Soil Disinfestation with steam

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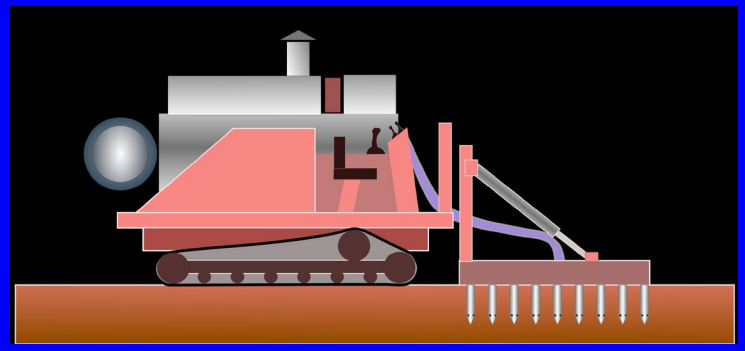


Financial support

- USDA ARS PAW Alternatives to Methyl Bromide.
- USDA CSREES Methyl Bromide Transitions
- Western SARE
- Propane Education and Research Council
- California Strawberry Commission

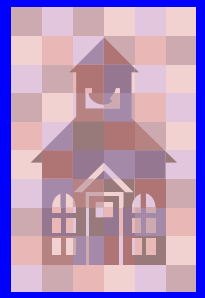
Assumptions

- Fumigants will remain the most cost-effective means for soil disinfestion where they can be used in strawberry fields.
- The percentage of acres that can be fumigated will decline due to regulatory restrictions.
- The need to produce strawberry without fumigants will increase.
- Many different tools are needed to produce strawberry without fumigants.

Areas that can not be fumigated

1. Organic-compliant production fields
2. Areas in fumigant buffer zones
3. Areas where the fumigant needs exceed the township cap limits

A field impacted by sensitive sites



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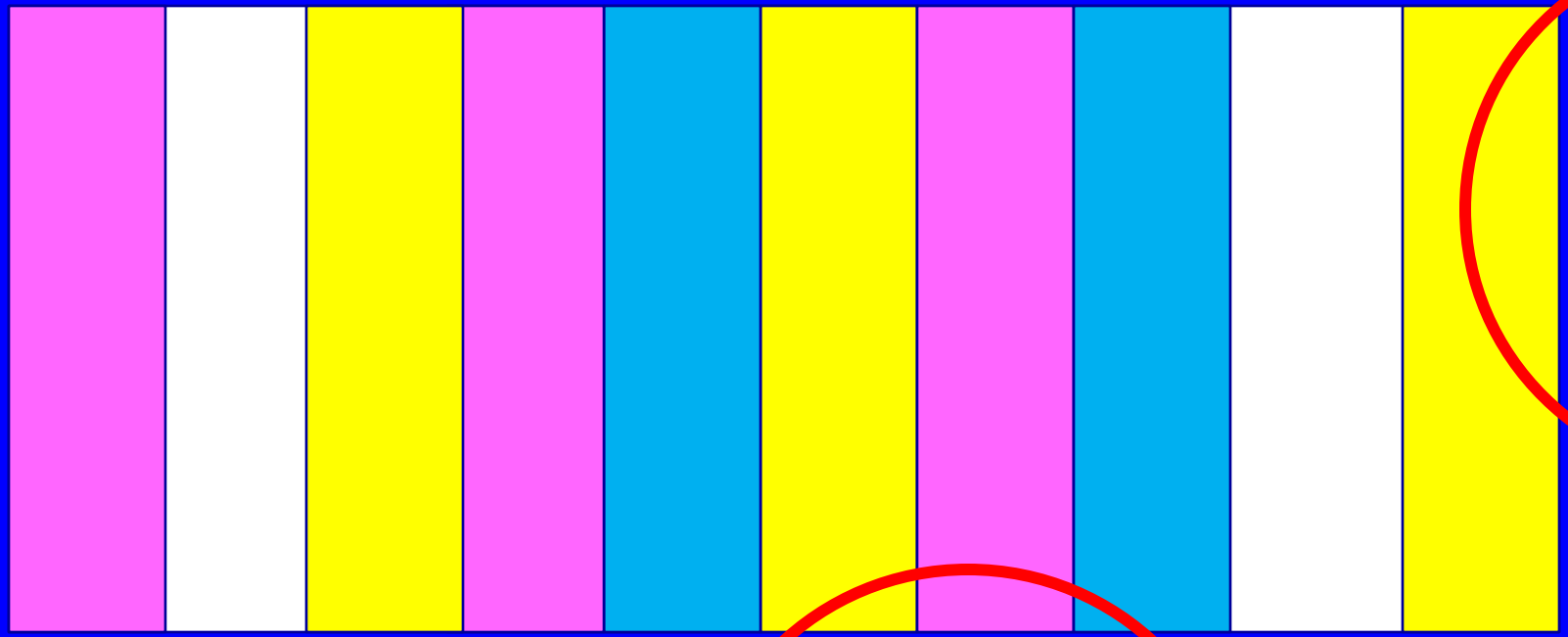

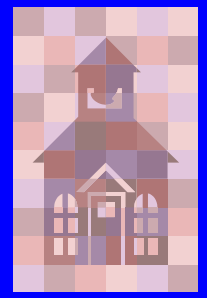

Question?

- What will you use the land for where you can not fumigate?
- How will you deal with the inconsistencies in management between the fumigated and nonfumigated areas?

