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IPM Approaches to Manage Soilborne Pathogens of Specialty Crops in North Carolina USA

Frank J. Louws
Department of Plant Pathology
North Carolina State University

LOSS OF METHYL BROMIDE

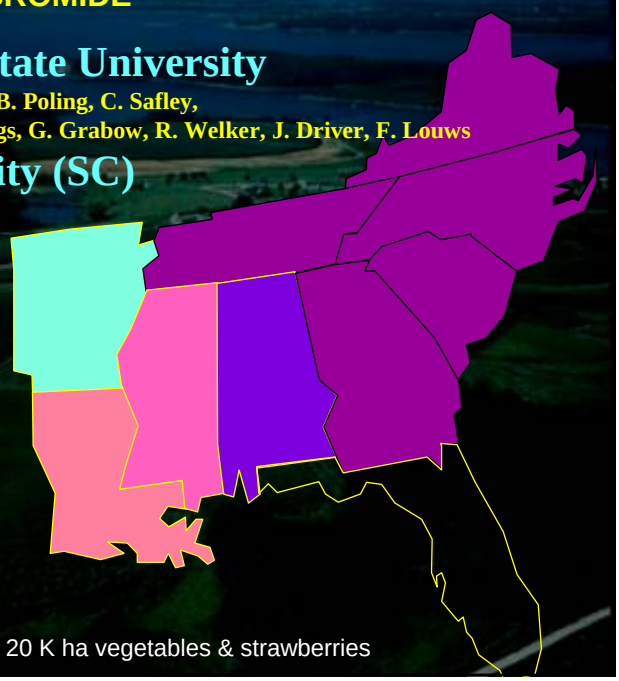
North Carolina State University
G. Fernandez, D. Monks, B. Poling, C. Safley,
O. Sydorovych, K. Jennings, G. Grabow, R. Welker, J. Driver, F. Louws

Clemson University (SC)
P. Smith

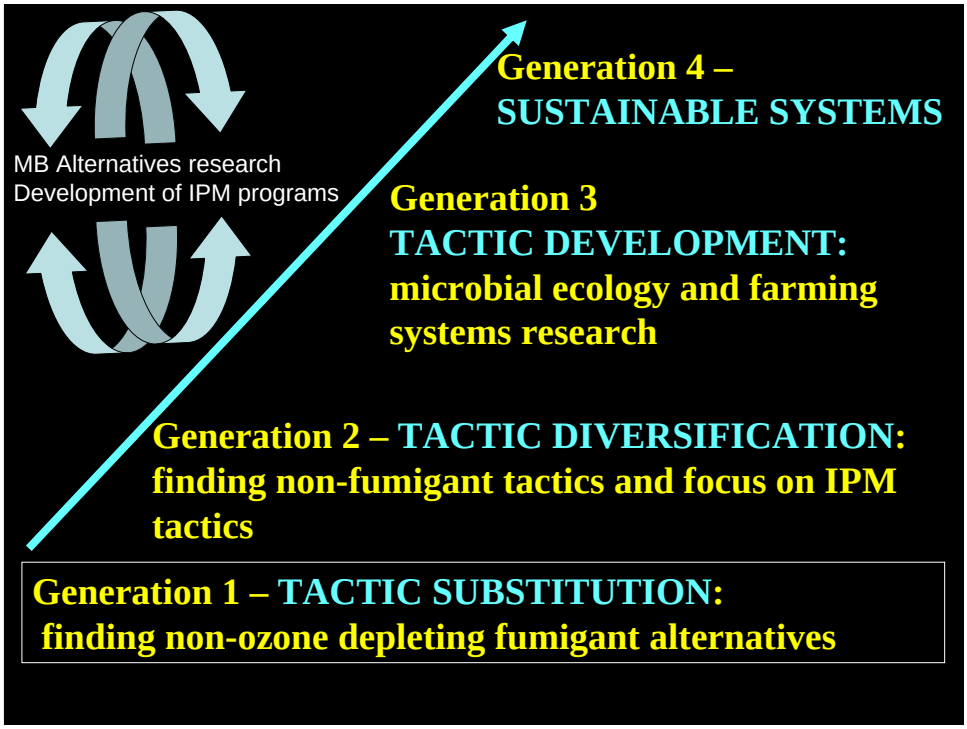
U. Of Georgia
P. Brannen

Virginia Tech
C. Johnston
C. Schiemann

University of TN
C. Sams



20 K ha vegetables & strawberries



Background:
Methyl Bromide Alternatives Research in SE

Strawberry and vegetable research and extension programs

Phase I:

- research station trials
- new products or methods of application

Phase II:

- on farm research trials
- on farm demonstrations (field scale implementation)

Phase III
Area Wide Pest Management Program

From Plots:

To Production:

What alternatives are we considering?

Chemical

- Telone / Chloropicrin
- metam sodium
- Basamid
- Iodomethane (Midas)
- chloropicrin

Non Chemical

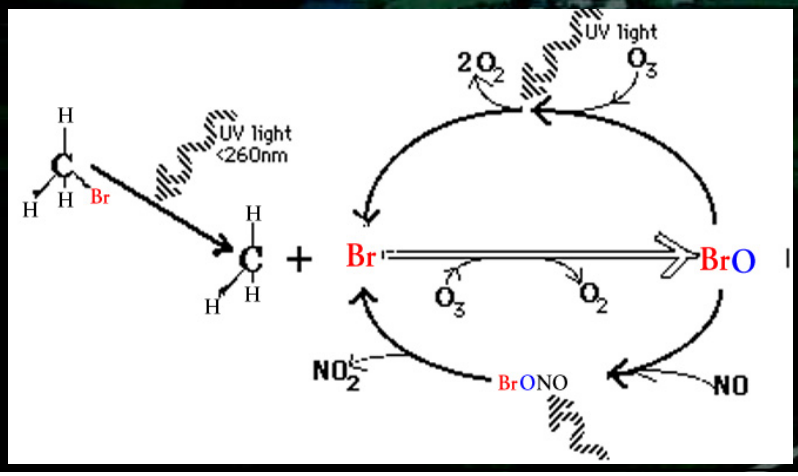
- Compost-based systems
- Solarization
- Cabbage residue
- Biological inputs
- Drip chemistries
- Grafting

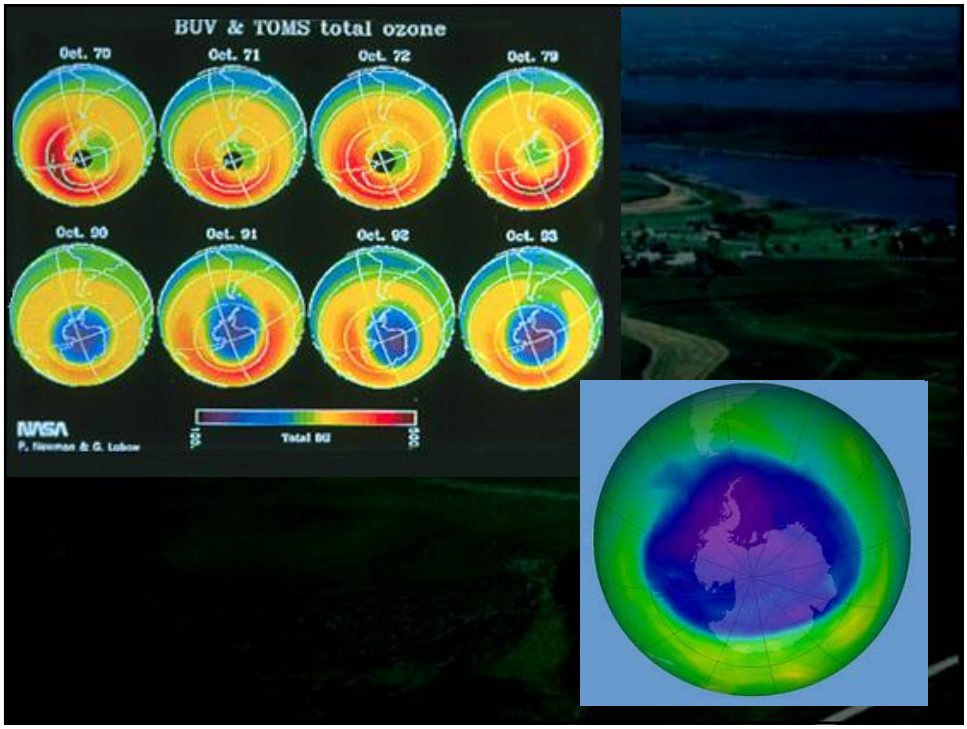
- New products (sodium azide, propozone, Acrolein, DMDS)

