

Small Dosage, Big Potential: Tips for Crop Biostimulants Serving California Central Valley Vegetable Operation

2019 Plant Protection & Nutrition

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In the Next 25-30 Minutes...

You will hear

- 1) a brief introduction of CA Central Valley's vegetable production (10 minutes), and
- 2) a general overview of the opportunities and challenges of using crop biostimulants regarding vegetable production in this area (20 minutes).

California Agriculture

The Golden State has/ranks/produces/supplies...

39.54 million population = 12% U.S. population.

5th largest economy globally if were a country.

Nation's leading agriculture > 50 years.

> 350 ag commodities, generating > \$ 47 billion.

> 1/3 country's vegetables and 2/3 fruit and nuts are grown in CA.

Ultra-Productive Central Valley



- 22,500 square miles: 50 miles wide x 450 miles length (Redding to Bakersfield)
- > 230 crops are grown, annual value = \$17 billion.
- < 1% of total farmland in U.S. produces 8% of nation's agricultural output.
- Total ag value: \$43.5 billion (data for 2013)
- Heavily relies on irrigation: 75% and 17% of irrigated land in California and U.S.

Source: USGS

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Ultra-Productive Central Valley



- Nation's largest patch of Class 1 soil
- 25-degree swing day to night temperature
- 300 days sunshine per year
- Cool-season to warm-season vegetables: broccoli, pepper, watermelon, melon, processing tomato, onion, carrot, etc.
- Processing tomato: 95% are produced from California compared to 5% from all other states.

Source: USGS

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**The other side of the “prosperity”
coin is “challenges”.**

**Water availability and quality are the
biggest challenges.**

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They Grow the Nation's Food, but They Can't Drink the Water



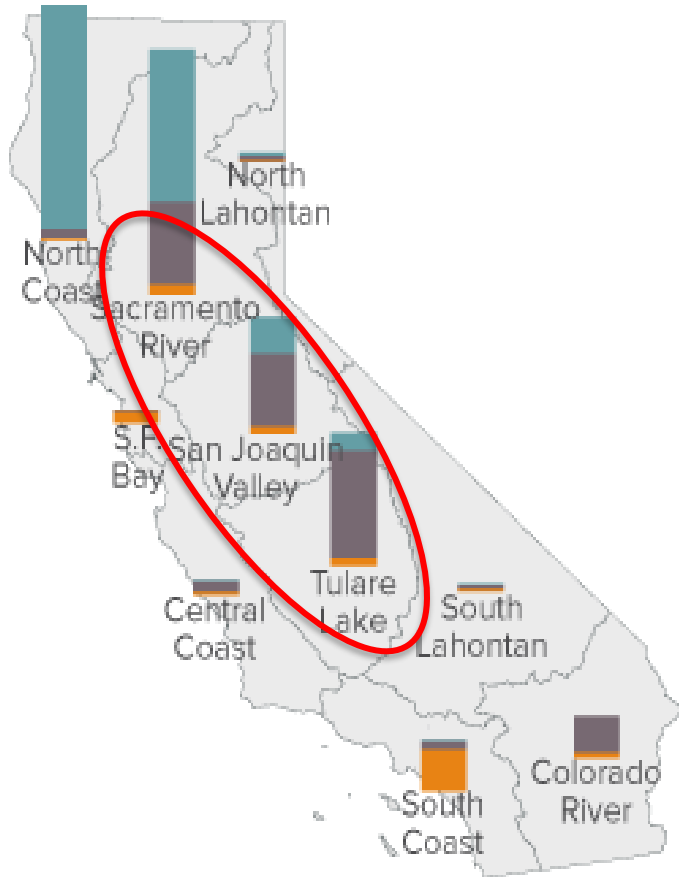
300 public water systems with unsafe drinking water

