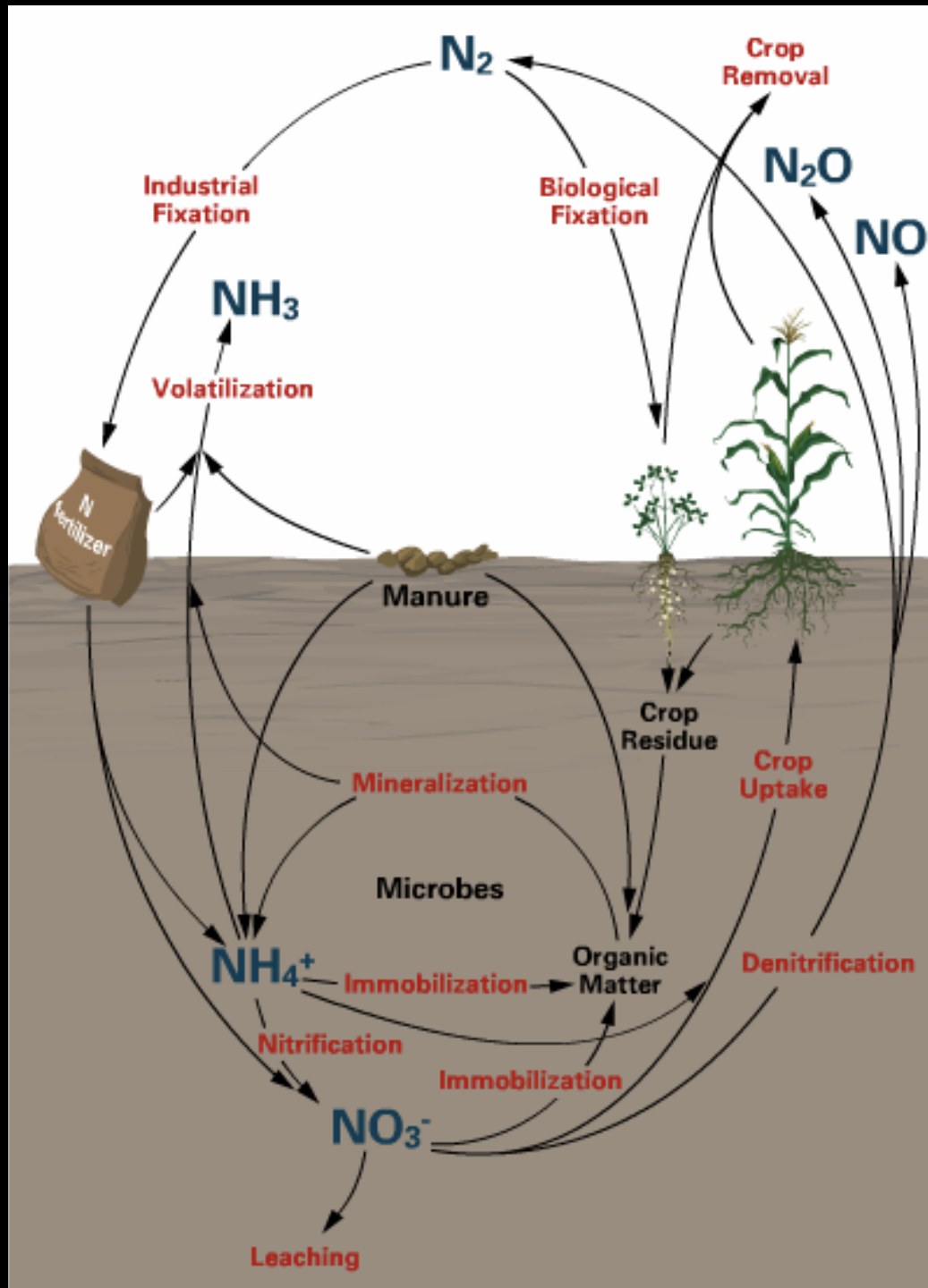
	Nitrate (ppm)	Brix	Nitrate (ppm) standardized to Brix
Avalanche	946	2.39	1718
Boulder	561	2.31	1007
Touchstone	719	3.00	1150
P-value	0.2701	ns	0.1175

Continued Work

- Seeking USDA Organic Research and Extension funding for larger project

Key Take-Aways

- Significant work has been completed since 2015 to better understand the ranges of nitrate we can anticipate from organically-grown celery
- More work needs to be completed to understand the role of G x E x M on nitrate concentrations and related variability



A photograph of three people, two men and one woman, smiling and eating together. The woman in the center is holding a piece of food. The background is slightly blurred, suggesting an indoor setting like a restaurant or cafe.