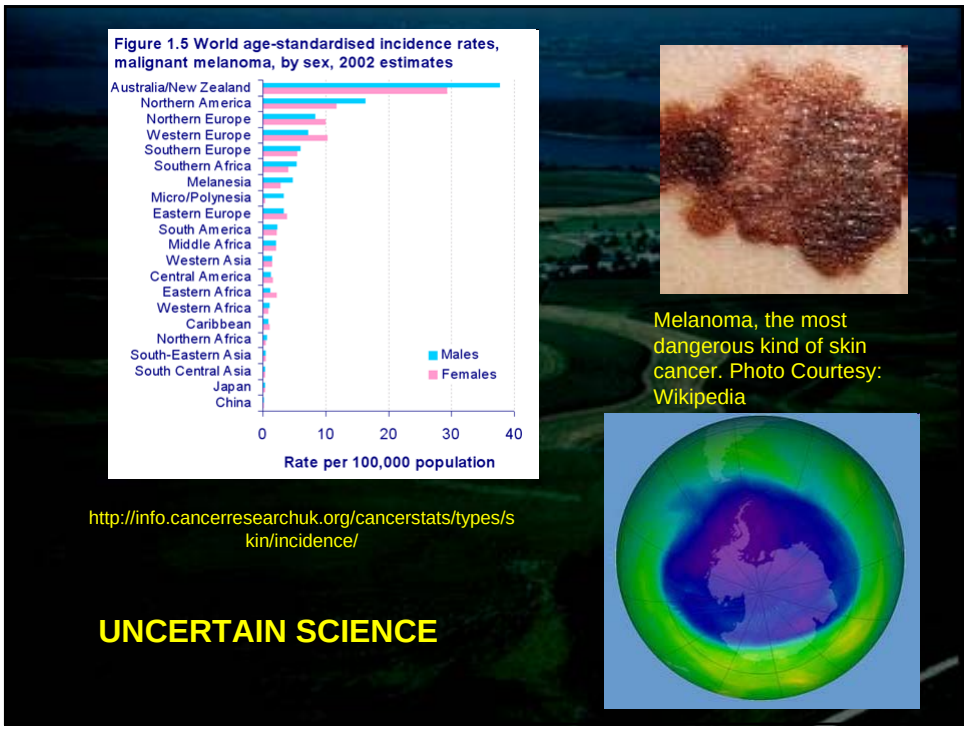
Know the product, conditions, protective and regulatory standards.

THE PROBLEM:

Chemical Reaction of Methyl Bromide(CH_3Br) Depleting Ozone (O_3)



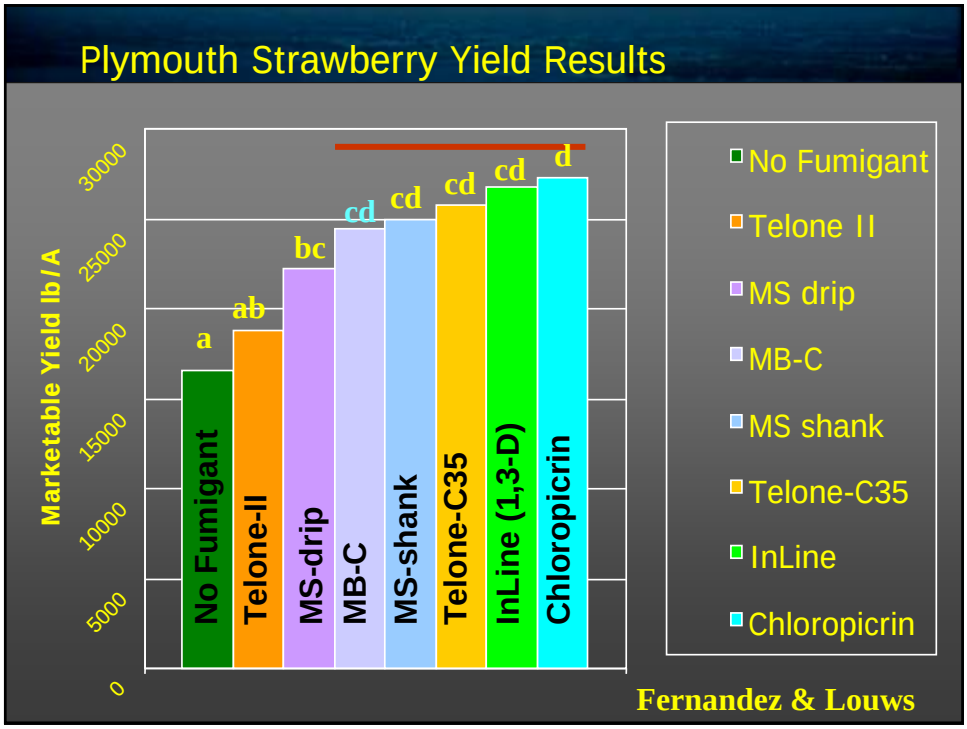




Melanoma, the most dangerous kind of skin cancer. Photo Courtesy: Wikipedia

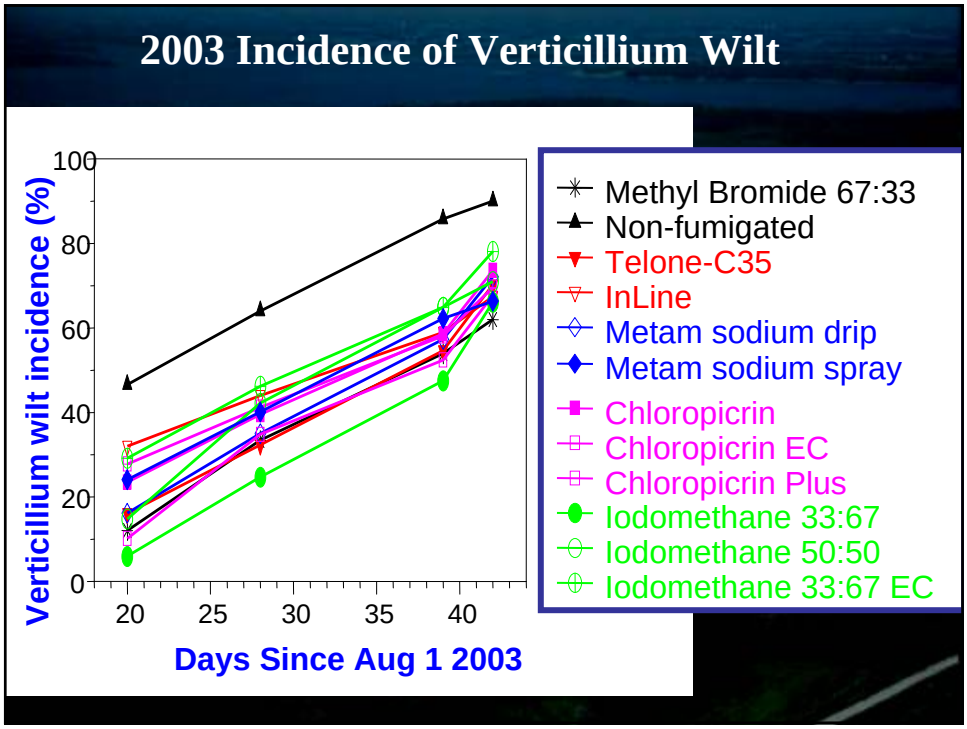
http://info.cancerresearchuk.org/cancerstats/types/skin/incidence/

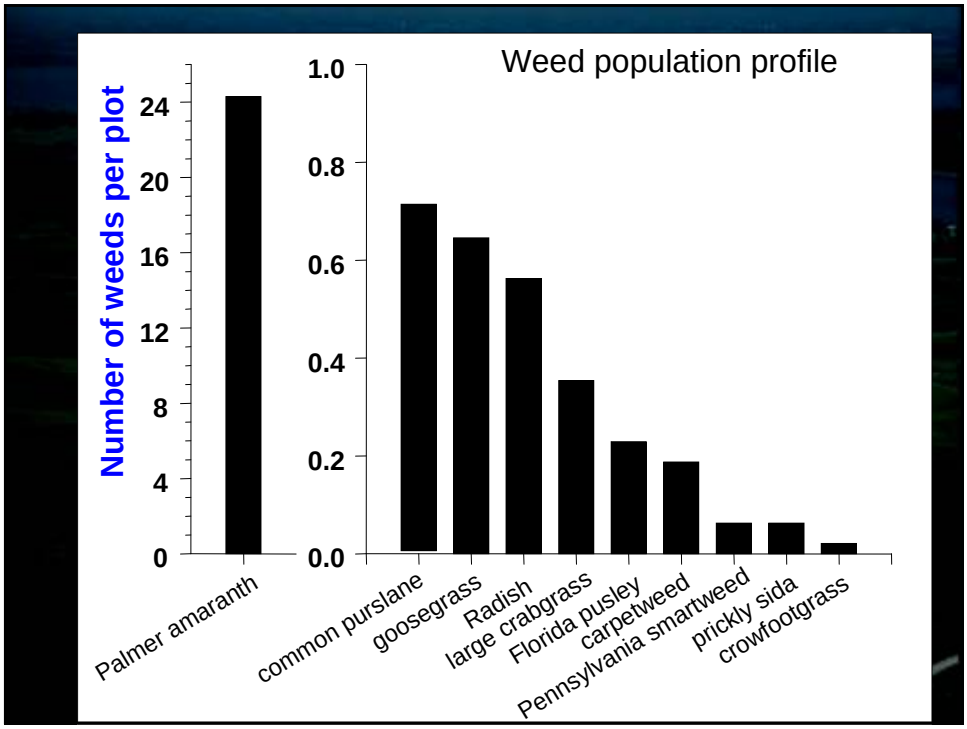
UNCERTAIN SCIENCE



Disease Problems in the Southeast

Strawberry Disease	Resistance	Avoidance	Cultural practices	Fumigate	Chemical	Other
Black Root Rot			*	*	*	
Phytophthora crown rot		*		*	*	
Root knot nematodes			*	*		
WEEDS			*	*	*	*


