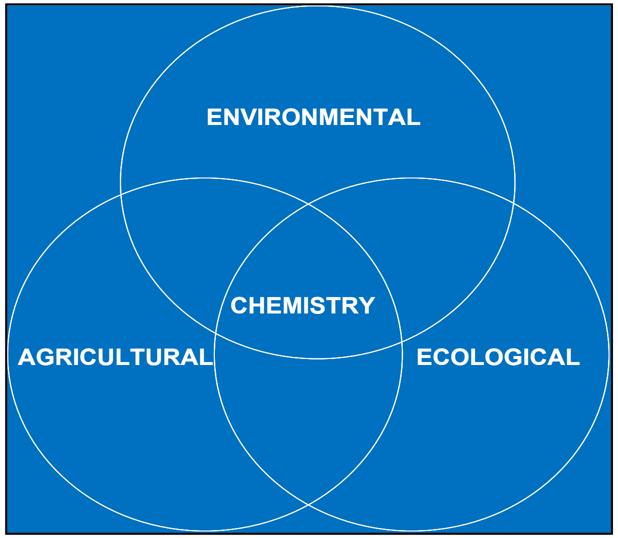
Theory and application of "systems approaches" for the trade of fresh fruit and durables

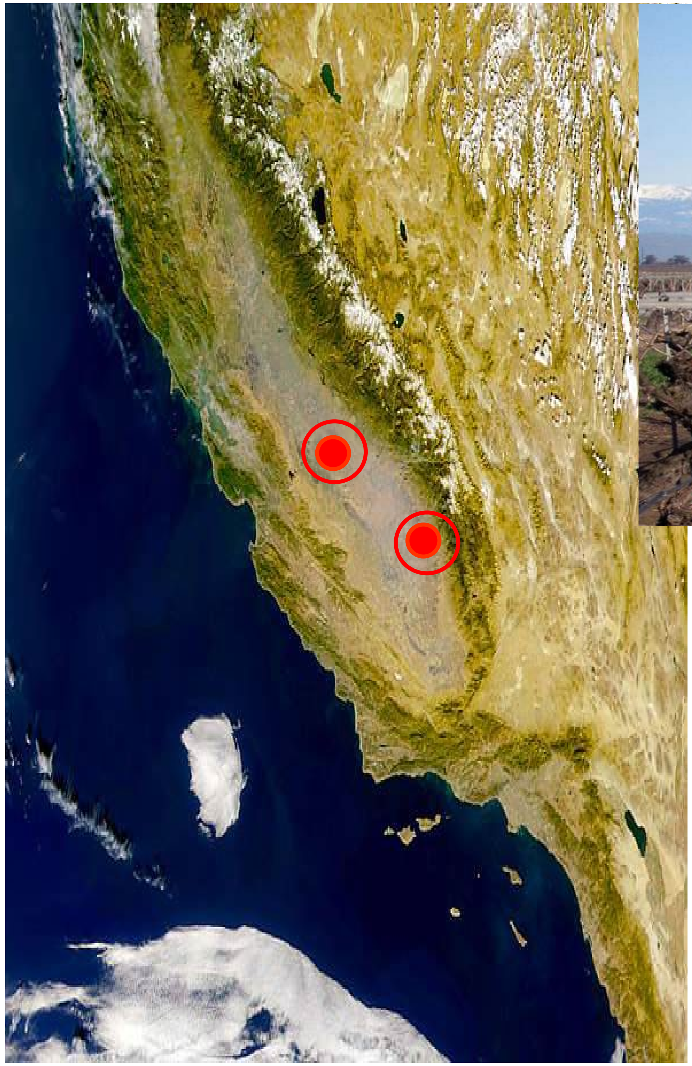
spencer.walse@usda.gov



IPPC ISPM 14 workshop

1 December 2025

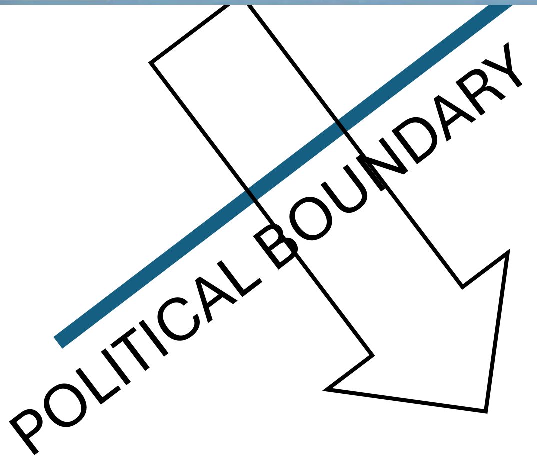
Santiago, Chile