>1 million suffered each year

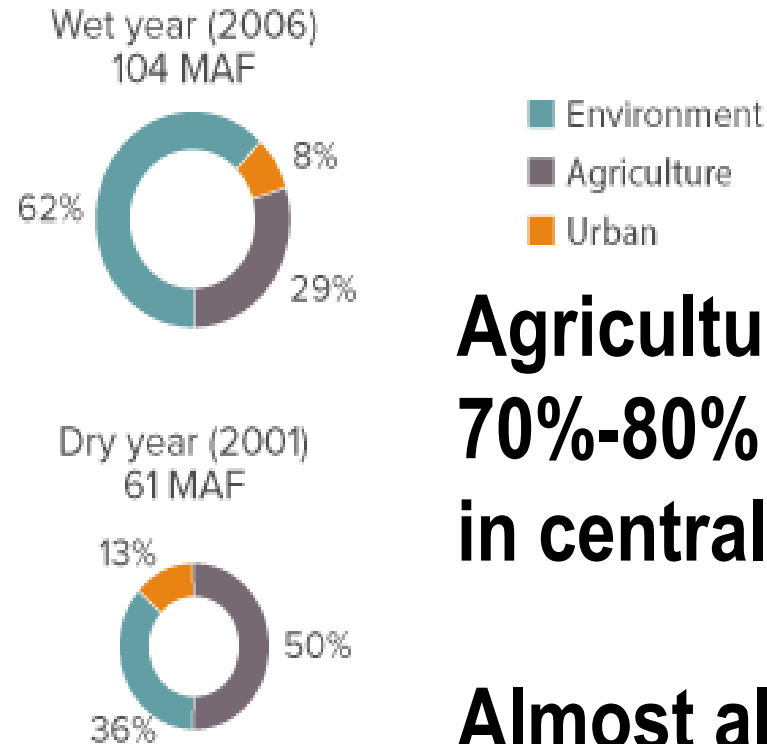
Small towns and unincorporated communities in Central and Salinas valley

Arsenic and fertilizer residues

Average annual applied water use (1998–2010)



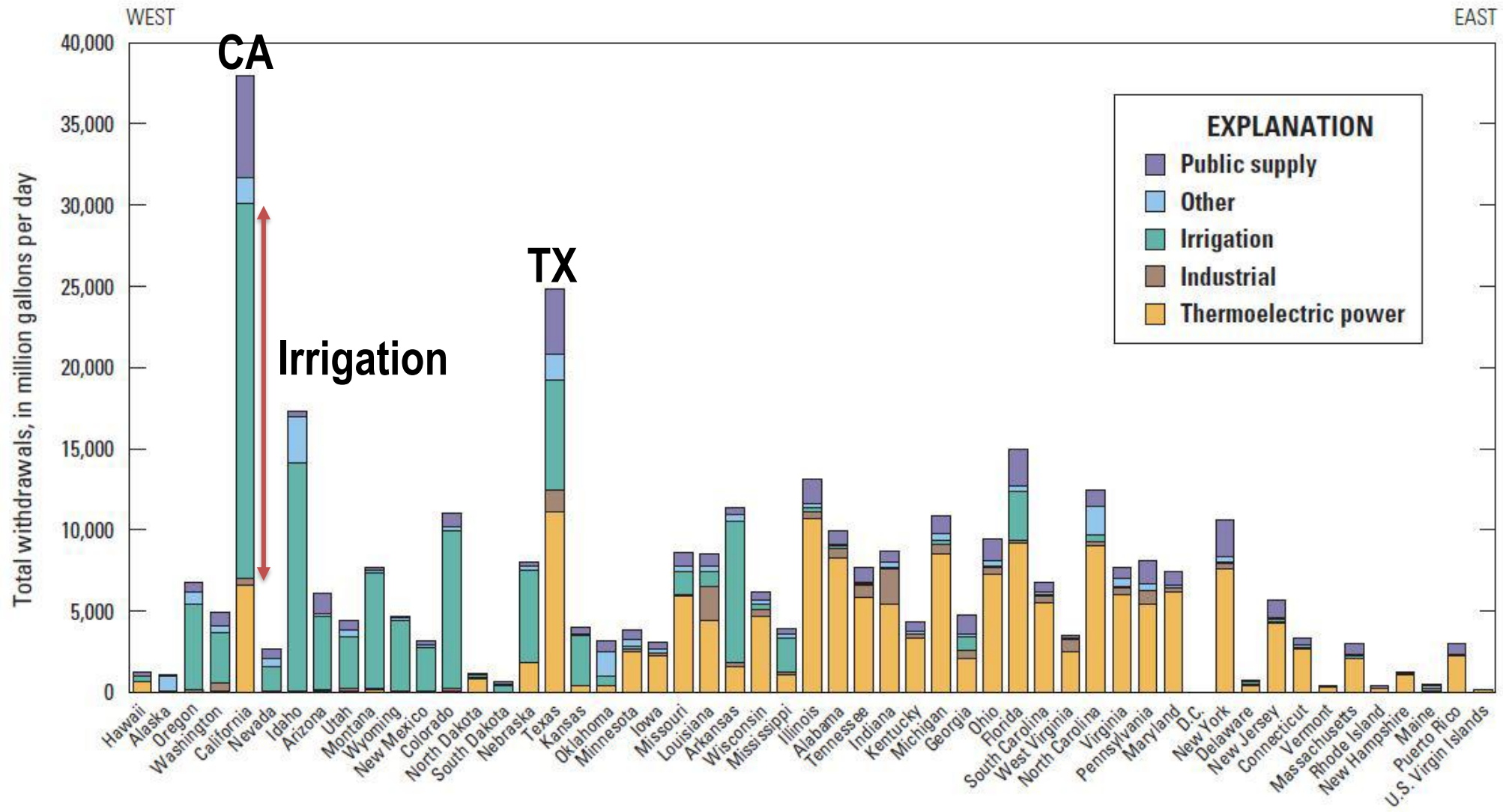
Statewide applied water use, millions of acre-feet (MAF)