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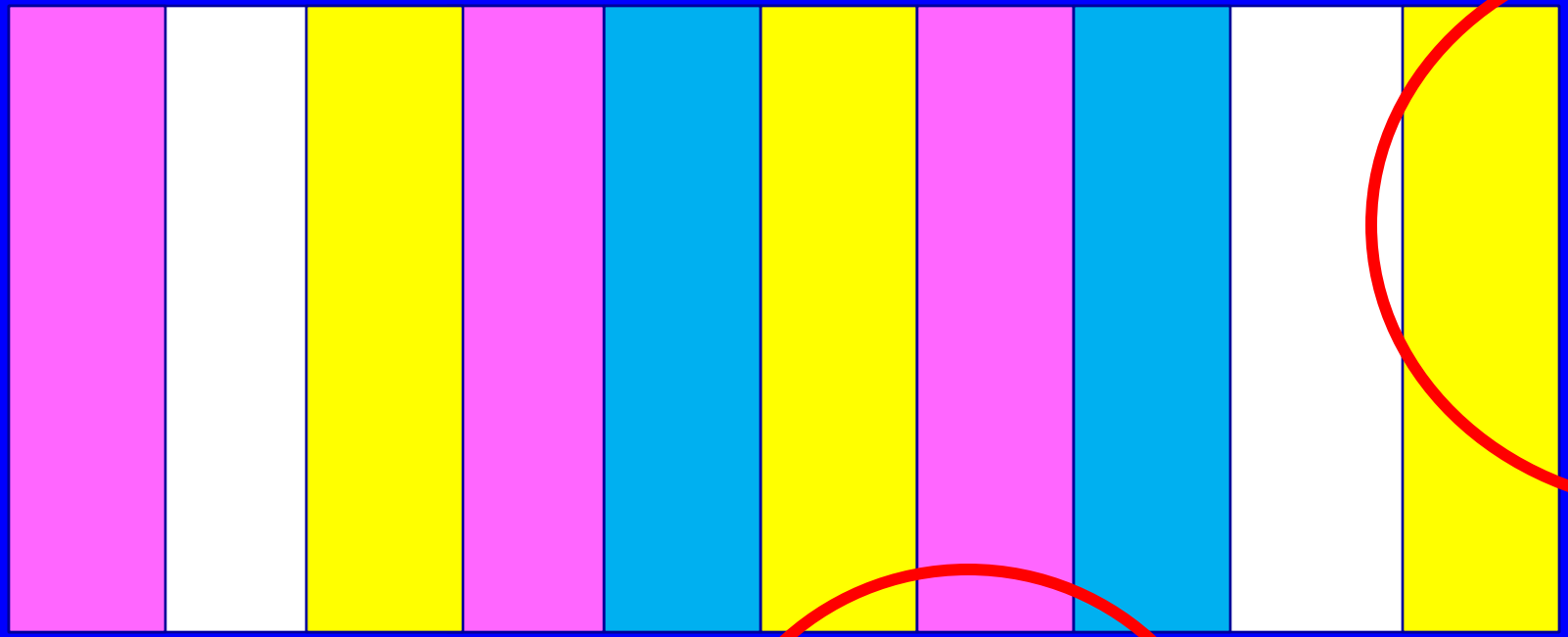
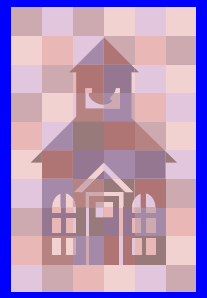
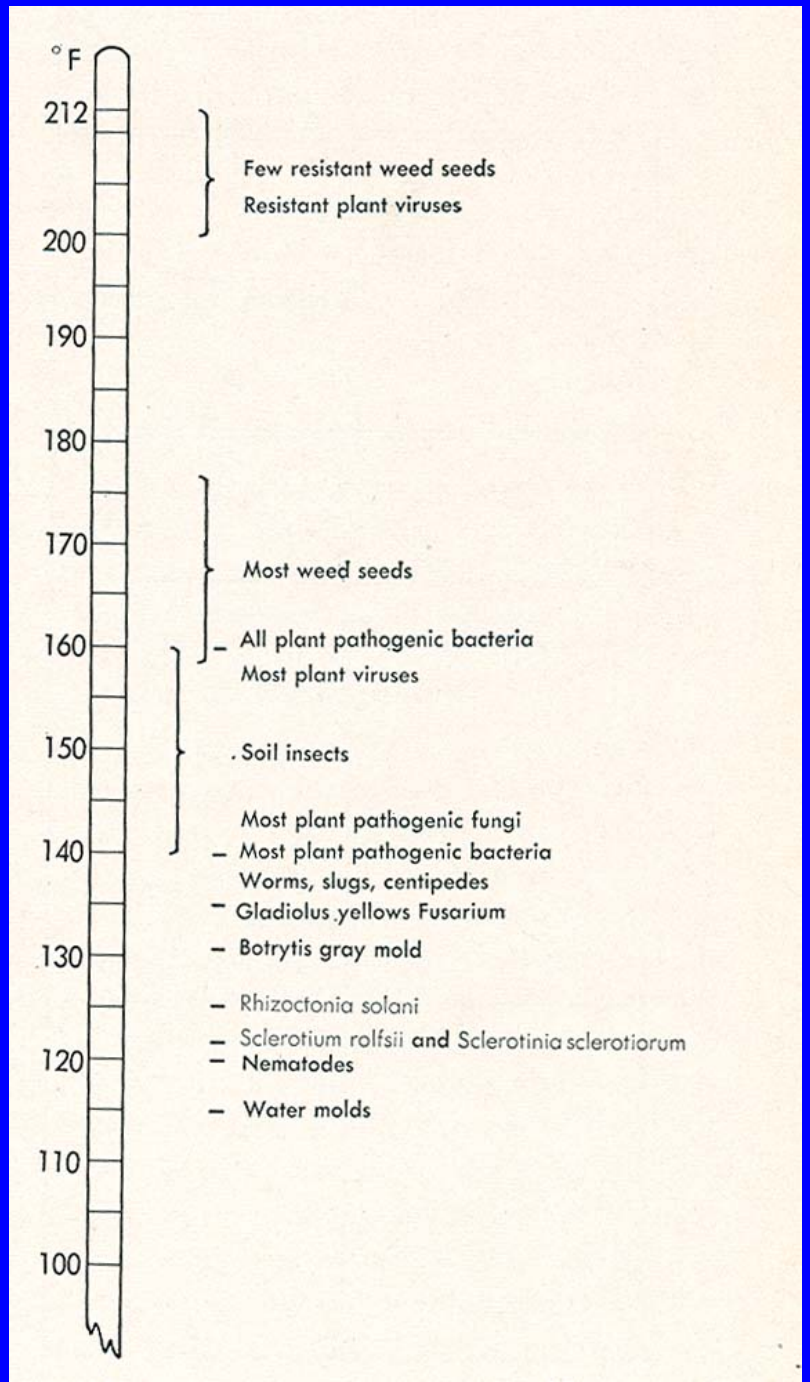