2003 Incidence of Verticillium Wilt
Verticillium wilt incidence (%)
100
80
60
40
20
0
20
25
30
35
40
Days Since Aug 1 2003
Methyl Bromide 67:33
Non-fumigated
Telone-C35
InLine
Metam sodium drip
Metam sodium spray
Chloropicrin
Chloropicrin EC
Chloropicrin Plus
Iodomethane 33:67
Iodomethane 50:50
Iodomethane 33:67 EC



WEED INCIDENCE (Weeds/plot)

1. Non Fumigated	32.0 c
4. Chloropicrin (150 lb/A)	22.0 bc
11. Telone C35 (35 gal/A)	3.0 ab
9. Chloropicrin (150 lb/A) + Pre Goal	1.5 a
5. Chloropicrin (150 lb/A) + Sulfentrazone	1.0 a
8. Chloropicrin (150 lb/A) + Pre Dual	0.5 a
12. K-Pam (75 gal/A)	0.5 a
2. Non Fumigated (hand Weeded)	0.5 a
10. Chloropicrin (150 lb/A) + K-pam (drip after 1 wk 75 gal/A)	0 a

Marketable yield as impacted by fumigants, time of application and time of tomato transplanting.

Treatment		Rate	Time of Application	Time of Planting	Marketable Yield (ton/A)
1	No Fumigation	--------	Fall	First	26.5 a
5	Methyl Bromide:Pic (67:33)	400 lbs/A	Fall	First	34.3 bc
7	Telone C35	35 gal/A	Fall	First	36.4 bcd
10	InLine	26 gal/A	Fall bedding; Spring injection	First	38.9 d
6	No Fumigation	--------	Spring	First	34.4 bc
9	Telone C35	35 gal/A	Spring	First	38.6 d
11	Methyl Bromide:Pic (67:33)	400 lbs/A	Spring	First	38.9 d
					P = 0.05

Disease Problems in the Southeast

Tomato Disease (Pepper[P])	Resistance	Avoidance	Cultural practices	Fumigate	Chemical	Other
Verticillium race 1	*					
Verticillium wilt race 2				*		
Southern bacterial wilt[P]	?	*	*	*		
Fusarium wilt race 1	*					
Fusarium wilt race 3	*	*		*		
Southern stem blight[P]			*	*	*	*
Root knot nematodes[P]	*			*	*	
Phytophthora[P]			*		*	
Pith necrosis			*			
Pythium root rot[P]			*		*	
WEEDS[P]			*	*	*	*

Economically Feasible Alternatives-Strawberry

Estimated Returns per Acre (Piedmont & Coastal Plain)
Based on up to 15 trials over 10 years and multiple locations

Fumigant	Additional NET Returns/A	Gross Returns/A
Chloropicrin	+ $1670	$30,269
Telone-C35	+ $277	$28,593
Metam Sodium (Shank)	+ $25	$28,378
Methyl Bromide*	$0	$28,451
Non-fumigated (check)	-$6,450	$ 21,344

•**Net Return for MB = $14,895/A**
= $36,806/ha

1 EUR/ha ~ $3.6/A

HortTechnology 16:118-128, 2006

Tomatoes: Economic Analysis of Alternatives

(Sydorovych et al. HortTechnology: 2008)

Selected alternative soil treatments	Net returns relative to MeBr
	($/acre)
Chloropicrin (high rate)	+906.68
Telone-C35	+848.02
Metam sodium (drip applied)	+136.65
MeBr	0.00
Metam sodium (broadcast + till)	-72.20
Midas (high rate)	-424.70
Non-fumigated	-2,133.01

Over 9 years of trials

Net return of MeBr = $8,758/A = $21,641/ha; 1 EUR/ha ~ $3.6/A

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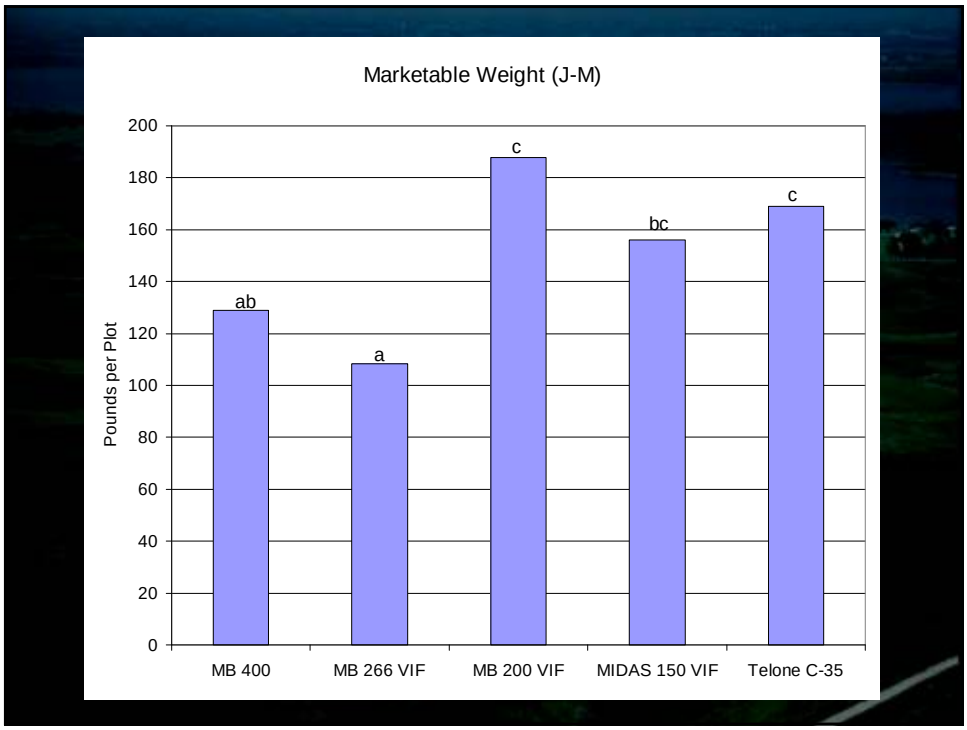
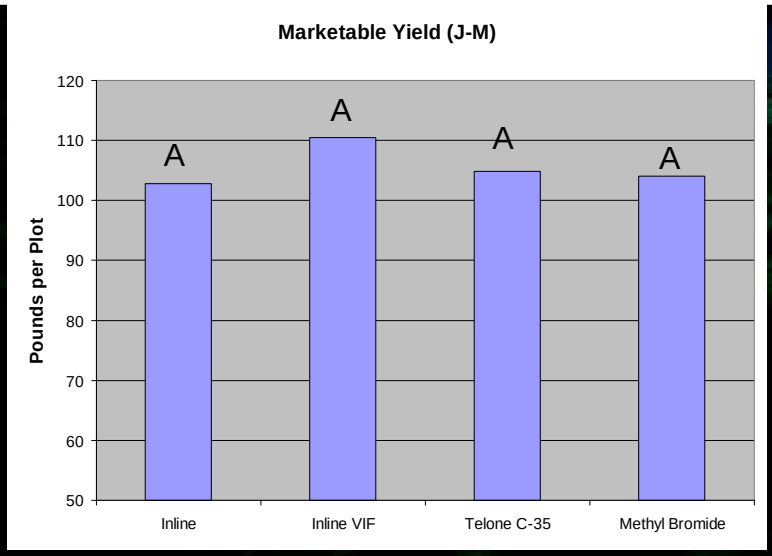
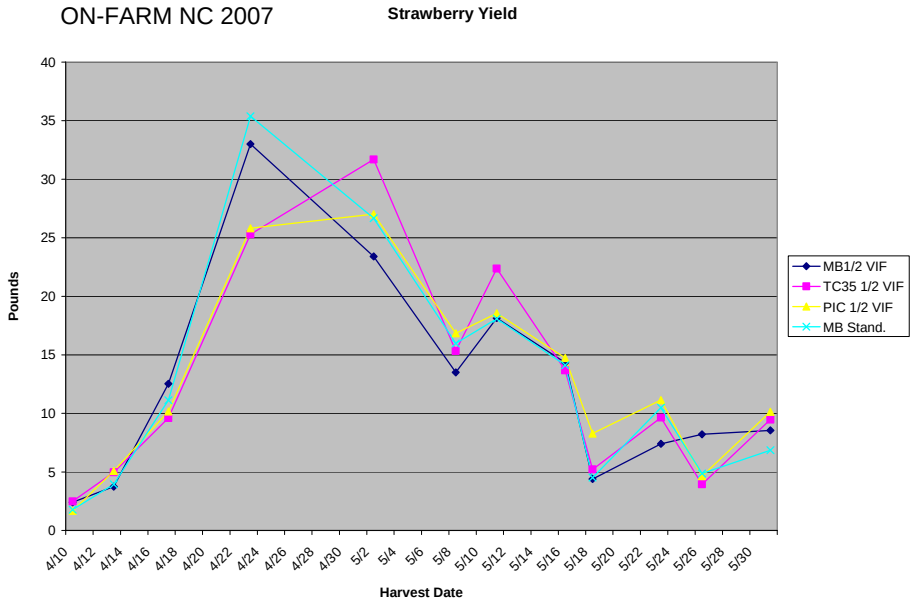
ON-FARM-TRIALS (Phase II & III)
(usually replicated with 2-4 alternatives)
Finding the holes – making it work