Agriculture accounts for about 70%-80% of total water applied in central valley.

Almost all crops in central valley need to be irrigated.

Source: California Department of Water Resources (2013)



Total Daily Water Use by State in 2010 (Source: USGS)



**Rain-fed crops in other states need irrigation in California.
Where is rainfall?**

Average Rainfall by Month: Modesto, CA (1888-2017, source: MID)

January	2.38"
February	2.05"
March	1.91"
April	0.97"
May	0.48"
June	0.10"
July	0.02"
August	0.03"
September	0.20"
October	0.63"
November	1.33"
December	2.10"

Typical Mediterranean climate lies most of rainfall during winter. Summer months are hot and dry.

Monthly Average Reference Evapotranspiration by ETo Zone (inches/month)



Zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	0.93	1.40	2.48	3.30	4.03	4.50	4.65	4.03	3.30	2.48	1.20	0.62	32.9
2	1.24	1.68	3.10	3.90	4.65	5.10	4.96	4.65	3.90	2.79	1.80	1.24	39.0
3	1.86	2.24	3.72	4.80	5.27	5.70	5.58	5.27	4.20	3.41	2.40	1.86	46.3
4	1.86	2.24	3.41	4.50	5.27	5.70	5.89	5.58	4.50	3.41	2.40	1.86	46.6
5	0.93	1.68	2.79	4.20	5.58	6.30	6.51	5.89	4.50	3.10	1.50	0.93	43.9
6	1.86	2.24	3.41	4.80	5.58	6.30	6.51	6.20	4.80	3.72	2.40	1.86	49.7
7	0.62	1.40	2.48	3.90	5.27	6.30	7.44	6.51	4.80	2.79	1.20	0.62	43.3
8	1.24	1.68	3.41	4.80	6.20	6.90	7.44	6.51	5.10	3.41	1.80	0.93	49.4
9	2.17	2.80	4.03	5.10	5.89	6.60	7.44	6.82	5.70	4.03	2.70	1.86	55.1
10	0.93	1.68	3.10	4.50	5.89	7.20	8.06	7.13	5.10	3.10	1.50	0.93	49.1
11	1.55	2.24	3.10	4.50	5.89	7.20	8.06	7.44	5.70	3.72	2.10	1.55	53.1
12	1.24	1.96	3.41	5.10	6.82	7.80	8.06	7.13	5.40	3.72	1.80	0.93	53.4
13	1.24	1.96	3.10	4.80	6.51	7.80	8.99	7.75	5.70	3.72	1.80	0.93	54.3
14	1.55	2.24	3.72	5.10	6.82	7.80	8.68	7.75	5.70	4.03	2.10	1.55	57.0
15	1.24	2.24	3.72	5.70	7.44	8.10	8.68	7.75	5.70	4.03	2.10	1.24	57.9
16	1.55	2.52	4.03	5.70	7.75	8.70	9.30	8.37	6.30	4.34	2.40	1.55	62.5
17	1.86	2.80	4.65	6.00	8.06	9.00	9.92	8.68	6.60	4.34	2.70	1.86	66.5
18	2.48	3.36	5.27	6.90	8.68	9.60	9.61	8.68	6.90	4.96	3.00	2.17	71.6