Need for flexible nonfumigant options

- Because the impacts of fumigant regulations are not always the same from year to year, there is need for flexibility in the nonfumigant treatment.

Steam



K.F. Baker, 1957

Points

- Steam is effective for soil disinfestation and has been used since the 1880s.
- The main objections to steam is that it is too slow and too expensive (USDS 2006).
- Can these obstacles be overcome?

MSD
Dämpfmobil
www.moeschle.de

Sheet steaming

M. Barel

Drain steaming – Nipomo, CA

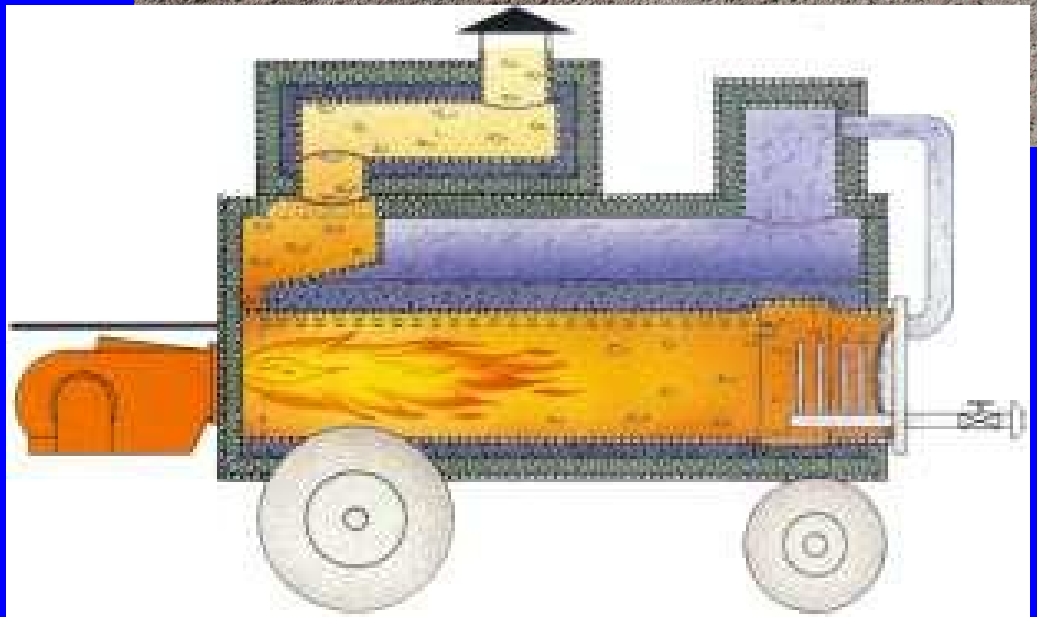
B. Hanson

Sandwich steaming

Hood 100-in x 74-in

99 spikes 10-in

4 outlets/spike



www.ferraricostruzioni.com

Hot air – “cultivit”

Steam application methods & fuel consumption in The Netherlands

Method	Diesel consumption Gal./A soil
Sheet steam	7,174
Neg. pressure	4,100
Mobile steam	1,025
Hot air	194

Adapted from Runia & Greenberger 2004

Points so far …

- There are huge differences in energy costs between the various steam application methods.
- **Assumption:** There are additional energy savings to be found and a reasonable cost per acre is within reach of current technology.