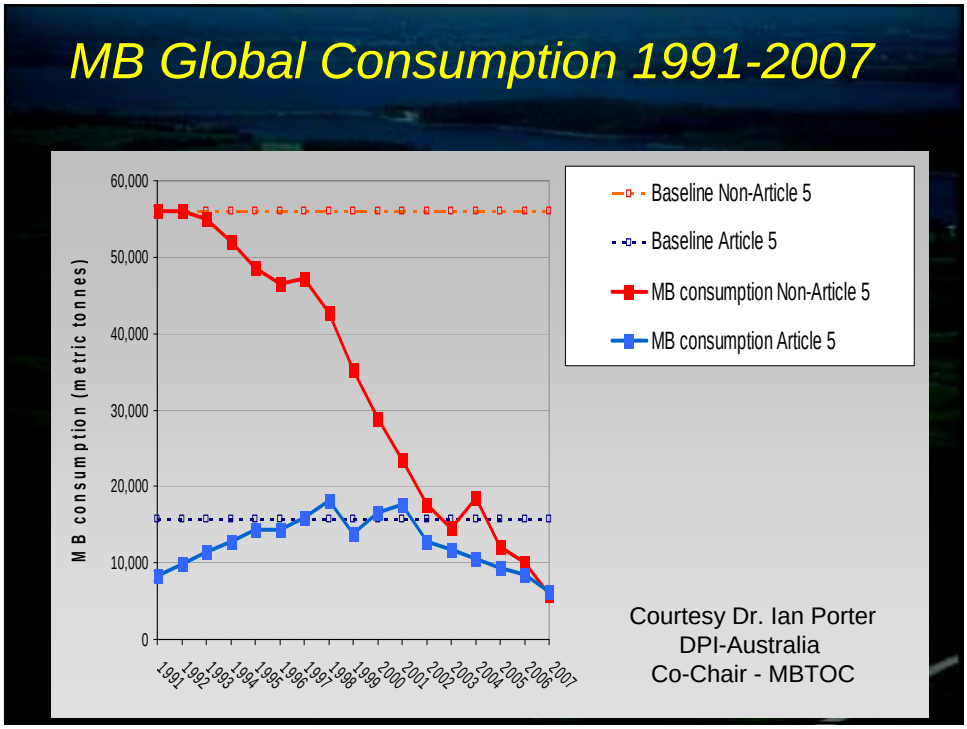

Marketable Weight (J-M)
Pounds per Plot
200
180
160
140
120
100
80
60
40
20
0
ab
a
c
bc
c
MB 400
MB 266 VIF
MB 200 VIF
MIDAS 150 VIF
Telone C-35

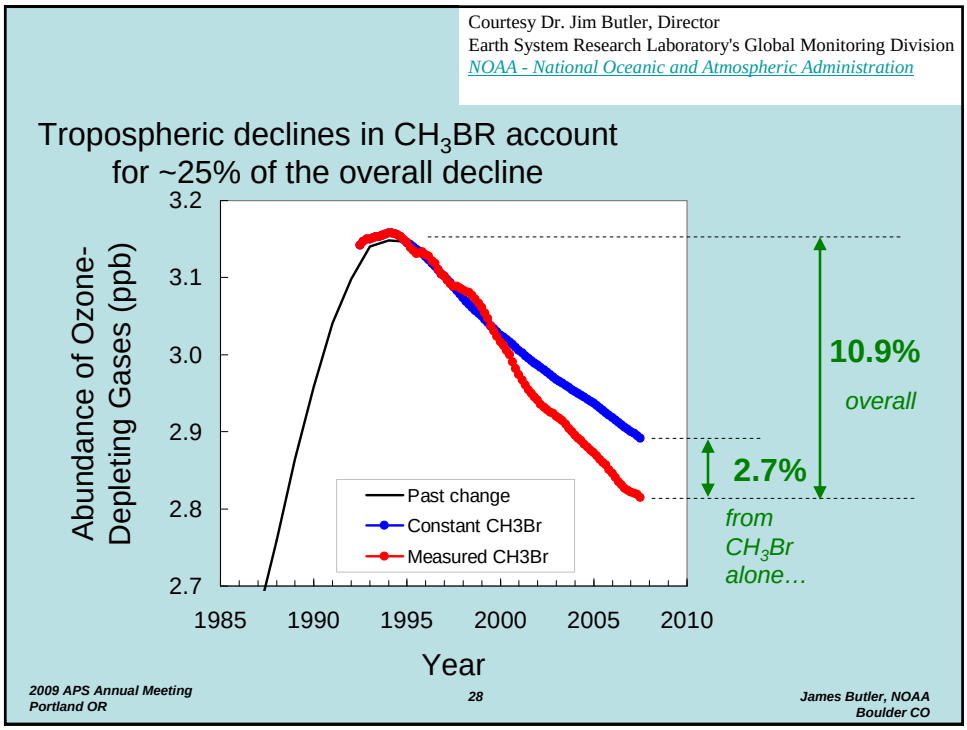
Carson King



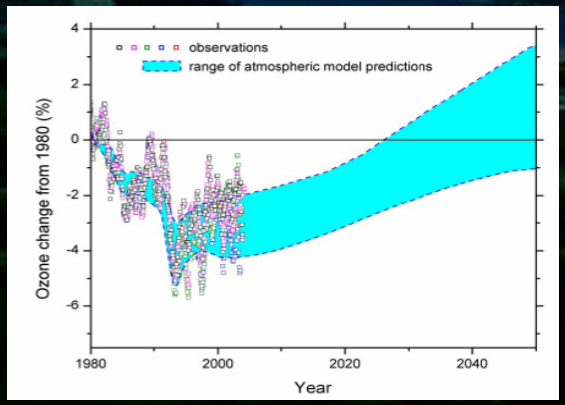
ON-FARM NC 2007



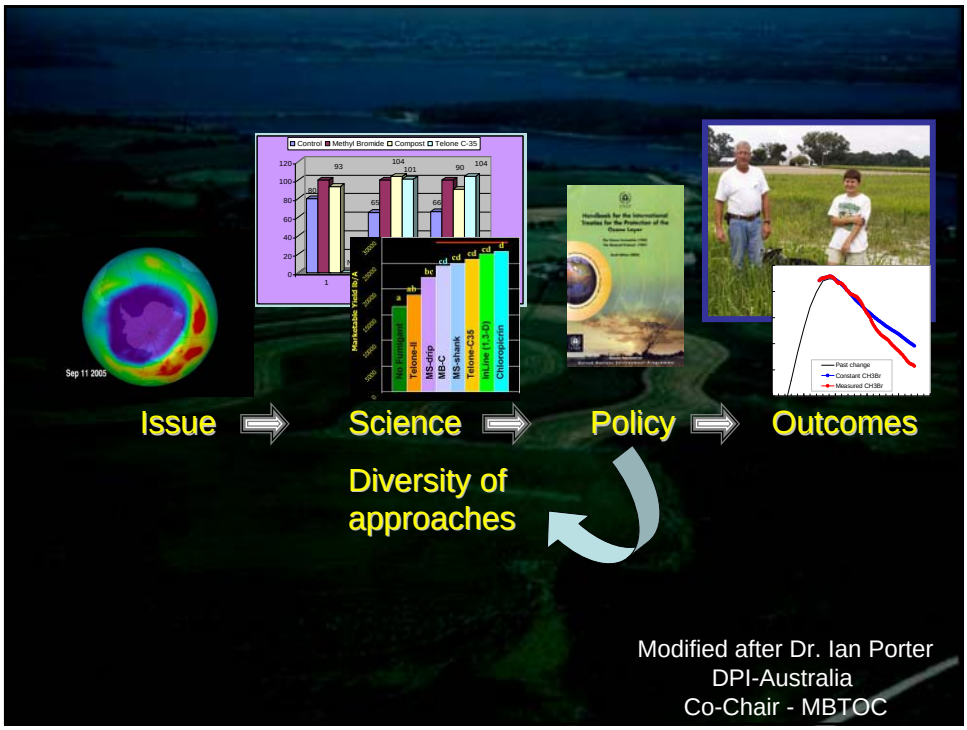

MB Global Consumption 1991-2007
MB consumption (metric tonnes)
60,000
50,000
40,000
30,000
20,000
10,000
0
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Baseline Non-Article 5
Baseline Article 5
MB consumption Non-Article 5
MB consumption Article 5
Courtesy Dr. Ian Porter
DPI-Australia
Co-Chair - MBTOC

