NONFUMIGANT EVALUATIONS IN CALIFORNIA STRAWBERRY NURSERIES

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LIMITS OF FUMIGANTS

- **The capacities and the capabilities of the Agricultural chemical industry to solve the fumigant needs of the strawberry industry are limited by:**
  - Small market size
  - High cost/risk of development (reminder Methyl iodide)
  - Strict fumigant use regulations
  - Unpopularity of fumigants vs. popularity of organic
- **Fumigants are not organic-compliant**

FIELD STEAMING

- **The oldest method of soil disinfestation**
  - Mostly used in greenhouses
  - There are several field steam machines in Europe and Asia
- **There has been limited interest in field steam in the USA. Why?**
  - Fumigants are still available and cost-effective
  - Commercial steam applicators are not available
  - Scale of operations is large in USA vs. Europe

ASSA Mission Statement

Agricultural Soil Steaming Association

The purpose of ASSA is to provide for development and promotion of large-scale soil steaming systems as a viable alternative to chemical fumigation to remove pathogens from soil and to mobilize academic researchers, technical experts, technology suppliers and growers to promote large-scale soil steaming systems to benefit crop growers across North America and subsequently to the general public.

The corporation will also provide a forum for academic researchers, technical experts, technology suppliers and growers to discuss methods, share ideas and ultimately lead adoption of large-scale soil steaming systems across the globe.

Why is ASSA needed?

COLLECTIVE ACTION

Need a commodity board to support collective action on steam

FUNDING CATALYST

ASSA helps access funding that would not otherwise be available

REAL WORLD

Keeps focus on realistic solutions – per acre costs, labor needs, fuel needs, machine performance & maintenance

SHARED RESOURCES

Shared resources – expertise, land, labor, shop work, equipment transport

ASSA

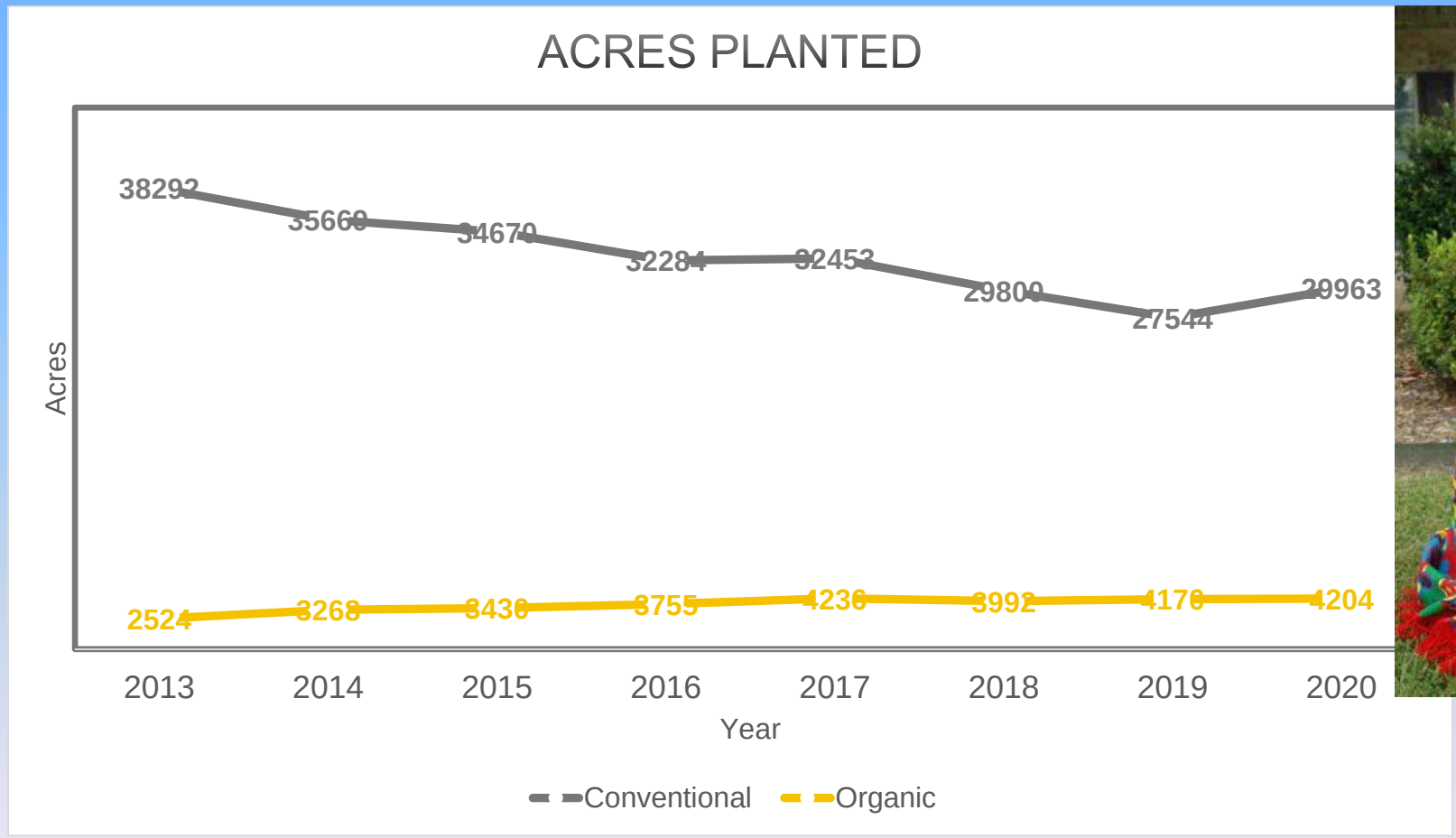
FUMIGANTS CURRENTLY USED IN CALIFORNIA 2017