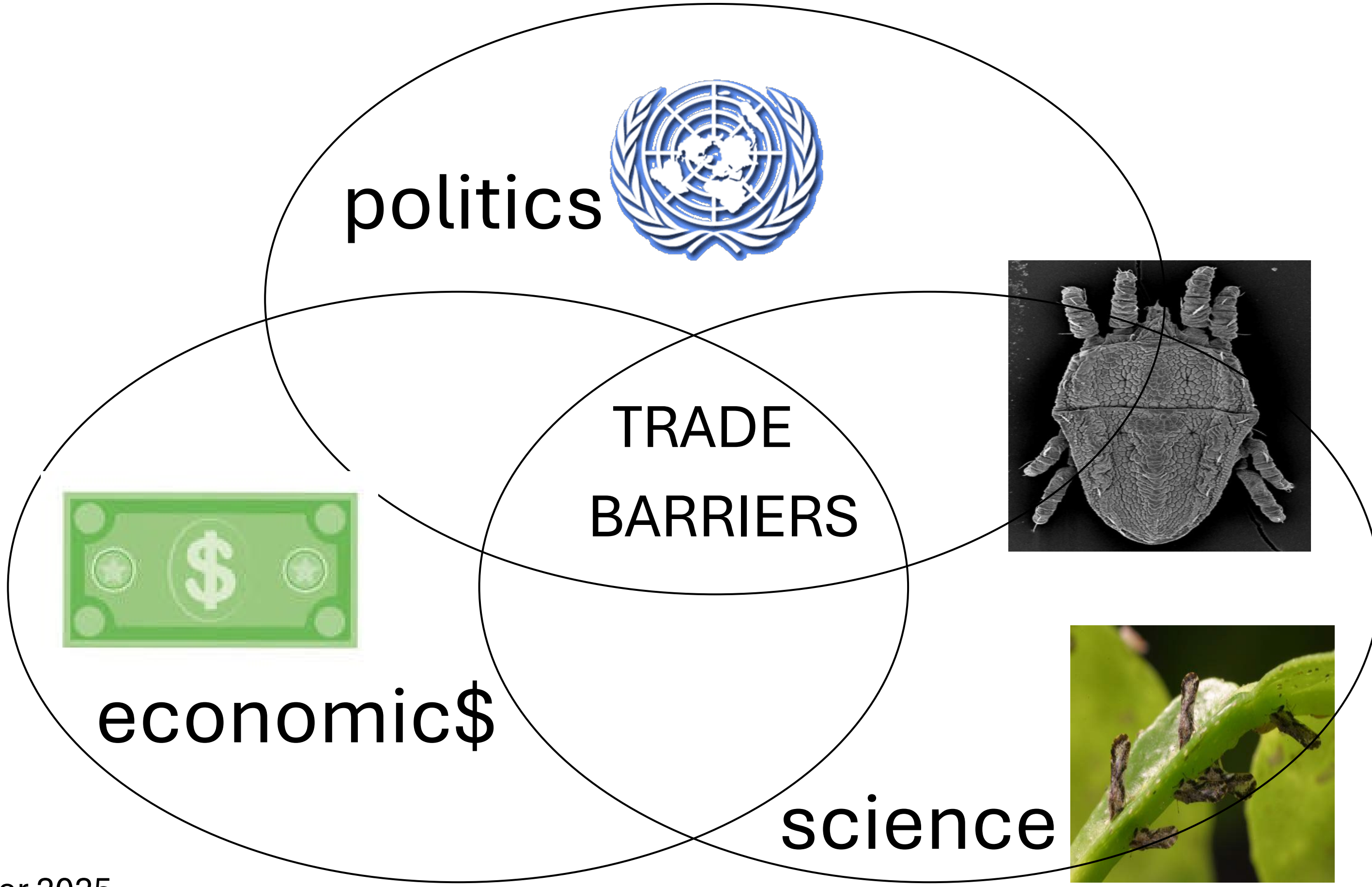
USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

SAN JOAQUIN VALLEY AGRICULTURAL SCIENCES CENTER

"Agricultural Trade"



County
State
Federal
International



Walse group (Proactively) Addresses
<u>Consumer & Regulatory Demands</u>.....