Source: State of California Department of Water Resources

Major growing seasons with no or very little rainfall plus the high monthly ET in summer limit the reliance of central valley agricultural production on precipitation.

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**Biostimulant is different from
biopesticide or other biocontrol agents.**

**Biostimulant has its own recipe in
terms of abbreviations, acronyms,
definition, etc.**

Input composition

		living			other substances		
		plants	animals	microbes	bio-based	mined	
Input function	control	weed	Cover Crops Vetch	Insects <i>Chrysolina quadrigemina</i>	Bioherbicides <i>Colletotrichum gloeosporioides</i>	Heat kill Propane gas for flame weeding	
		Insect	Alfalfa	Ladybugs	<i>Bacillus thuringiensis</i>	Biopesticides Pyrethrin	Kaolin clay
		disease	Brassicas	Psyllid parasitoids (<i>Tamarixia radiata</i>)	<i>Apleomyces quisqualis</i>	Neem oil	Potassium bicarbonate
	stimulate plant growth		Buckwheat (pollinator habitat)	Pollinators	<i>Pseudomonas putida</i>	Biostimulants Seaweed extract	Humic substances
	improve/maintain	access to nutrients	Legumes	Livestock Pastured poultry	Biofertilizers Rhizobia	Fertilizers Manure Rock phosphate	
soil health		Rye	Soil Fauna Earthworms	Actinomycetes	Soil Conditioners Molasses	Vermiculite	

Chart of major input categories (dashed boxes) organized by function and composition. Examples of specific inputs are in gray, and inputs may fall into more than one category.

Biostimulants

**Microbial
Biostimulants**

Bacteria

Fungi

**Bacteria
and Fungi**

**Other
Biostimulants**

How Biostimulants Work

- regulate plant growth
- enhance tolerance to abiotic stress (e.g., drought)
- improve nutrient acquisition (N, P, Fe; biofertilizers)

Other
biostimulants are
broad in types
and numbers.

First Statutory Language Regarding Plant Biostimulant in the U.S. (2018 Farm Bill)

“a substance or micro-organism that, when applied to seeds, plants, or the rhizosphere, stimulates natural processes to enhance or benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, or crop quality and yield”.

Source: Biological Products Industry Alliance

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Biostimulants for this big Ag region: products have to match growers' needs and production practices.

Work in Five Main Ways:

- 1. Increase nutrient availability**
- 2. Plant hormones (produce, trigger)**
- 3. Limit plant stress**
- 4. Extend root systems**
- 5. Suppress pathogens, induce resistance (indirect)**