- **Chloropicrin 86% strawberry plantings**
- **1,3-dichloropropene 47% plantings**
- **Metam sodium 3% plantings**
- **Methyl Bromide 816,000 lbs. used on 3,569 acres nursery (QPS)**

CA Dept. of Pesticide Regulation

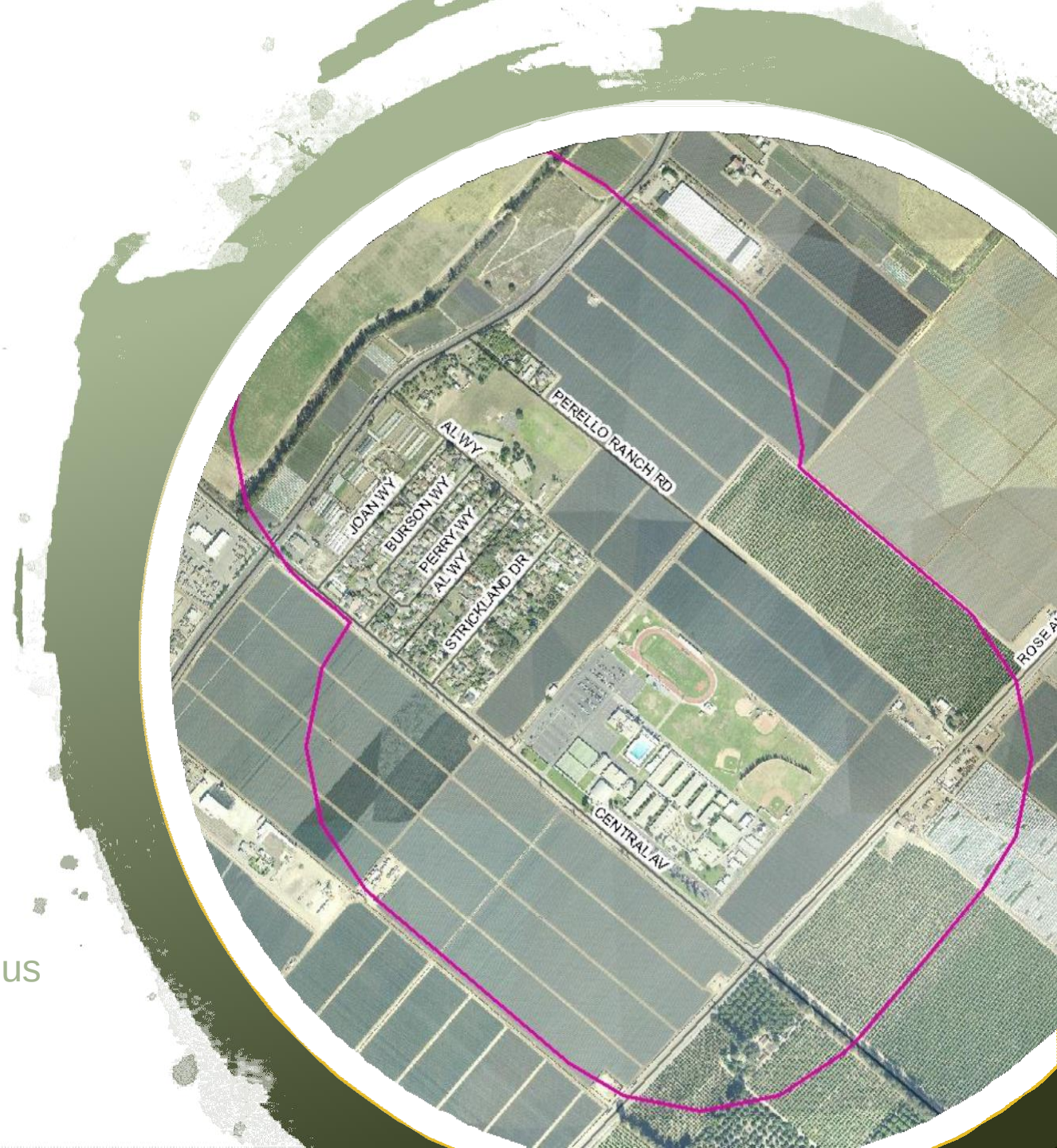
MacDoel, CA

TRENDS IN CONVENTIONAL VS. ORGANIC PLANTINGS - FRUIT



Why We Need Steam in California

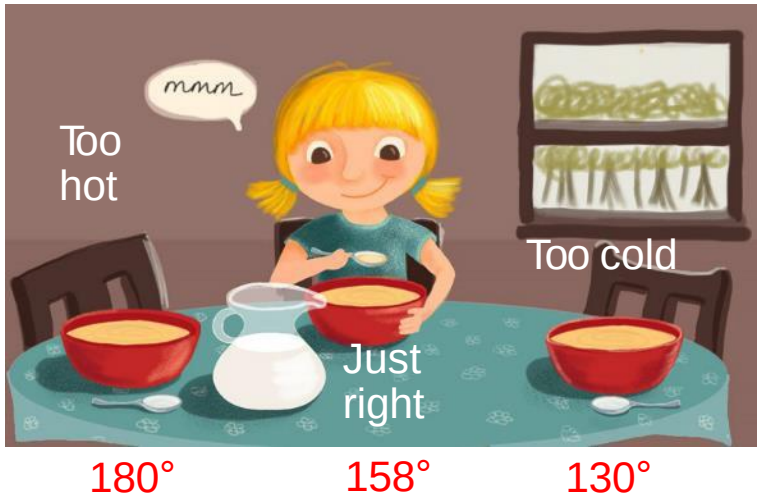
- For soil disinfestation in:
  - Buffer-zones
  - Organic fields
  - Fumigant regulations



Note: 0.25 mile radius

The Objective of Soil Treatment with Steam

- Raise the soil temperature to 150-158° F for 20 minutes – DWELL TIME
- Soil pathogens like Pythium and Verticillium are more easily killed than beneficial soil microorganisms
- The objective is not to sterilize soil but to selectively pasteurize it
- Not too hot, not too cold



STEAM TERMS

- Steam is a method of soil disinfestation – a process that kills soil pests by cooking them
- Dwell time is the necessary time above the target temperatures – 20 minutes at 158°F
- Too hot and the beneficial nitrifying bacteria can be killed
  - Nitrifying bacteria convert ammonium to nitrate
  - If they are killed then ammonium toxicity can result
  - Easy to avoid this overheating problem with the moving applicators we are working with
- Too cold and Verticillium and Macrophomina are not killed