Background....

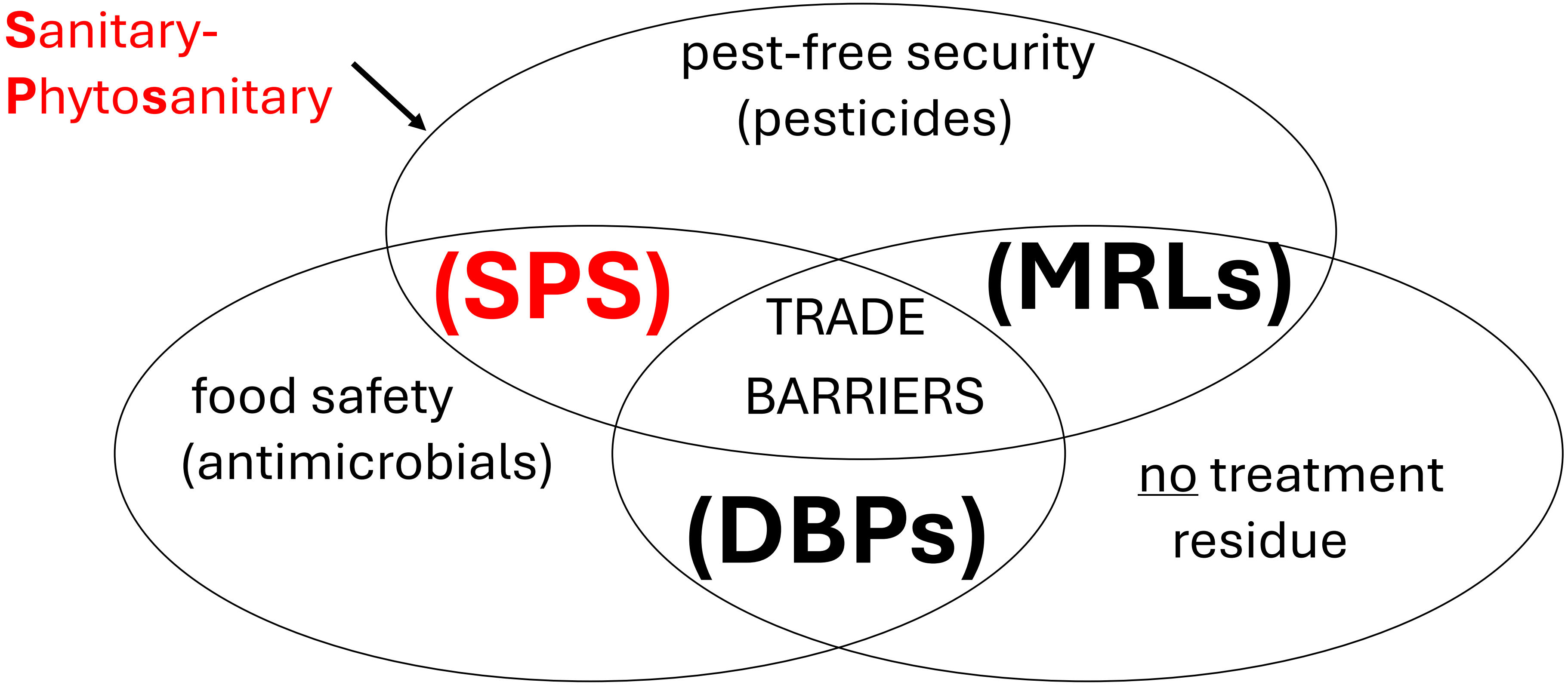
ARS Parlier (proactively) addresses consumer & regulatory demands for the global agricultural market

ARS Parlier trade research directly supports $1- 5 Billion USD annually, the units historic efforts approach Trillions