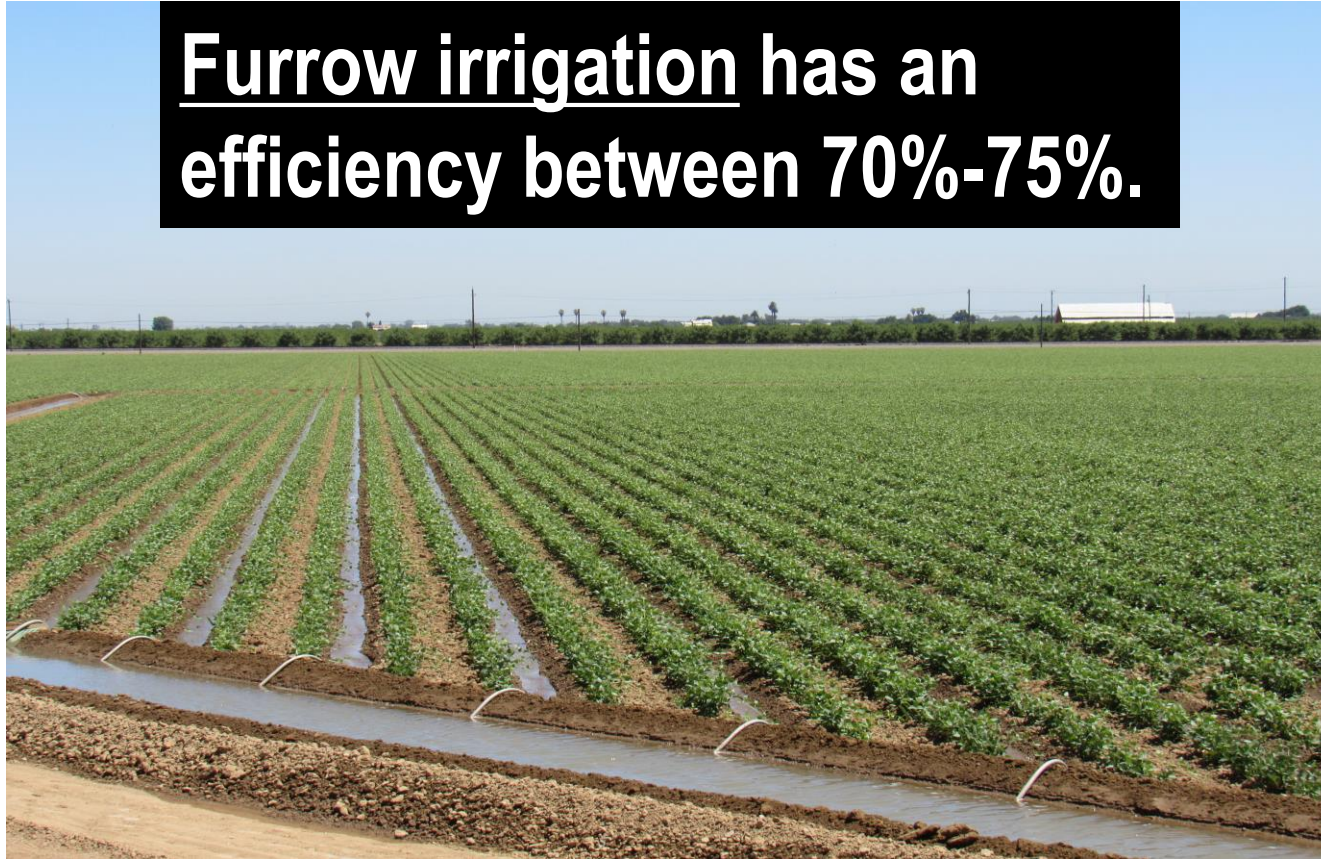
Example: small grower vs. big grower



Root dipping/tray soaking is hard for big growers. Large-scale growers in central valley contract with nurseries to produce transplants.

Example: Application through irrigation

Furrow irrigation has an efficiency between 70%-75%.



Despite of low irrigation efficiency, furrow and flood irrigation still account for about 45% of all irrigated lands.

Irrigation efficiency: ratio of volume of water used to produce a crop to volume of water taken from a water source.

Example: Application through irrigation

Drip irrigation has an efficiency as high as 90%.



Adoption of drip irrigation doubled in the past 25 years, now accounting for about 40% of all irrigated lands. It includes surface and sub-surface drip, and micro-sprinkler irrigations.

Trends in Irrigation Method in Central Valley, by Hydrological Region (2001 and 2010).

Hydrological Region	Furrow and Flood		Drip Irrigation		Sprinkler/Foliar		Other	
	2001	2010	2001	2010	2001	2010	2001	2010
Sacramento River	56%	52%	20%	30%	21%	16%	3%	2%
San Joaquin River	54%	45%	35%	43%	8%	7%	3%	5%
Tulare Lake	57%	47%	36%	42%	6%	8%	1%	3%

Source: California Water Plan Update 2013, California Department of Water Resources.

Biostimulants for this big Ag region: collaboration is needed for more convincing data.

Who will be involved when a product is used?