Steam **No steam**

Steam was applied by spike hose Nov. 2008, Watsonville, CA

Watsonville 2008-09

Treatment	Diameters 5/20/09 Cm	Fruit 5/7/09 No./plant	Fruit 6/9/09 No./plant
Steam	34 a	6.2	12.4 a
No steam	29 b	4.7	7.7 b
LSD	2.6	2.8	3.2

2008 Trials

solar + steam treatments

steam spike

steam pipe

2008-09 Steam evaluation in strawberry

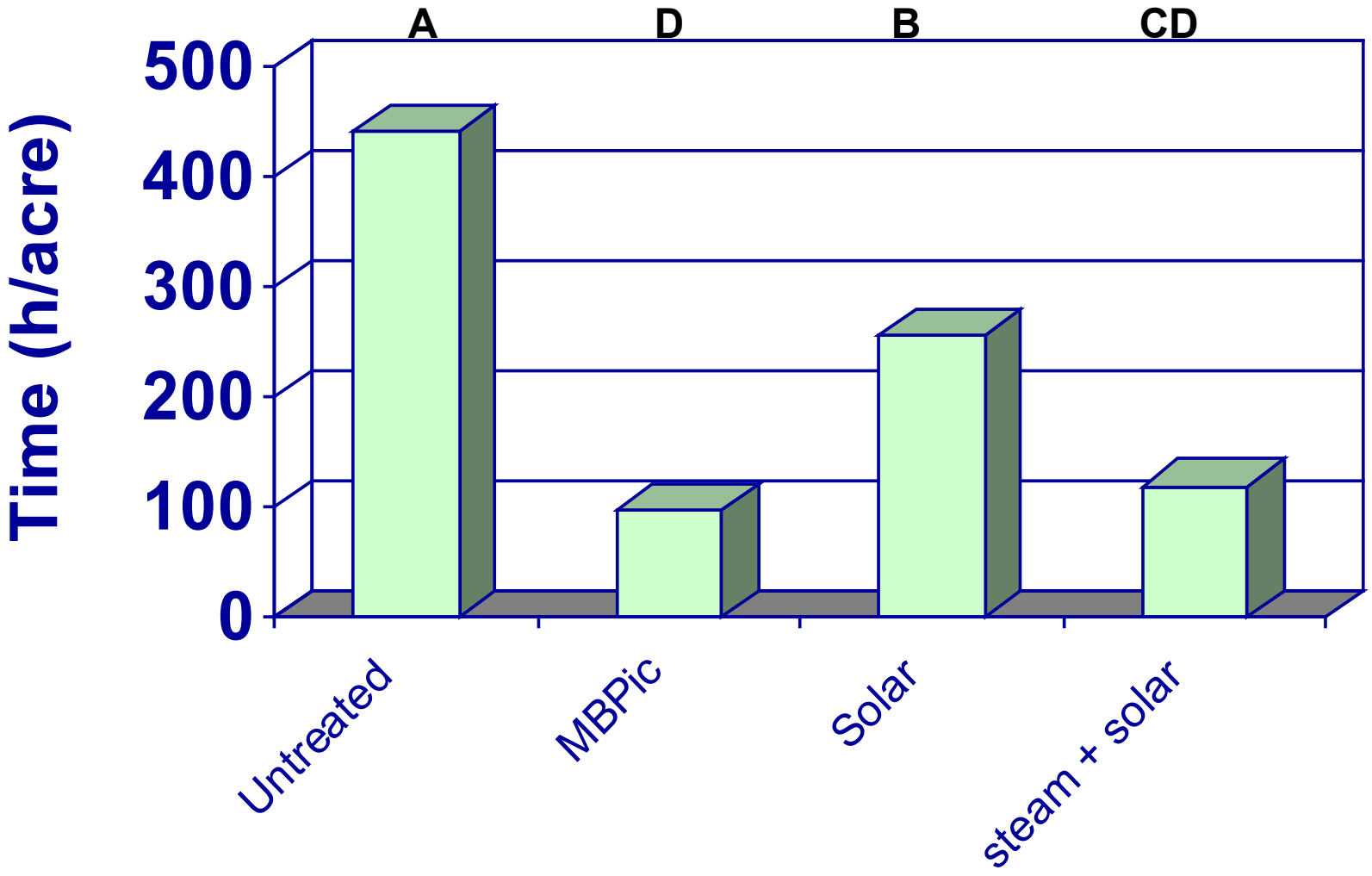
Control

Methyl bromide