More effort is needed to address emerging pest issues, esp. pathogens

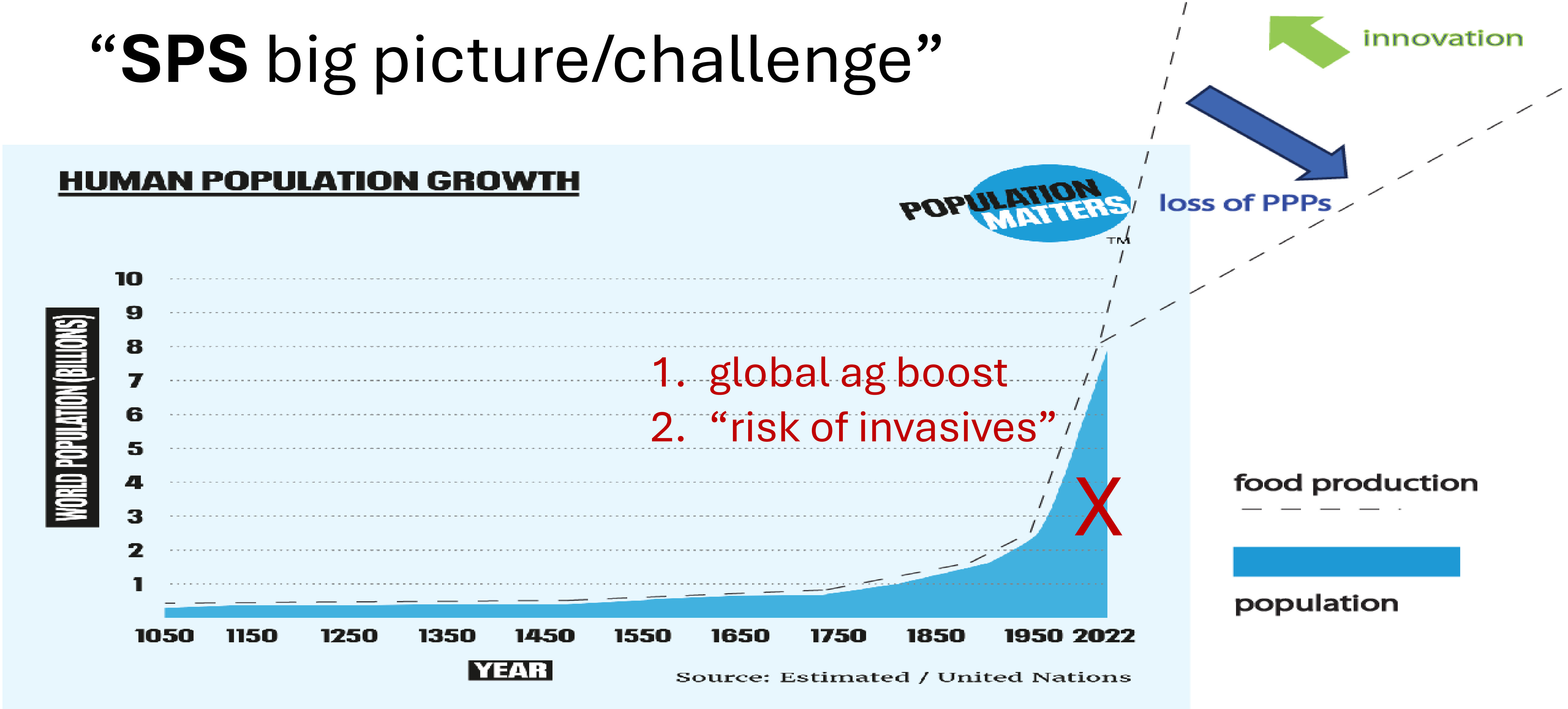
- ARS Parlier trade research critically relies on industry support (>85%)
- 45-55% annually comes from USDA-FAS Technical Assistance

Ag Trade Research Demands



Agricultural Conundrum –must use biocidal chemicals, but can't????
(biologicals)

"**SPS** big picture/challenge"



SPS measures and “Risk”