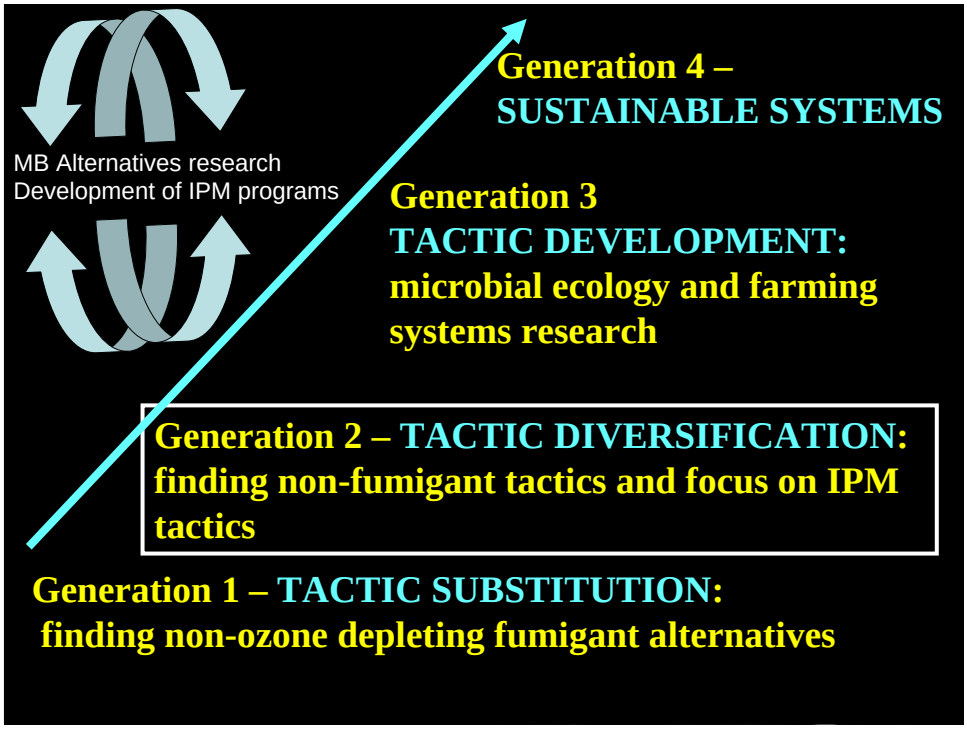

Courtesy Dr. Jim Butler, Director
Earth System Research Laboratory's Global Monitoring Division
NOAA - National Oceanic and Atmospheric Administration
Tropospheric declines in CH3BR account for ~25% of the overall decline
Abundance of Ozone-Depleting Gases (ppb)
3.2
3.1
3.0
2.9
2.8
2.7
1985
1990
1995
2000
2005
2010
Year
Past change
Constant CH3Br
Measured CH3Br
10.9%
overall
2.7%
from CH3Br alone…
2009 APS Annual Meeting
Portland OR
28
James Butler, NOAA
Boulder CO

Summary: Benefit of The Montreal Protocol



Full compliance with the Montreal Protocol will see concentrations of stratospheric ozone return to baseline levels towards the middle of this century.





IPM: INTEGRATED PEST MANAGEMENT

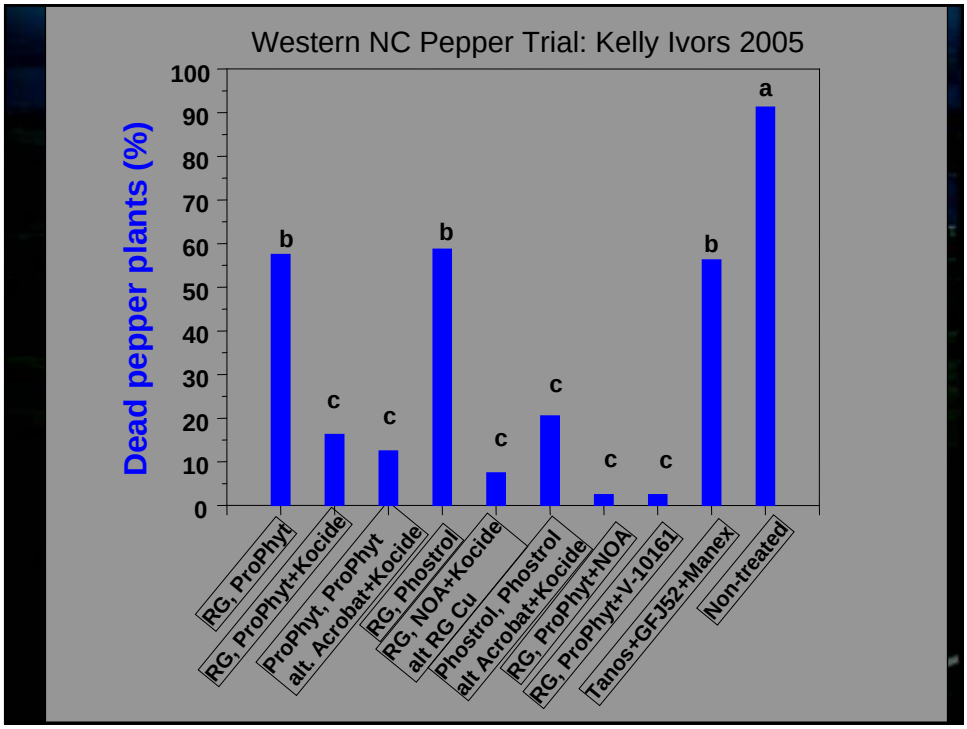
- Proper diagnosis
- Clean seed/plants
- Variety selection
- Transplant production IPM
- Site selection/field management
- Crop rotation/cover crops (farming system design)
- Fungicide/biological control selection

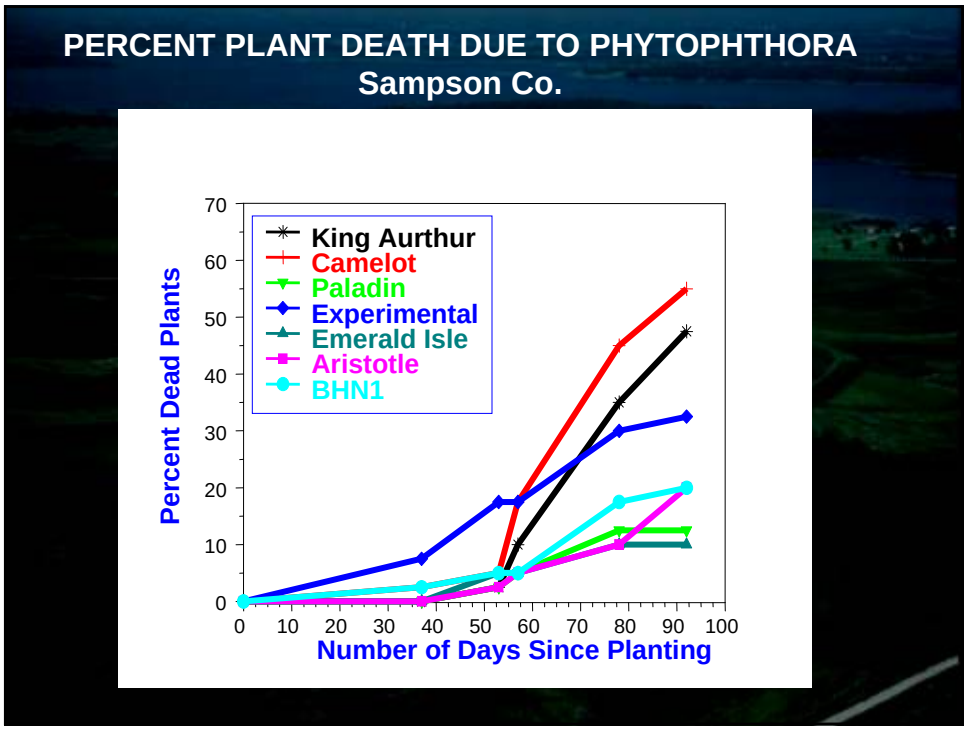
SYMPTOMS: PROCESSING/FRESH

SYMPTOMS: FOLIAR BLIGHT/FRUIT ROT

Phytophthora Symptoms on Squash

WATER MANAGEMENT


Western NC Pepper Trial: Kelly Ivors 2005
Dead pepper plants (%)
100
90
80
70
60
50
40
30
20
10
0
b
c
c
b
c
c
c
c
b
a
RG, ProPhyt
RG, ProPhyt+Kocide
ProPhyt, ProPhyt alt. Acrobat+Kocide
RG, Phostrol
RG, NOA+Kocide alt RG Cu
Phostrol, Phostrol alt Acrobat+Kocide
RG, ProPhyt+NOA
RG, ProPhyt+V-10161
Tanos+GFJ52+Manex
Non-treated