KERRY

Leading to Better

Growing the Market for Sustainable, Profitable Organic Vegetables

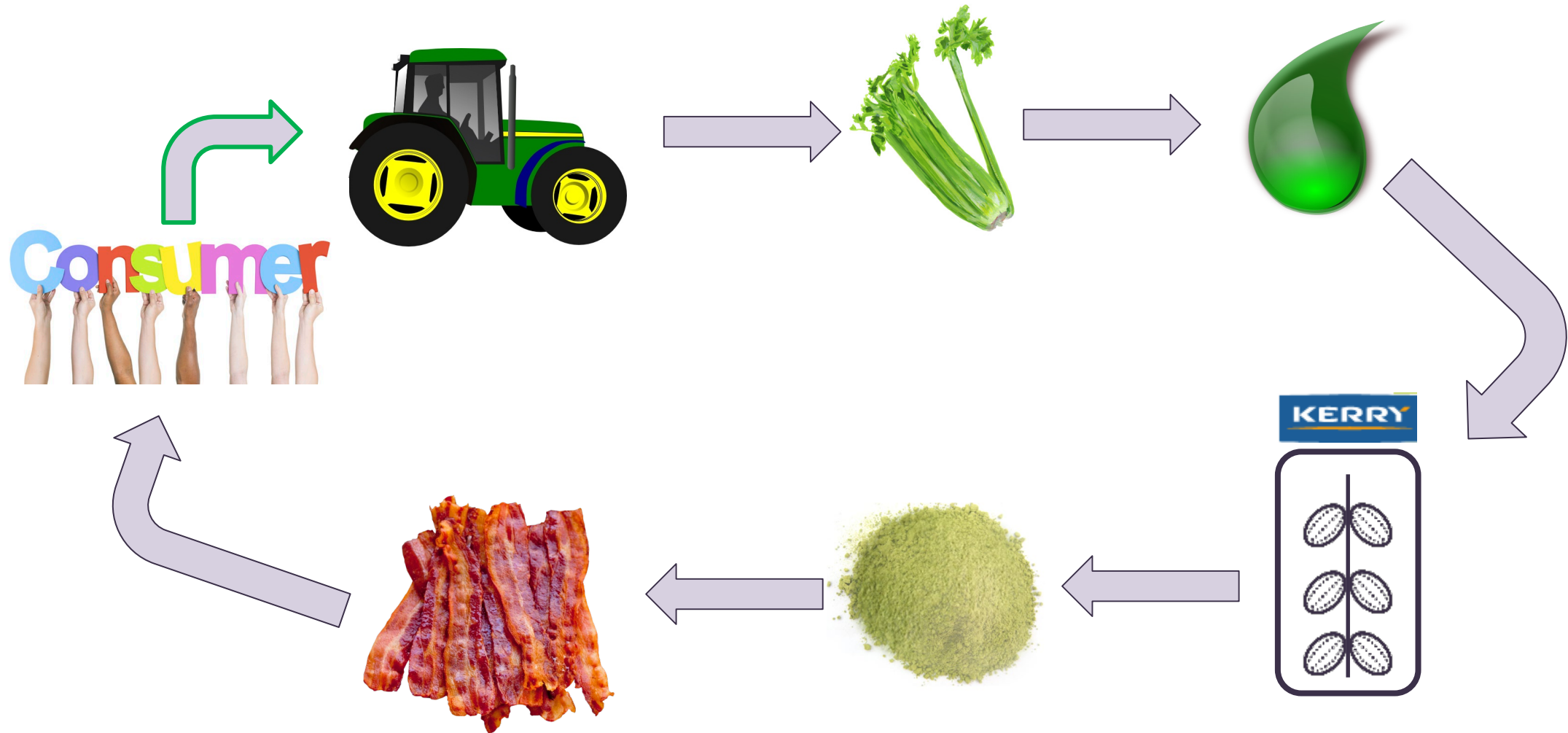
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The Celery Circle

The number of steps within the celery circle add complexity to this initiative.