ARS

USDA

APHIS

- Hazard
- (consequence) X

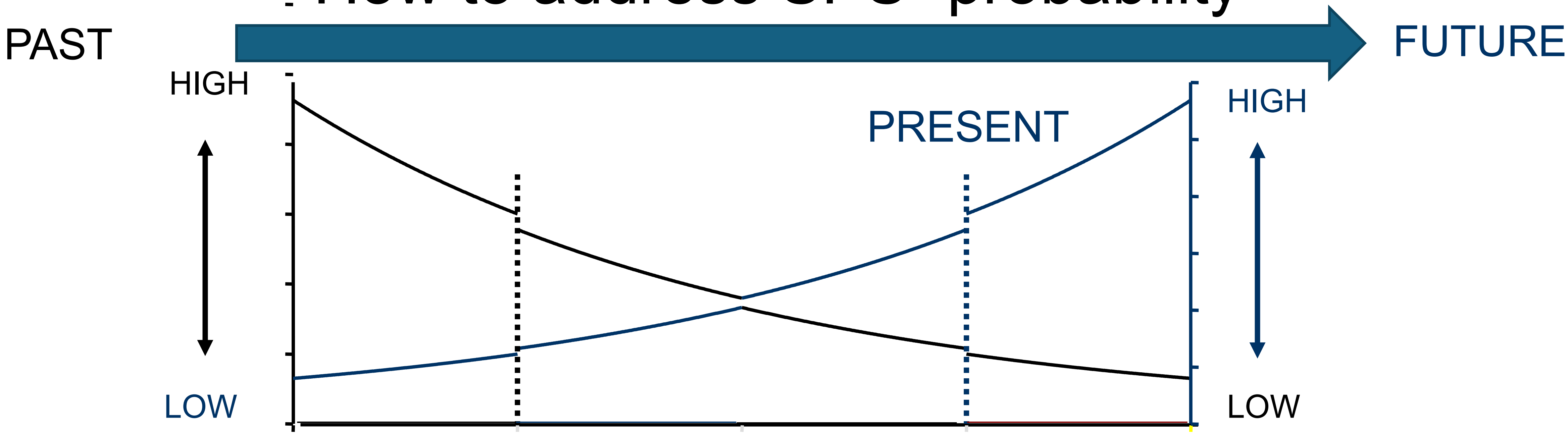
Probability of incidence
(likelihood)

= Risk

Pesticide labels and practices minimize risk associated with the hazard

SPS measures minimize risk associated with the hazard

How to address SPS “probability”



- biological rationales
- qualitative

} expert opinion

- stand-a-lone treatments (e.g., fumigation)
- commodity specificity

- quantitative
- integrative
- multiple measures
- universal

Food and Agriculture Organization of the United Nations

International Plant Protection Convention

USDA

IPPC Global Workshop on Systems Approaches

Biorationale

Old classics

Quarantine Treatments: A Biological Approach to Decision-Making for Selected Hosts of Codling Moth (Lepidoptera: Tortricidae)

P. V. VAIL, J. S. TEBBETS, B. E. MACKEY,[1] AND C. E. CURTIS

Commodity Protection and Quarantine Insect Research Unit, Horticultural Crops Research Laboratory, USDA–ARS, 2021 South Peach Avenue, Fresno, CA 93727

Table 2. Infestation rates of codling moth (CM) in selected hosts

Host	Number of					98.5% Upper CL (no. CM/kg)
	Larvae	Fruit/nut (1000s)	Kg	CM per fruit/nut	CM per kg	
Cherry	2	315,969.4	1,987,229	6.33×10^{-9}	1.01×10^{-6}	4.00×10^{-6}
Nectarine	3	328.0	46,857	9.15×10^{-6}	6.40×10^{-5}	2.02×10^{-4}
Walnut	206	70.5	840	2.92×10^{-3}	2.45×10^{-1}	2.85×10^{-1}

Stand-a-lone "hammer" (& still benchmark?)

...fidence Limits and Sample Size in Quarantine Research

H. MELVIN COUEY[1] AND VICTOR CHEW[2]

FORUM: J. Econ. Entomol. 79: 887–890 (1986)

ABSTRACT Formulas and a table for the calculation of the upper confidence limit for the true unknown survival proportion, based on the number of survivors in quarantine experiments, are presented. The table can also be used to calculate the number of insects that must be treated such that, if s survivors are found ($s = 0, 1, 2, \ldots$), there is $(100\ C)\%$ confidence (where C is between 0 and 1) that the true unknown proportion (p) of survivors for that treatment is less than some preassigned upper limit (p_U).

KEY WORDS quarantine, binomial distribution, Poisson distribution, statistics

99.9968% mort   Probit 9

Baby steps toward compounding (systemic) measures

Alternative to the Use of Probit 9 Mortality as a Criterion for Quarantine Treatments of Fruit Fly (Diptera: Tephritidae)-Infested Fruit

P. J. LANDOLT,[1] D. L. CHAMBERS,[1] AND V. CHEW[2]

Agricultural Research Service, U.S. Department of Agriculture

J. Econ. Entomol. 77: 285–287 (1984)

ABSTRACT Problems with the use of a probit 9 mortality rate as a criterion for quarantine disinfestation treatments for fruit flies (Diptera: Tephritidae) are discussed. We recommend that a maximum infestation level in shipped fruit be set (as an acceptable risk limit) and that this infestation level be used as the criterion for quarantined fruit. The infestation level should be set based on calculations of the probability of a mating pair surviving a shipment.