Steam + Solar

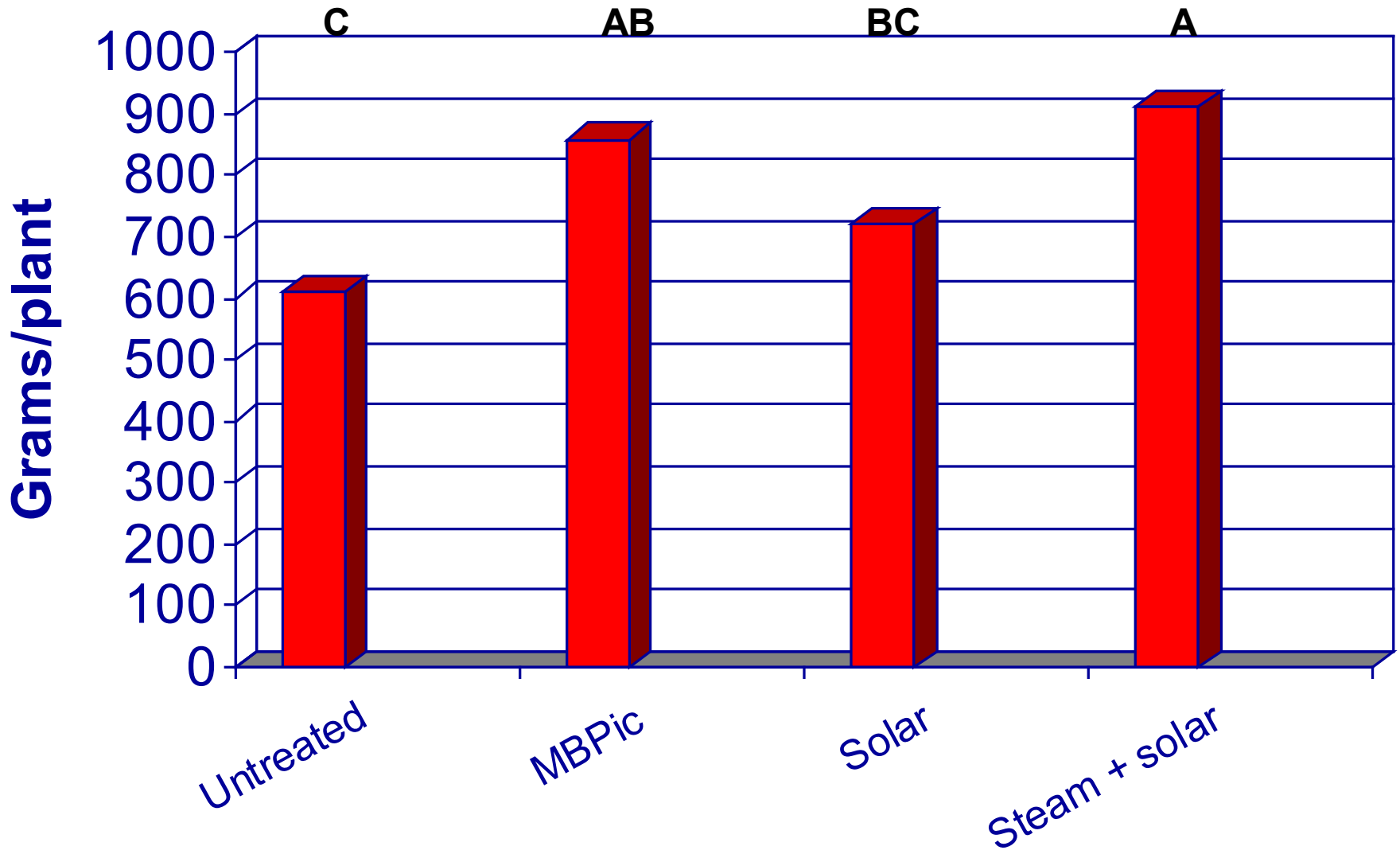
Solar alone

Hand weeding time in strawberry (Salinas), 2008-09



LSD = 0.05

Strawberry yield at Salinas 2008-09



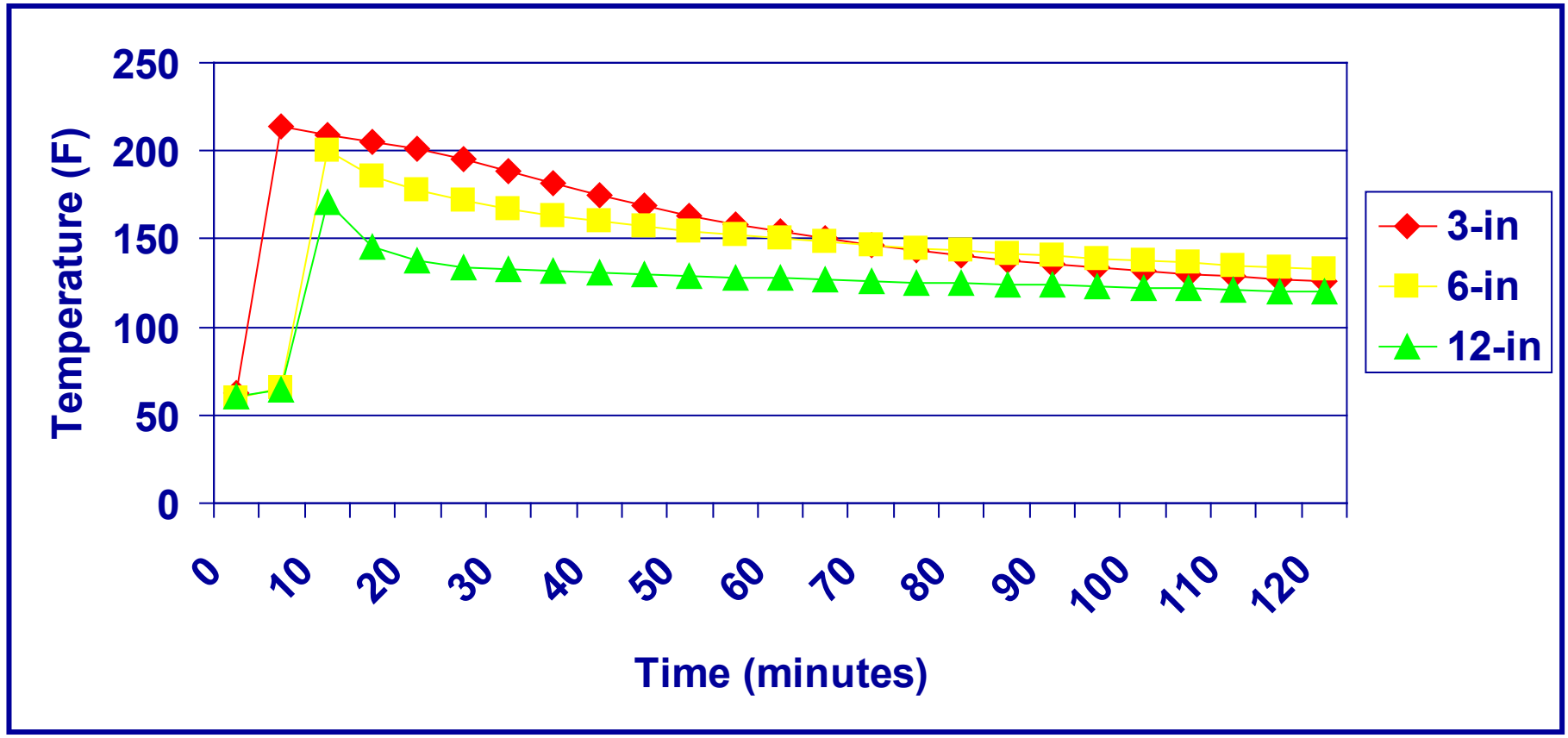
LSD = 0.05

Sandwich steaming

Why the Sterilter is different

- Super heated steam – heats soil fast 5-7 minutes.
- Short distance from boiler to soil (6 ft).
- Injects steam 9 inches in the soil effectively treating the top 12 inches.