PERCENT PLANT DEATH DUE TO PHYTOPHTHORA
Sampson Co.
Percent Dead Plants
70
60
50
40
30
20
10
0
King Aurthur
Camelot
Paladin
Experimental
Emerald Isle
Aristotle
BHN1
0 10 20 30 40 50 60 70 80 90 100
Number of Days Since Planting

INTEGRATED DISEASE MANAGEMENT

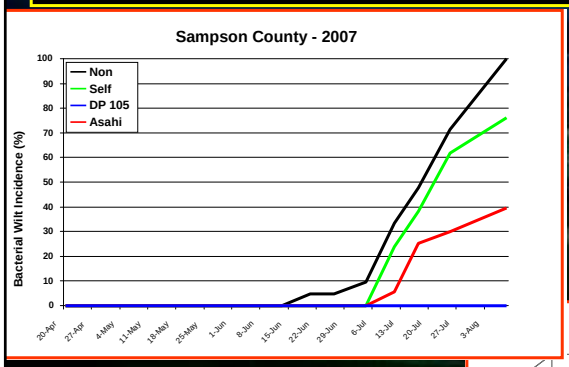
MANAGE THE CROP
Rotate away from susceptible crops
Manage cover crops to limit dispersal
Explore resistant varieties
MANAGE THE WATER
Avoid poorly drained soils and low lying areas
Do not block water drainage
Break up hard pans, ensure good percolation
Ridge plant and avoid depressions at plant base
Use non-infested irrigation water
MANAGE THE PATHOGEN
Avoid transferring disease from one field to the next
Rogue infected plants, remove plants after harvest
Use fungicides and fumigants

- To what extent can we use drip-applied fungicides to manage soilborne pathogens?
- For the entire field?
- For Border rows?