FORUM

Development of a Maximum Pest Limit for Fruit Flies (Diptera: Tephritidae) in Produce Imported into New Zealand

R. T. BAKER, J. M. COWLEY, D. S. HARTE,[1] AND E. R. FRAMPTON[2]

Lynfield Plant Protection Centre, Auckland, New Zealand

J. Econ. Entomol. 83(1): 13–17 (1990)

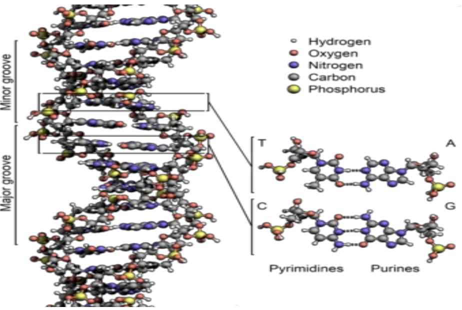
ABSTRACT New Zealand is the only major fruit-producing nation that has remained free of economically important fruit fly species. Maintenance of this status is essential not only to guarantee horticultural exports but also to minimize production costs associated with field control and disinfestation treatments against fruit flies after harvest. To guarantee continued freedom from fruit flies, the concept of a maximum pest limit is developed as an alternative to a very restrictive import policy. The maximum pest limit is defined as the maximum number of immature fruit flies that may be present in consignments imported during a specified time to a specified location. To preclude the establishment of fruit flies, we propose a maximum pest limit of three live larvae per day. Applying a treatment of known efficacy ensures that this limit is not exceeded only if the infestation level is below a predetermined value. We describe a sampling model for accurate assessment of the infestation level and examine the practical implications of setting the maximum pest limit.

RETROspective integration of SPS measures

quantitative

uncertainty — certainty

"Pest control based retrospectively through the point of marketing/consumption"



PREPLANT — PRODUCTION — POSTHARVEST

start — "SYSTEM" — finish

marketing ends at the consumer

Underpinnings:

General rule for the multiplication of independent probabilities (Finney, 1948; Rosenthal, 1978)

Psychological Bulletin
1978, Vol. 85, No. 1, 185–193

"Meta-analysis"

Combining Results of Independent Studies

Robert Rosenthal
Harvard University

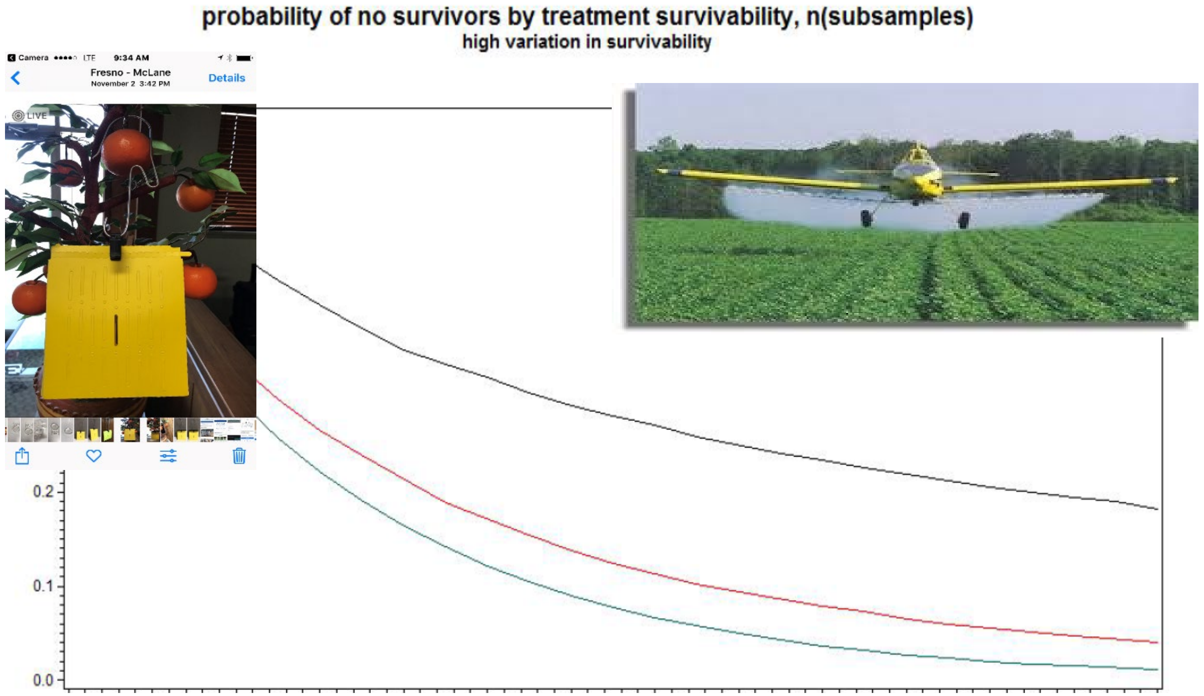
Methods for combining the probabilities obtained from two or more independent studies are described, and their use is illustrated. The methods include adding logs, adding probabilities, adding *t*s, adding *Z*s, adding weighted *Z*s, testing the mean *p*, testing the mean *Z*, counting, and blocking. Selection of one or more appropriate methods is discussed, and the reporting of an overall estimated effect size to accompany the overall estimated probability is recommended.