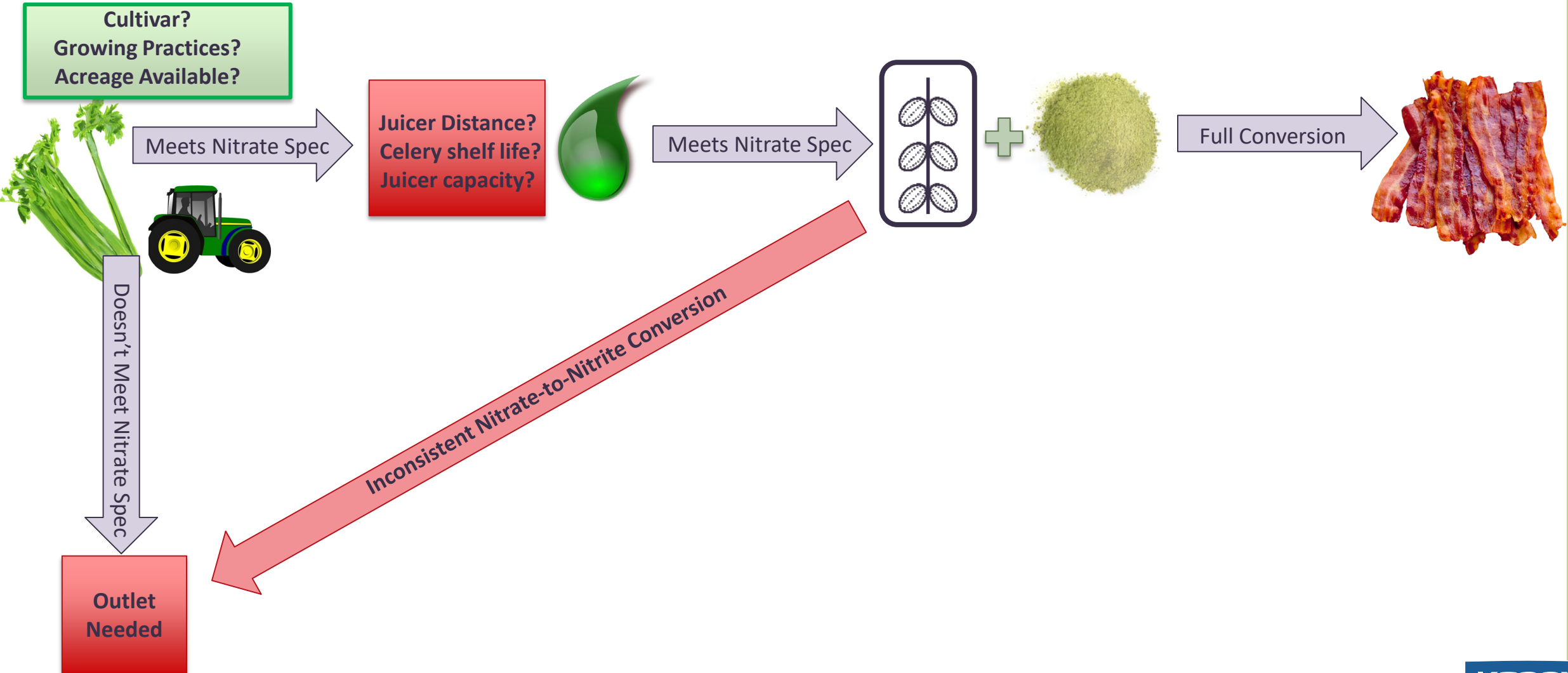




Are there strategies to produce organic celery powder that is standardized to consistently meet the safety and other requirements of the meat processing industry?

Sustainable, Profitable Celery Circle: Opportunities & Challenges

Progress has been made but additional research is needed to develop a robust process to minimize risk for Organic growers.