- Operates automatically – low labor input.
- However, the unit we have is slow. There are larger models and we are discussing several modifications such as bed steaming.

Sterilter soil temperatures



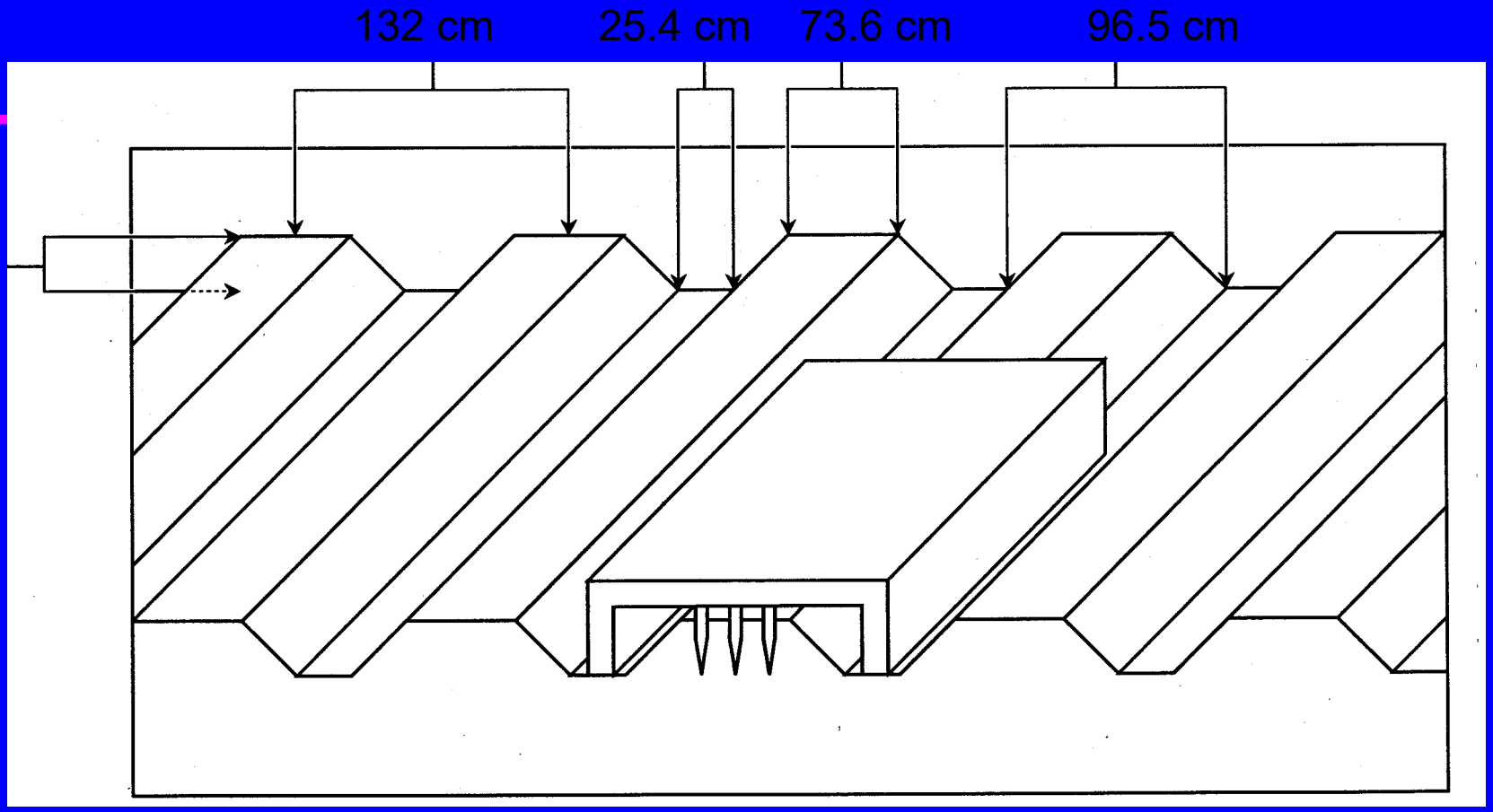
Nov. 2, 2009

Operation costs for Sterilter

Item	Cost $/A
Diesel ($2.28/gal)	2,052
Labor ($17.35/hr)	1,488
Machine (5 yr dep.)	$308
Total	$3,848