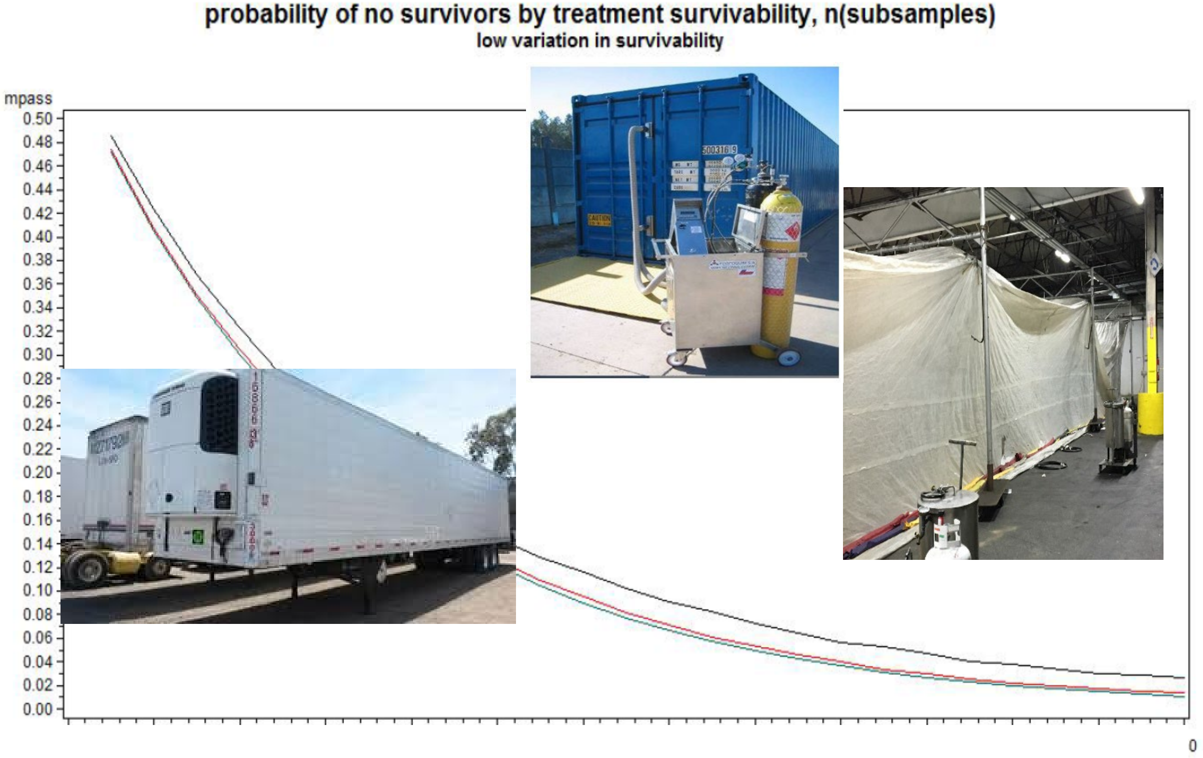
$$P(E_1 + E_2 + En) = 1 - (1 - P(E_1))(1 - P(E_2))(1 - P(En))$$