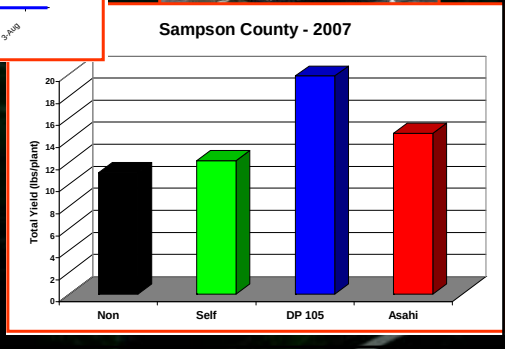
Tomatoes: Tactic Diversification

Tube Grafting

Tomatoes: Tactic Diversification

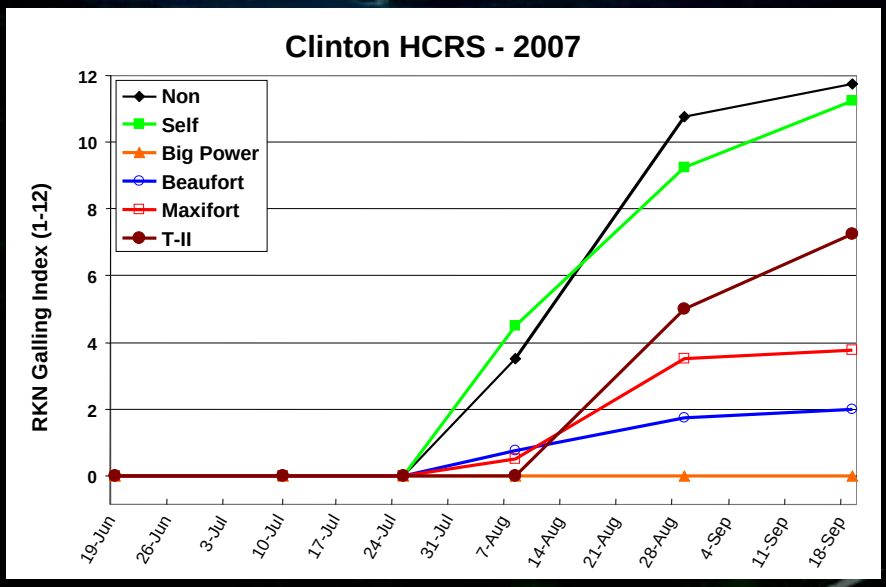


- *Ralstonia solanacearum*
- *Bacterial wilt*

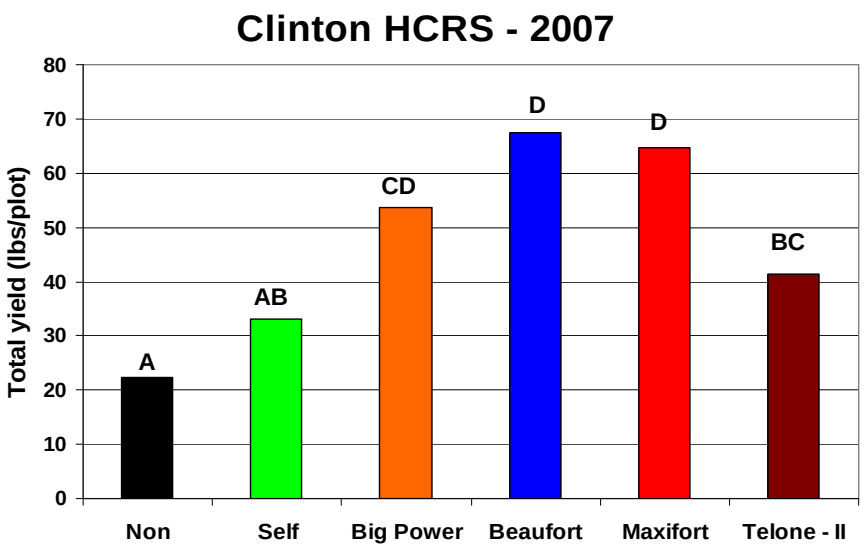


Root-knot Nematodes

Root Knot Nematode

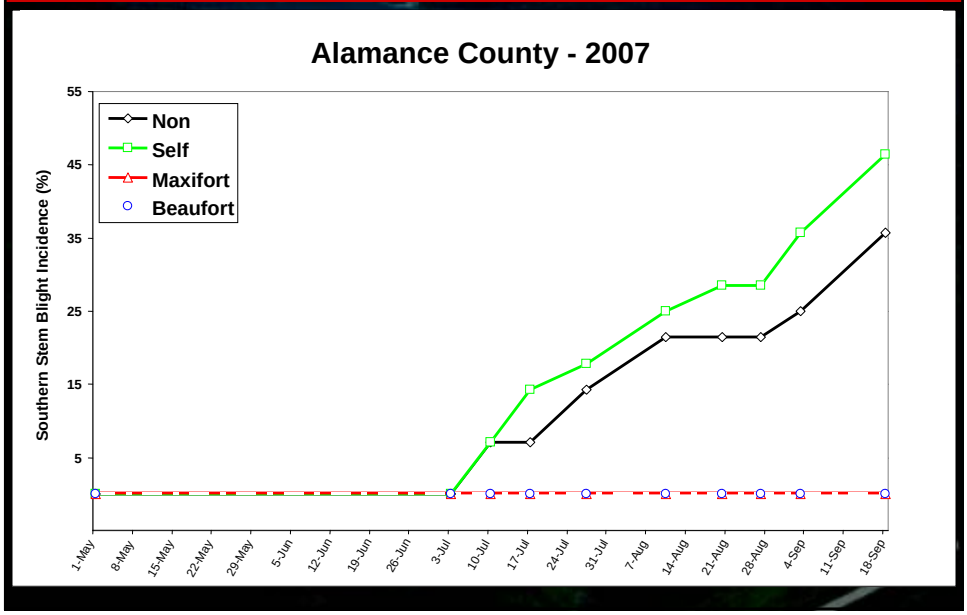


Root Knot Nematode

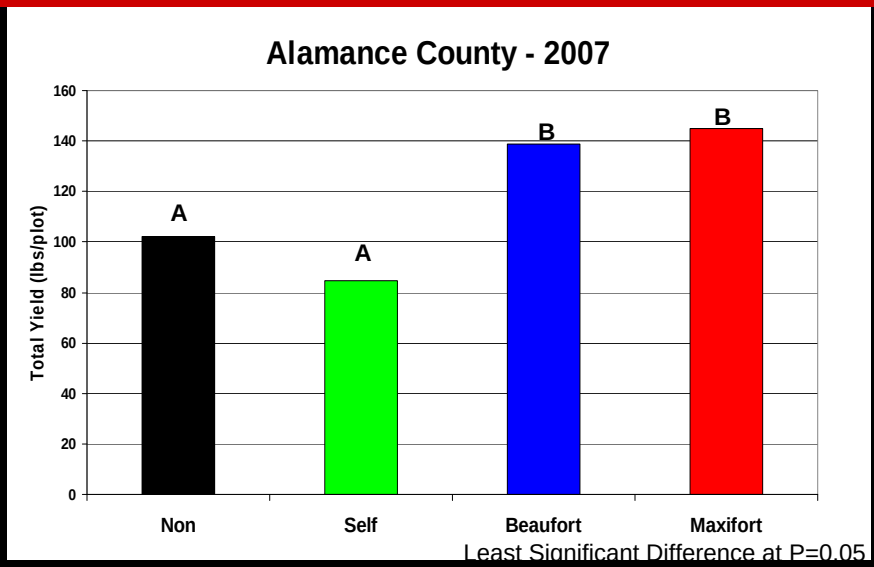


Southern Stem Blight

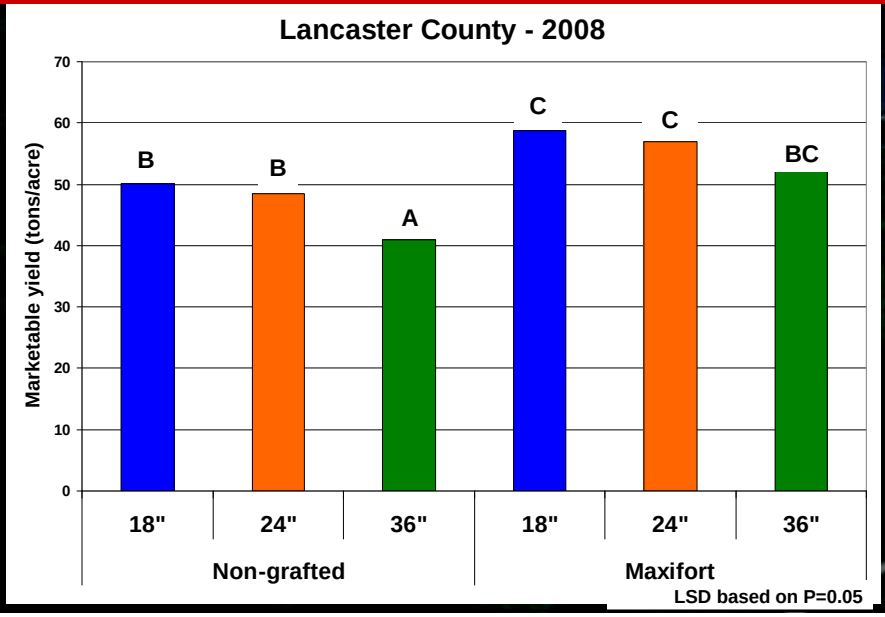
Southern Stem Blight

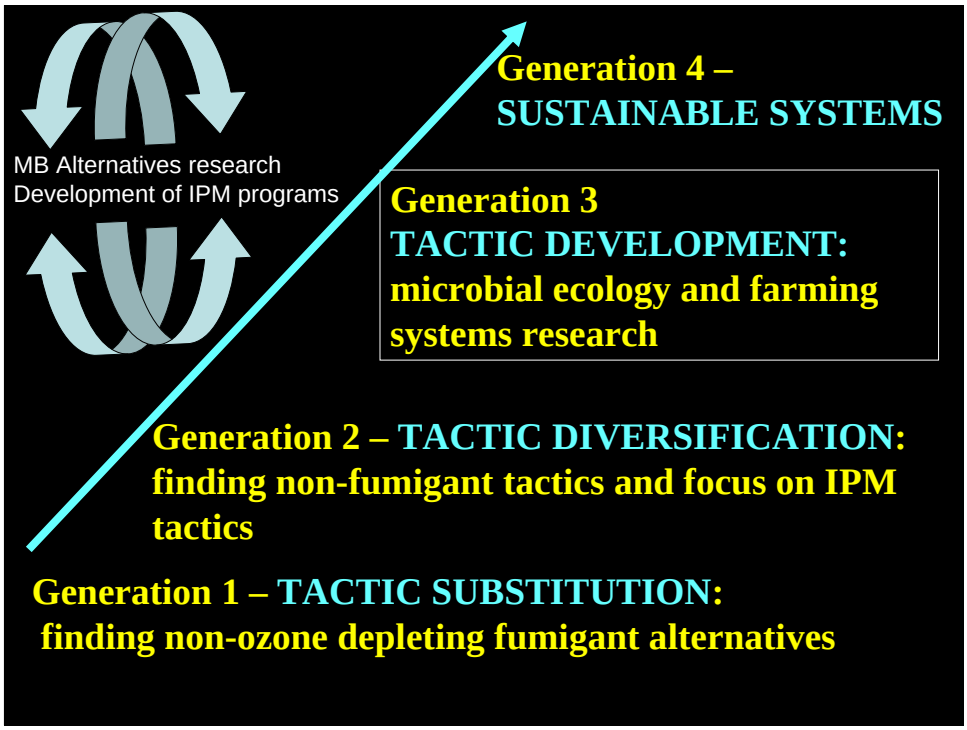


Southern Stem Blight



Cedar Meadow Farm, PA





Practitioner Approach: Can we implement a compost-based production system and improve soil health as an alternative to methyl bromide?
JUST DO IT!

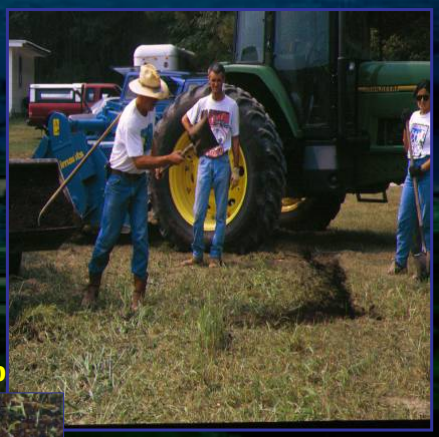
John Vollmer
- on farm research
- organic transition