Design for bed steaming: MSD Germany

Future Design for a steam hood for 52-in beds



Reconfiguration: 33 spikes per bed X 74-in long X 3 beds = 54 hr/A with the S500

With the S950 unit it should be possible to do 1 acre/day

THE MACHINE AT WORK

THE BIOFLASH SYSTEM

works at controlled temperatures for a long period of time, at a deep homogeneous layer

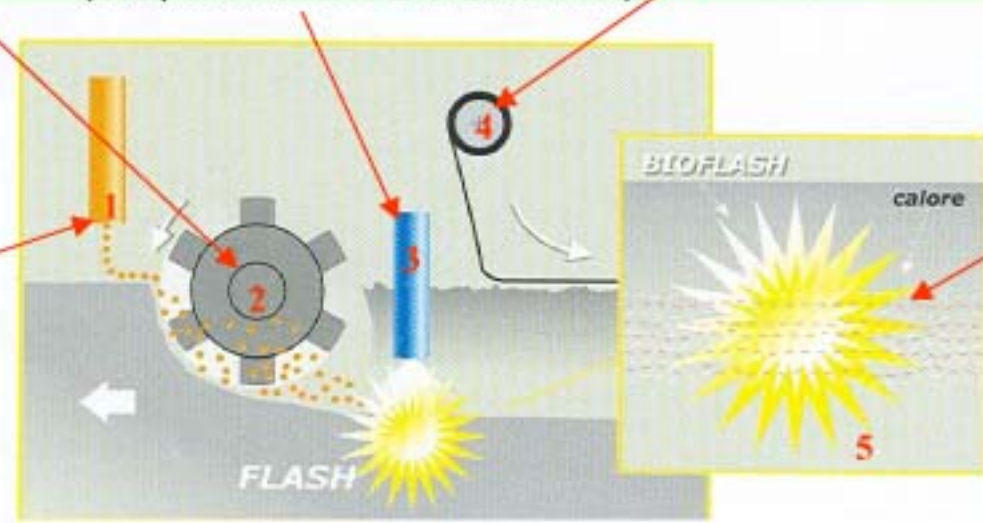
The application of the "exotermic reaction" on the Celli machine

2) In depth reagent leakage

3) Steam injection
(it is possible to fit 2 release bars)

4) Possible covering with plastic film (mulch)