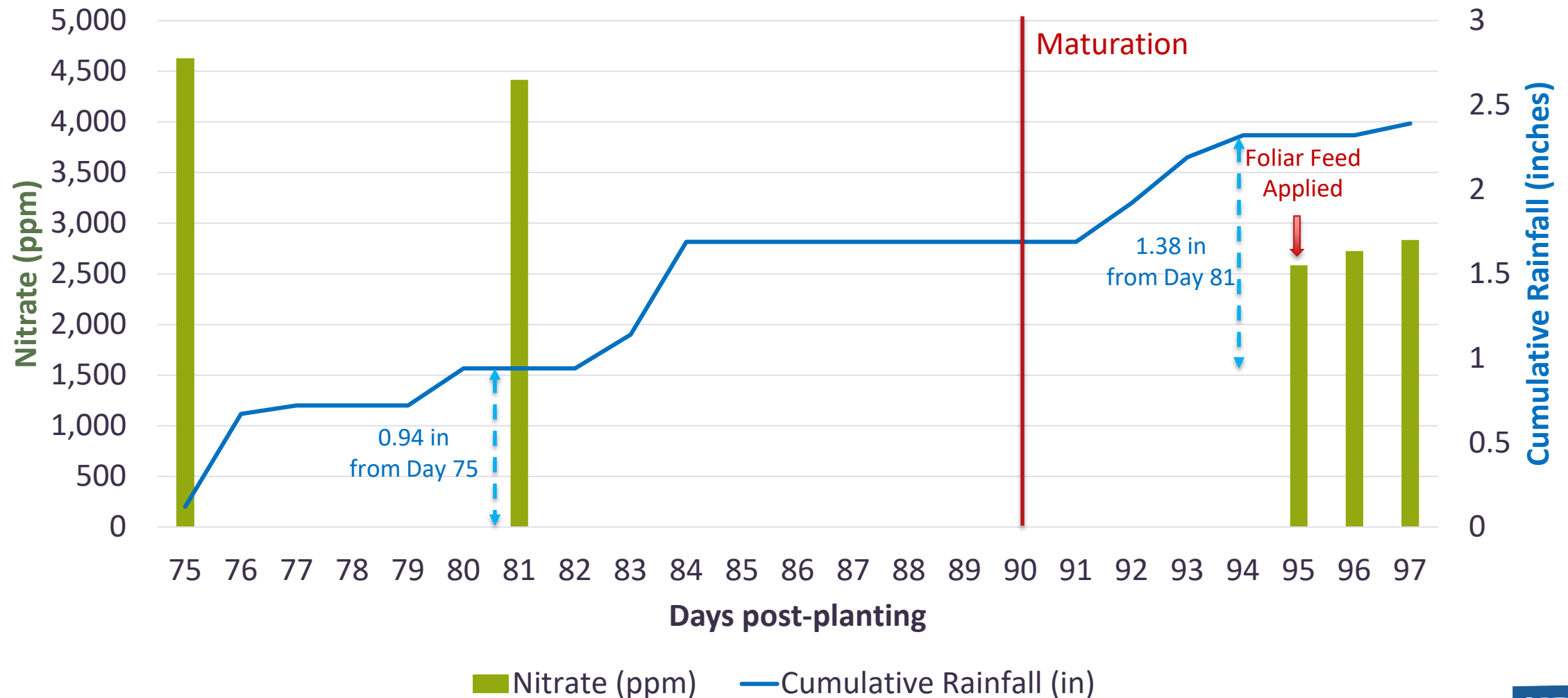


Is an increased amount of synthetic nitrogen fertilizer required to produce plants with high nitrate levels for celery powder production?

Nitrate Levels of Conventional Celery Approaching Maturation

High nitrate levels can be achieved by strategically timing harvest.

Foliar feeding with urea had minimal impact on conventional celery nitrate levels.





Since 2015, what progress has been made on the production of organic celery for powder production?

Nitrate-to-Nitrite Conversion Data

Organic celery has shown inconsistent performance. Future research is needed to address this.

- Four Organic celery varieties were grown at the West Madison Agricultural Research Station in 2016 & 2017.
- Before planting each year, the soil was tested and a nitrogen based fertilizer was applied so that the starting nutrients would have been the same year on year.

Table 1. % Nitrate-to-Nitrite Conversion of Organic celery varieties grown in 2016 & 2017

Organic Celery Variety	% Conversion 2016	% Conversion 2017
Conquistador	100%	47%
Tall Utah	100%	27%
Calypso	100%	55%
Tango	85%	49%



Are there commercially available, agriculturally produced alternatives to celery powder?