Michelle Grabowski
MS student

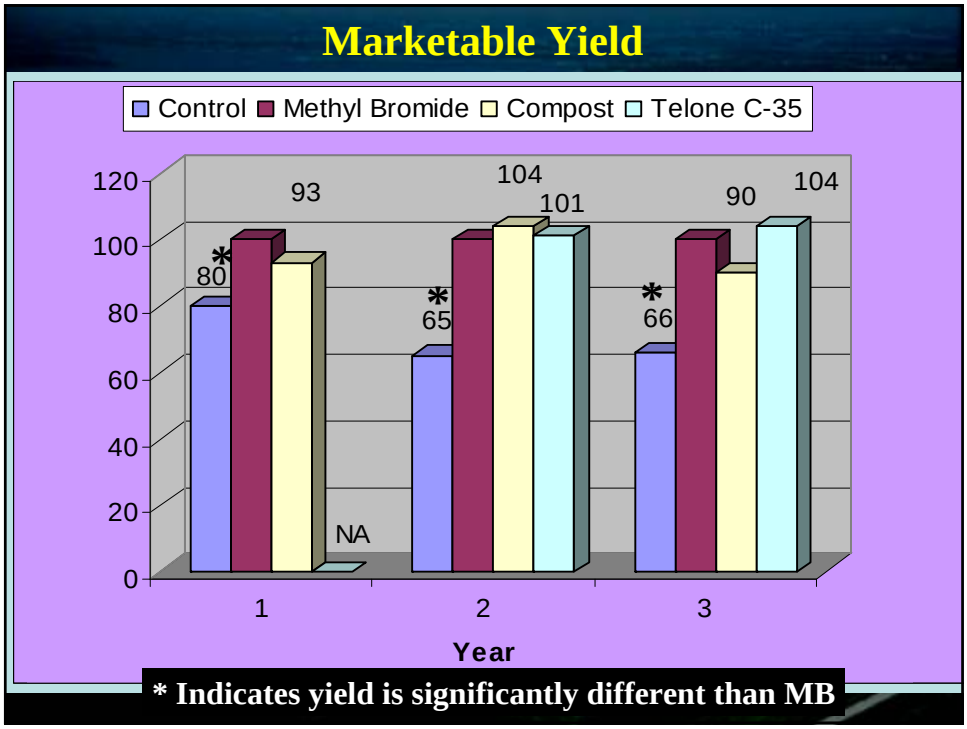
Practice

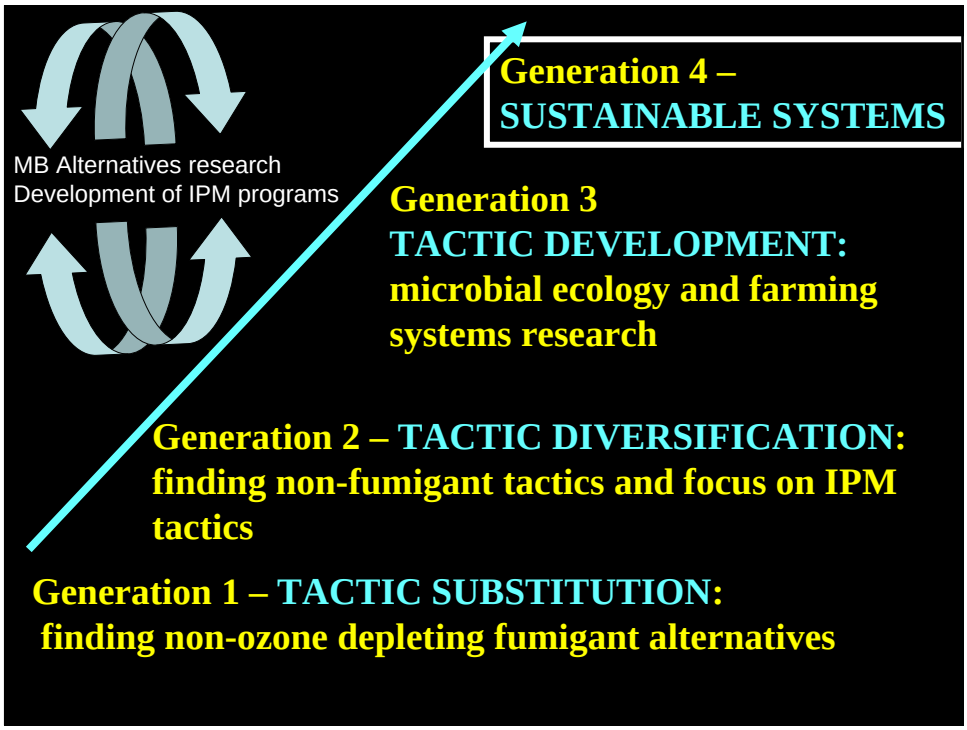
Science

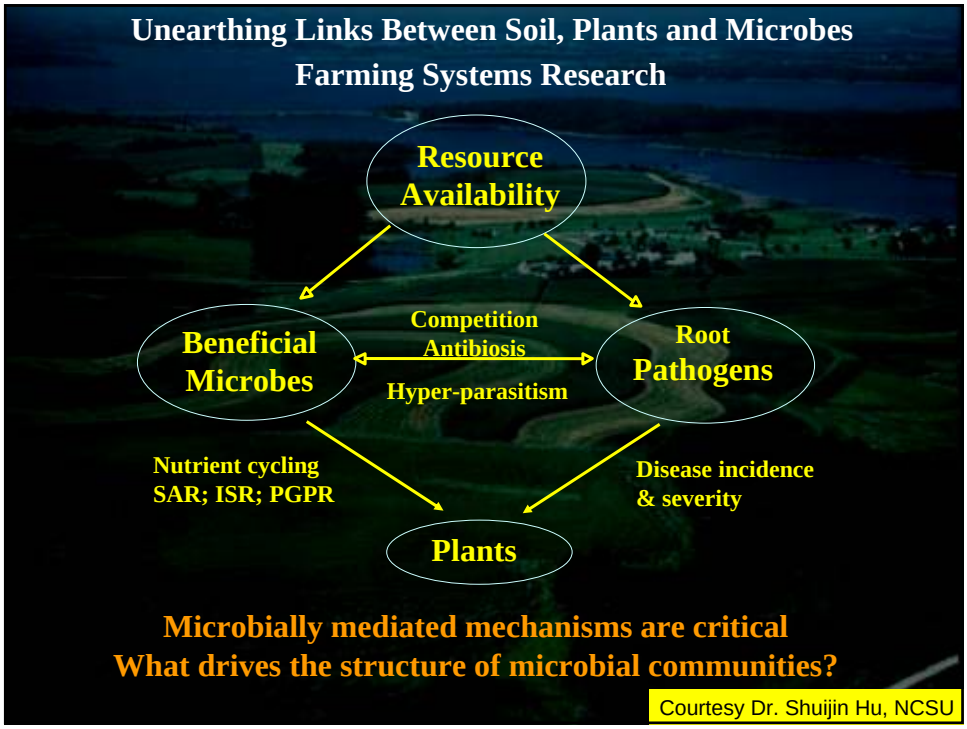
Legume-Grass Cover Crop

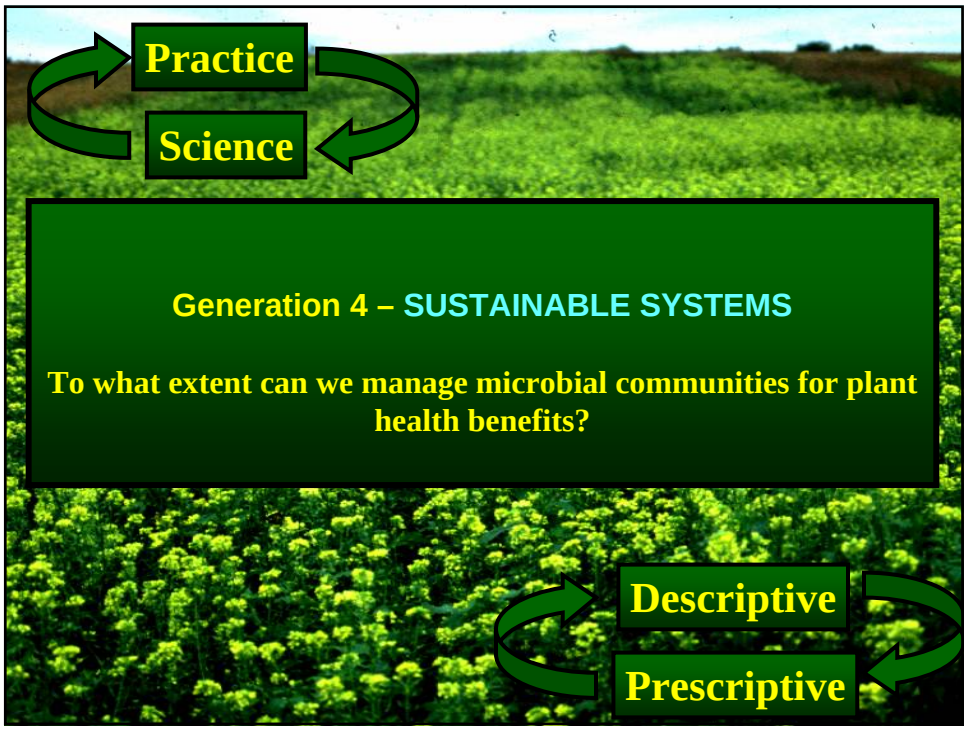


Year 1: 30 yd^3/acre
Year 2: 20 yd^3/acre
Year 3+: 15-20 yd^3/acre


Marketable Yield
Control
Methyl Bromide
Compost
Telone C-35
120
100
80
60
40
20
0
80
*
93
NA
*
65
104
101
*
66
90
104
1
2
3
Year
* Indicates yield is significantly different than MB

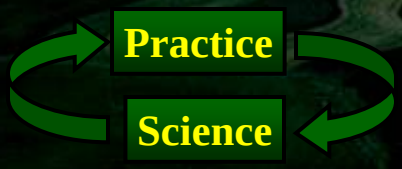

MB Alternatives research
Development of IPM programs
Generation 4 –
SUSTAINABLE SYSTEMS
Generation 3
TACTIC DEVELOPMENT:
microbial ecology and farming systems research
Generation 2 – TACTIC DIVERSIFICATION:
finding non-fumigant tactics and focus on IPM tactics
Generation 1 – TACTIC SUBSTITUTION:
finding non-ozone depleting fumigant alternatives


Unearthing Links Between Soil, Plants and Microbes
Farming Systems Research
Resource Availability
Beneficial Microbes
Competition
Antibiosis
Hyper-parasitism
Root Pathogens
Nutrient cycling
SAR; ISR; PGPR
Disease incidence
& severity
Plants
Microbially mediated mechanisms are critical
What drives the structure of microbial communities?
Courtesy Dr. Shuijin Hu, NCSU


Practice
Science
Generation 4 – SUSTAINABLE SYSTEMS
To what extent can we manage microbial communities for plant health benefits?
Descriptive
Prescriptive

Long Term Question:

Can you design Farming Systems that have suppressive soils and promote plant health?



IPM-based Management