STEAM WORK 2018-2020

- **Three trials in nurseries at MacDoel, CA**
  - Two conventional trials Steam vs. MB
- **Three trials in fruiting fields at Salinas & Watsonville**
  - Steam vs. chloropicrin

PROTOTYPE OPERATING COSTS

- In field costs $4,050/A (fuel, labor, machine)
- Transportation costs not included
- 10 ft treated by 10-12 inches deep 13.7 hr/A
- Target temperature 158°F for 20 min
- Southern Turf Nurseries

STEAM EFFECT – TCR 2012-13

OUTLINE

- **Need for steam**
- **Strawberry nurseries**
  - Lassen Canyon Nurseries
  - Sierra Cascade Nurseries
- **Nursery results**
- **Fruit field results**
- **Soil Steam International**
- **JSE South Korea**

LASSEN CANYON NURSERIES

Treatment	Weed densities	Pythium	Daughter plants
	Number/A	#/g	Number/A
MBPic 57:43	769 a	0	922,673
Steam	1416 a	0	857,923

SIERRA CASCADE NURSERIES

Treatment	Weed densities	Verticillium	Nematodes	Daughter plants
	Number/A	% viable	#/50 g	Number/A
MBPic 45:55	9308 a	0	10.8	348,026
MBPic 57:43	27518 a	2.5	2.0	267,089
Steam	16997 a	0	17.0	323,745

WEED CONTROL 2018-19 STEAM TRIAL AT SALINAS, CA

Treatment	Purslane	Nutsedge	Verticillium
	---------- viable % ----------		Ms/g
Control	78 b	84 b	220 b
Steam	3 a	7 a	0 a
Chloropicrin	2 a	2 a	3 a

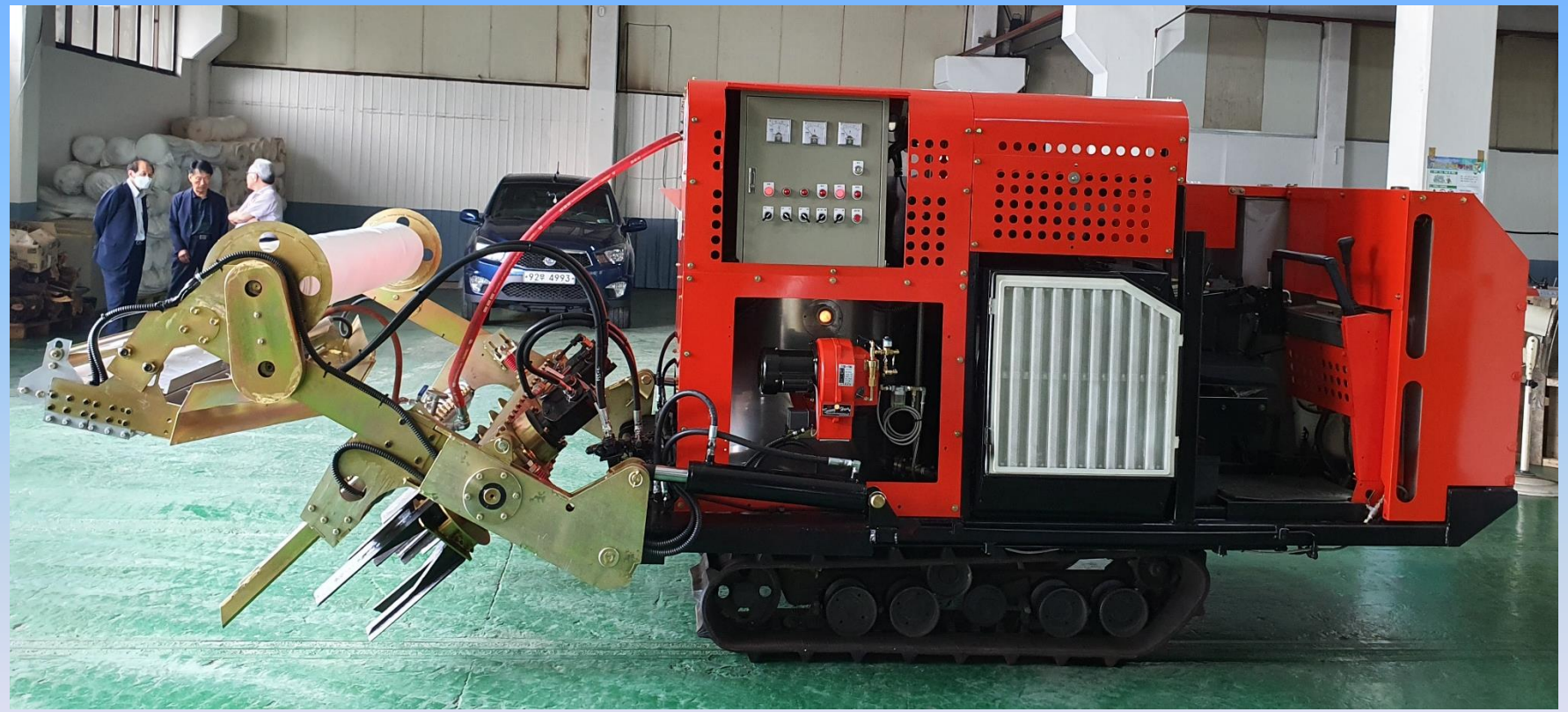
FRUIT YIELDS 2018-19 STEAM TRIAL AT SALINAS, CA