- 1. Growers**
- 2. Grower advisors (extension, research)**
- 3. Products manufacturers and distributors**

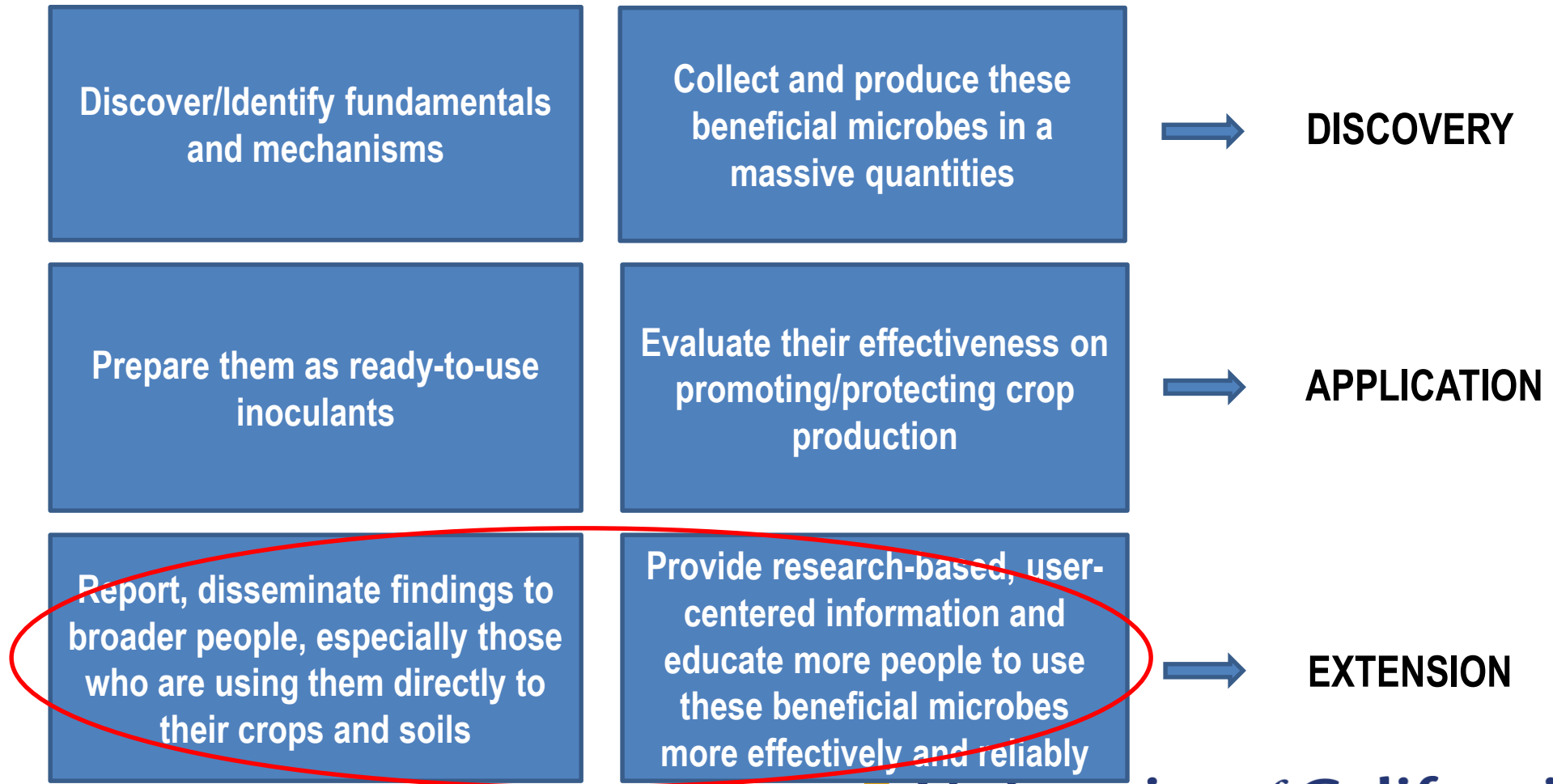


**Growers
expecting
reliable
ROI**

**Scientific
data**

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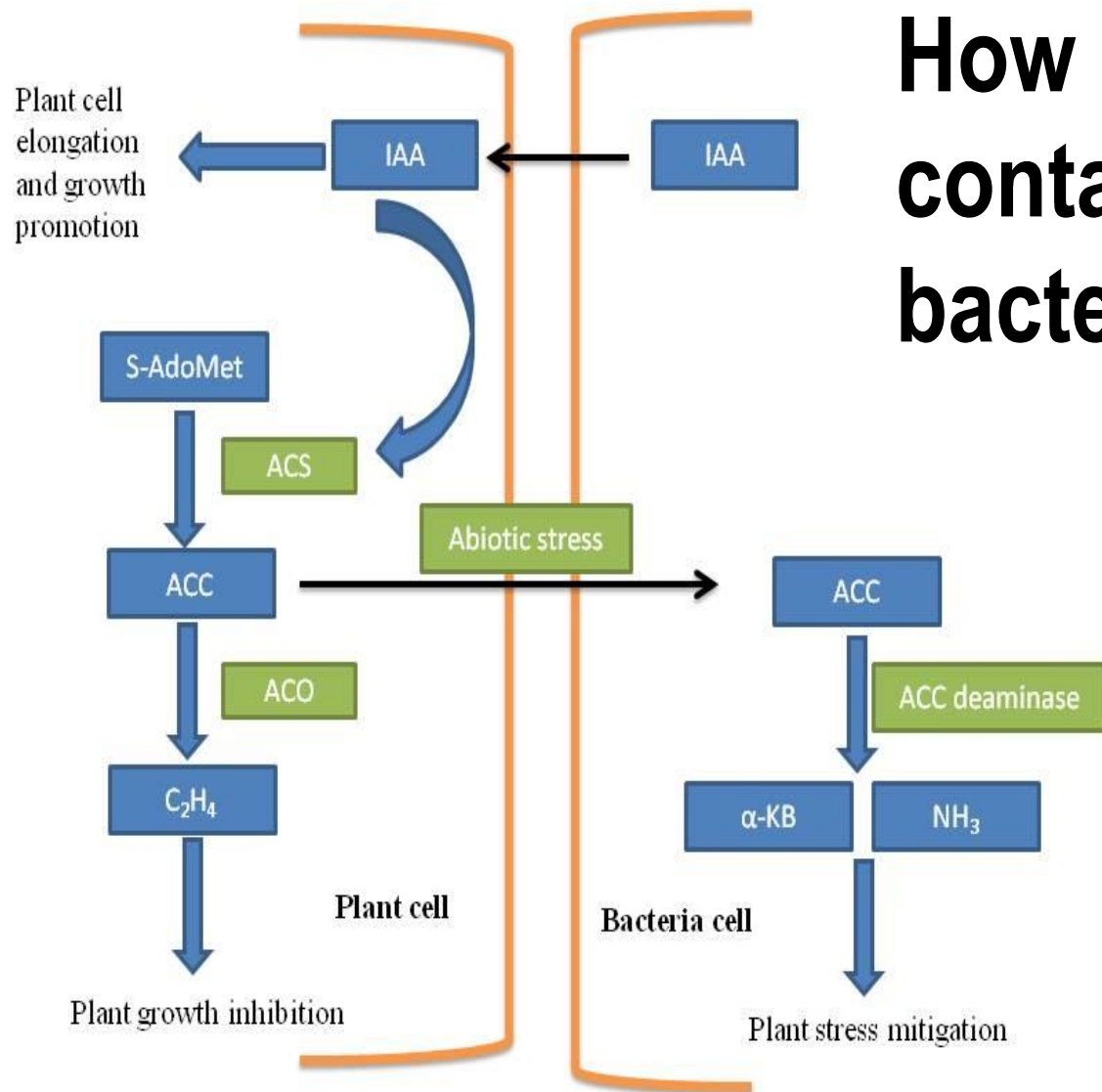
Example: A microbial biostimulant



**Reliance and trust are built upon promising data,
firsthand education, and patience.**

**EXPLAIN IN A GROWER-
FRIENDLY WAY!**

How do we tell growers products containing ethylene-inhibiting bacteria can mitigate plant stress?