1) Reagent release

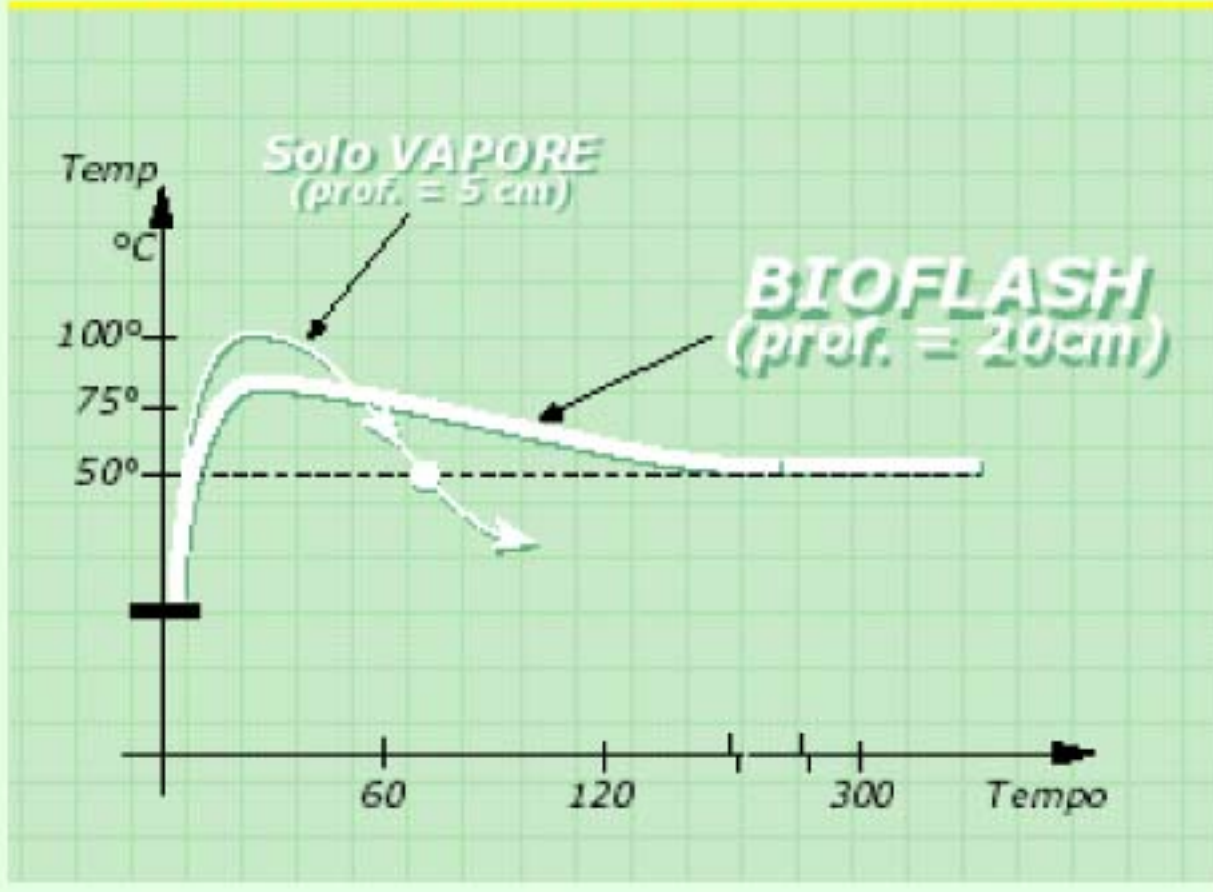


5) FLASH EFFECT

BIOFLASH SYSTEM

- PASTEURISATION
- AND NOT SERILIZATION
- AVOIDING THE BIOLOGICAL VACUUM

DIFFERENCES BETWEEN BIOFLASH AND TRADITIONAL SYSTEMS



Barberi et al. 2009 Weed Research 49:55-66

The curves of temperatures show the difference between the BIOFLASH system and the traditional system based on steam only: with less steam we obtain much longer heating effect

Bed steaming – future objective

- Our objective is to increase steaming time and fuel efficiency by 27% per acre. Insulation of the steam hood will also increase fuel efficiency.
- Bed steaming can also increase labor use efficiency and decrease machine costs per acre.
- A larger machine can also increase labor use efficiency.
- Switch to propane to reduce impacts on air quality.
- Try combinations of steam and “activating compounds” CaO. Eg. 3,570 lb/A CaO + H_20 = 1,828 MJ energy = 12.7 gallons of diesel.

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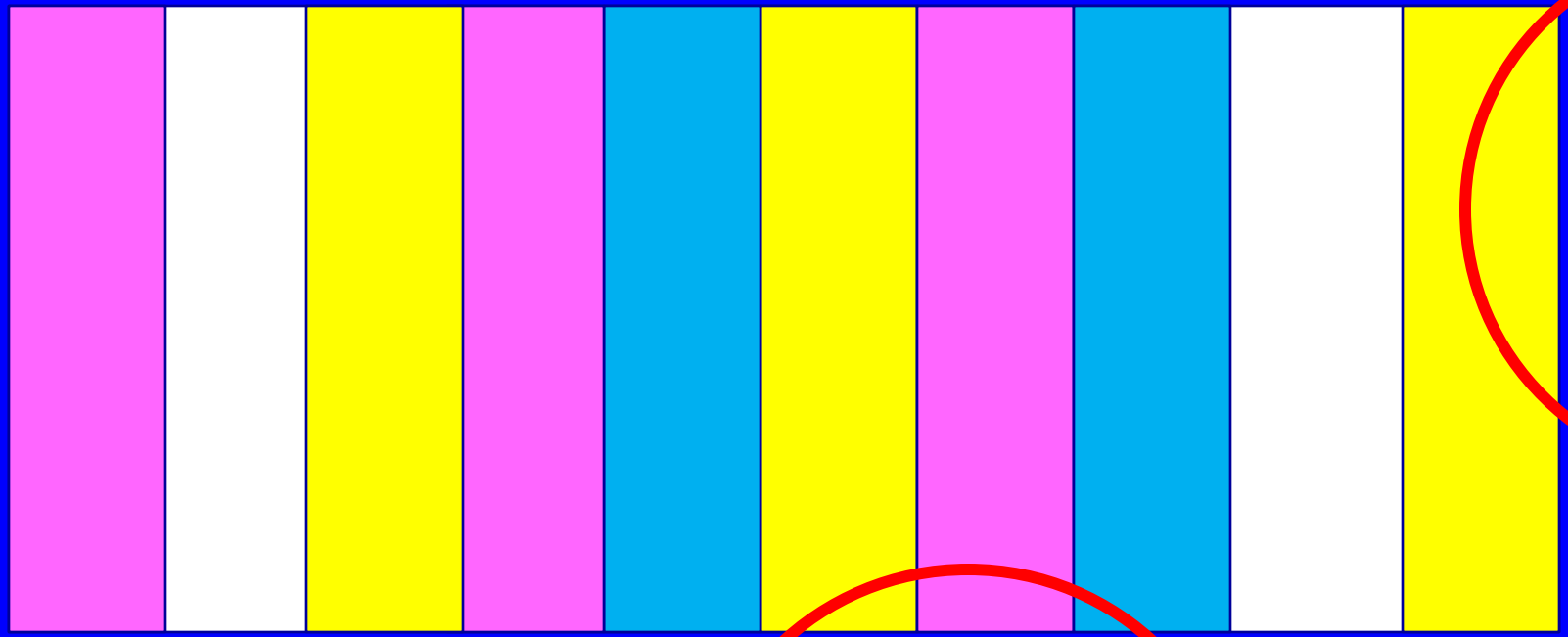

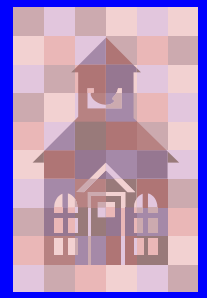

Conclusion/ Ideas

- Bed steaming is the direction we want to head in strawberry. Potential costs are $3,500/A.
- Can we use activating compounds (CaO, KOH) or biofumigants (Mustard seed meal) to reduce steaming costs?
- The steam system appears most practical in organic fields, buffer zones and high demand townships.