Treatment	Yield
	Lbs./A
Control	20,512 a
Steam	25,468 b
Chloropicrin	28,080 b

CONCLUSIONS

- In nurseries and fruit fields the Southern Turf Nursery steam applicator worked
- Steam efficacy is about the same as fumigants even in strawberry nurseries where MB is used

STEAMY FROM JSE – SOUTH KOREA

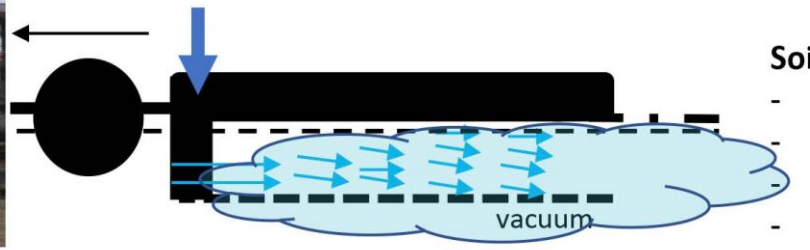


Steams approximately 0.4 acres in 10 hours
Will be delivered to California August 8, 2020

SoilPrep2020™- Norway

Steams approximately 1 acre in 6.7 hours

VACUUM STEAMING IN THE FIELD



Soil preparation system

- Continuous – Tractor Drawn
- Up to 14 in”
- Low pressure boiler
- Under vacuum system
- Most efficient – 400 gal propane /acre
- Soil Steam International (NV)

Soil Prep 400 burns 534 gallons diesel per acre

SOILPREP 400

- Results from Lanförden, Germany found that the SoilPrep 400 provided 98% weed control.
- SoilPrep 400 reduced nematode populations by 95%

Dr. Felix Koschnick,
unpublished 2017

ESTIMATED COSTS FOR SOILPREP 2020

- **Soil Steam International 455 GPA propane**
- **Time per acre estimates 3.4 to 6.7 hours**
- **2.7 acres per 18 h day per applicator**
- **Estimated cost $1,416 per acre (machine, fuel, labor)**

2020 PLANS

- ❖SoilSteam 2020 will be delivered to CA late 2020
- ❖Note Soil Steam International now has a US subsidiary
- ❖JSE Steamy applicator will be delivered to CA in August
- ❖Other potential crops: flowers, golf course renovation, vegetable crops

SUMMARY

- Steam controls soil pathogens and weeds.
- Strawberry plant & fruit yields with steam are equivalent to fumigants
- Strong interest in plant industry to produce strawberry plants for the organic market without using fumigants

ACKNOWLEDGEMENTS

- Propane Education and Research Council
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- Nathan Dorn, Jenny Broome, Melody Meyer-Jertberg
- EB Woerner Enterprises, Elberta, AL
- Soil Steam International, Sandefjord, Norway
- JSE Seoul, South Korea