Alternate Vegetable Sources Tested

Celery is the ideal vegetable for meat due to its high functional and low organoleptic properties.

	Low Nitrate Levels	Conversion Consistency Issues	Acceptable Nitrate + Conversion
Organic	Celery Spinach	Spinach	
Conventional	Kale Yellow Beet	Swiss Chard* Lettuce	Chinese Cabbage**

*Dark color may have impact in lighter meat applications.

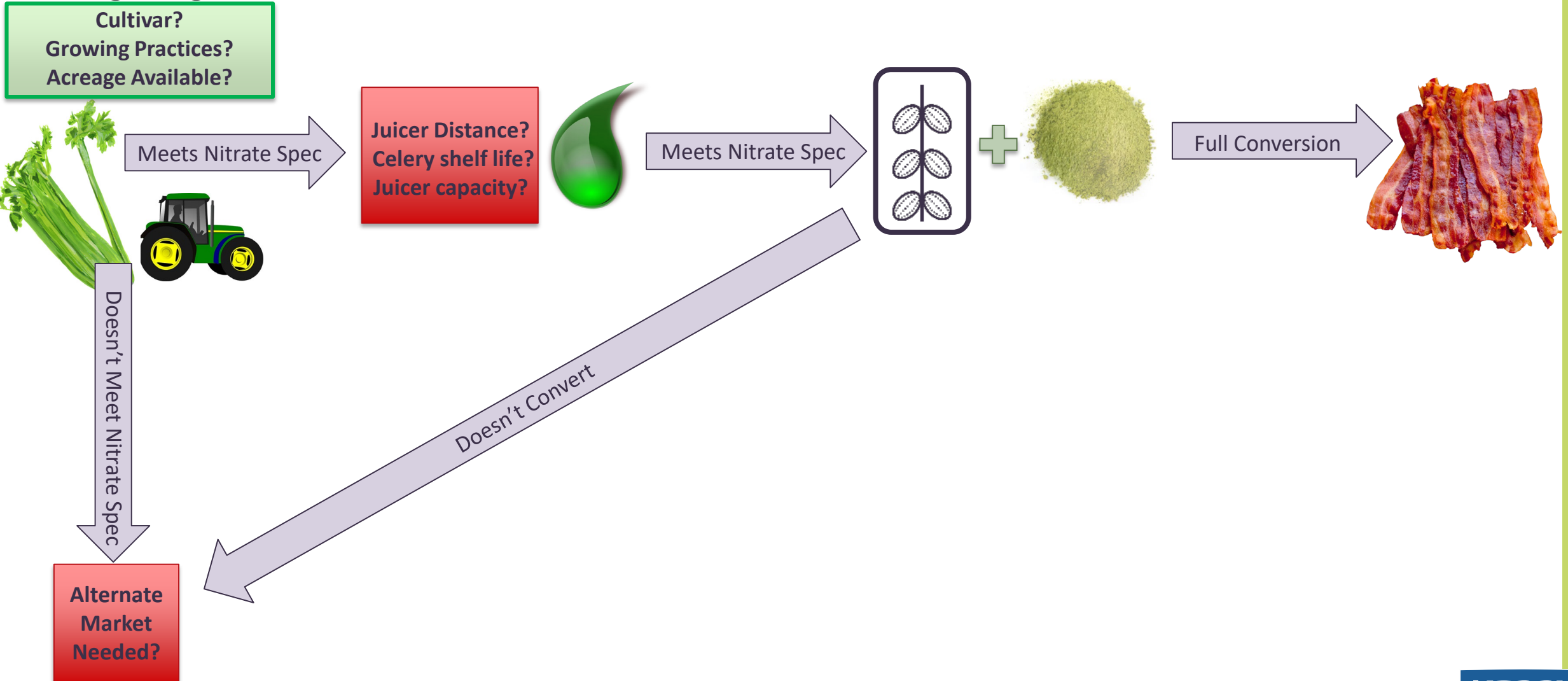
**Strong flavor impact



If not enough organic celery is being produced to support the meat industry, why not?

Sustainable, Profitable Celery Circle: Opportunities & Challenges

Progress has been made but additional research is needed to develop a robust process to minimize risk for Organic growers.



Thank you!!!