ACC = 1-Aminocyclopropane-1-carboxylic acid

ACS = ACC synthase

ACO = ACC oxidase

S-AdoMet = S-Adenosyl Methionine

α-KB = α-ketobutyrate



Conducting on-farm research can promote the adoption of crop biostimulants and generate statistically viable data.



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More user-friendly resources are key to promote the use of biostimulants.

Three things to look for in a biofertilizer and biostimulant. From Julie Laudick, Zheng Wang, and Matt Kleinhenz, Graduate Program and Department of Horticulture and Crop Science, The Ohio State University. Find out more about the Ohio vegetable growers who were the first to use biofertilizers in July 2018. Find out more about the biostimulants used on tomatoes. Find out more about the biostimulants used on tomatoes.

Getting the Most from Crop Biostimulants and Microbial Fertilizers. Zheng Wang, Julie Laudick, and Matthew Kleinhenz, Department of Horticulture and Crop Science, The Ohio State University. Microbial biostimulants are dwelling in the root zone are invisible to the naked eye. They can have identified microbes that can help plants grow better (e.g., moisture, fertility) more effectively. Evidence indicates that biostimulants can enhance plant growth and yield in a greenhouse setting.

Introduction. Most of the life in the soil is beyond our sight, too small to see without powerful magnification. Still, these microbes affect soils and crops significantly – pro or con in the eyes of growers. Identifying which naturally-occurring microbes can benefit crops is the first step in using them to enhance production. The idea has been to identify beneficial microbes, produce them in massive quantities, prepare them as inoculants, and apply them to crops and soils with the hope that they will stimulate or protect crops in some way. Microbe-containing bioproducts (MCBPs) that limit damage due to pests and diseases are known as biopesticides. MCBPs that can improve plant growth and health by other means are known as biofertilizers. Some biofertilizers work by extending the reach of the root system, giving crops access to more nutrients or water. Others convert nutrients in the soil to forms that crops can use while others encourage the plant to make hormones that speed growth. This presentation will focus on biofertilizers.

Microbial Biostimulants in Vegetable Crop Production: Facts, Experiences, and Hopes. Zheng Wang, Julie Laudick, and Matt Kleinhenz, Department of Horticulture and Crop Science, The Ohio State University, Ohio Agricultural Research and Development Center, Wooster, Ohio. We also recently...

CROP BIOSTIMULANTS

The blog offers various resources to help with better understanding the crop biostimulants.

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First Statutory Language Regarding Plant Biostimulants

Author: Zheng Wang

Published on: February 8, 2019

According to the report from Biological Products Industry Alliance (BPIA), the Agriculture Improvement Act of 2018, also known as the 2018 Farm Bill, was signed into law on December 20, 2018, and provides the first statutory language regarding plant biostimulants in any law in the United States.

The Farm Bill describes a plant biostimulant as “a substance or micro-organism that, when applied to seeds, plants, or the rhizosphere, stimulates natural processes to enhance or benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, or crop quality and yield.”

This first official language is a major step moving forward for a better understanding of biostimulants, a more regulated biostimulant market, and a wider adoption of using these biologics.

The original news from BPIA is here <https://www.bpia.org/2018/12/biostimulants-in-farm-bill/>.

Tags: [biostimulant](#) (0), [farm bill](#) (0), [first definition](#) (0)

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Biostimulant World Congress Digital Week Registration Opens

Author: Zheng Wang

Published on: September 4, 2018

The 2018 Biostimulant Digital Week (4-Day Webcast Series) registration now opens. Use the link to

Biostimulants for this big Ag region: product quality assurance is critical.

**CHOOSING WRONG
PRODUCTS IS COSTLY.**

- *Rhizobia*
legumes ... yes
- Mycorrhizal Fungi
Brassica ... no

Where to find the information?

LABEL: Be as specific as possible

Store, handle, and prepare properly

- **expiration/best by date?**
- **dark, dry, with consistent and moderate temp. often best**
- **follow label to prepare**

Application factors

- **timing**
- **soil condition**
- **placement**
- **rate**

Example: application timing for fresh market tomato



Fresh market tomato in central valley are harvested at green for large scale production.

- 1. Know the production and people**
- 2. Educate and be educated**
- 3. Adjustment**

GOOD LUCK!

THANK YOU

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