Rule for the multiplication of conditional probabilities

$$P(E_b|E_a) = \frac{P(E_a \text{ and } E_b)}{P(E_a)}$$

"SPS (quarantine/trade) solutions" are critically linked to postharvest, even "systems-approaches"





trial reps (n): —— 1; —— 5; —— 95,000

high dispersion - *variance* (field treatment)<<<<<<

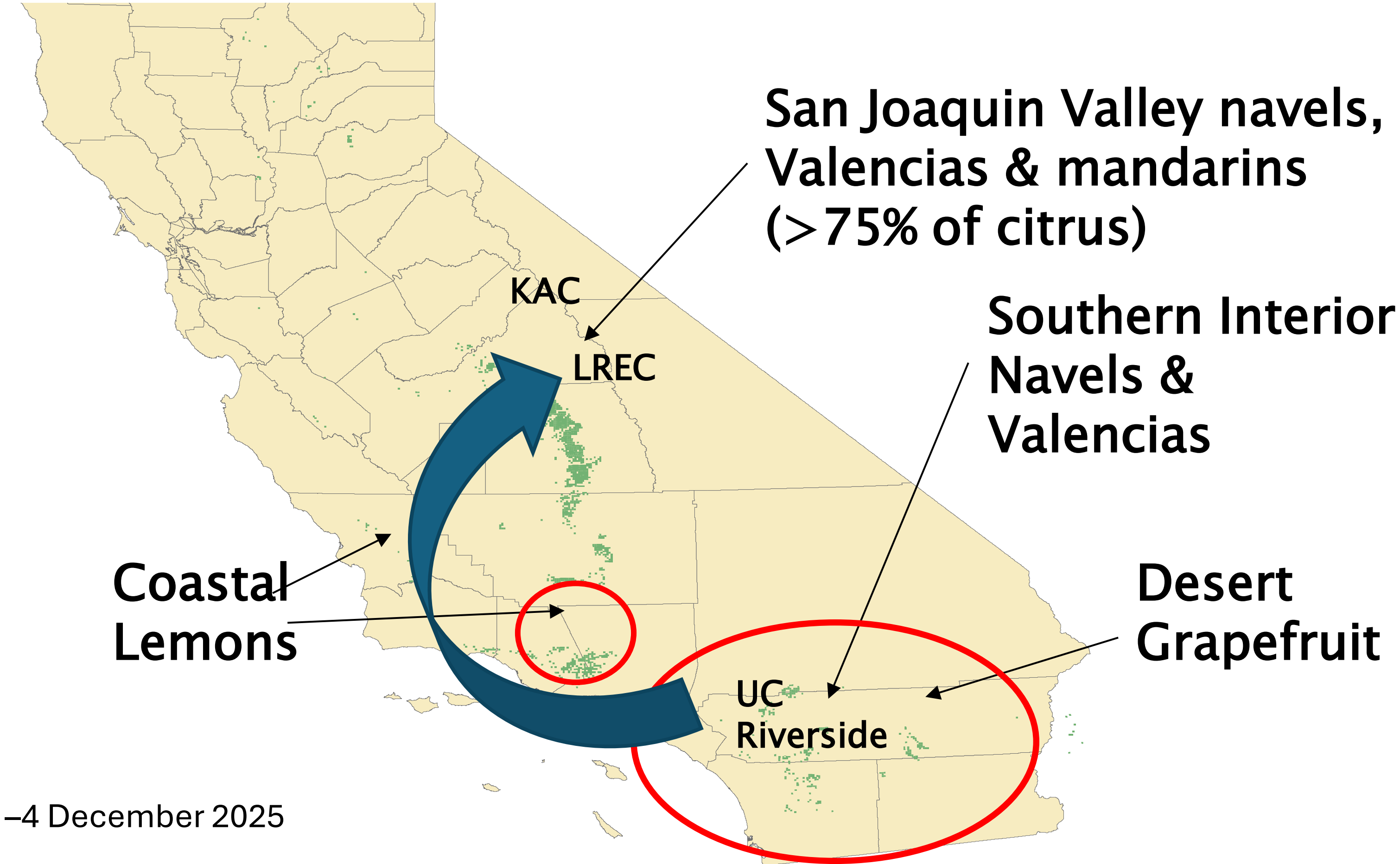
relatively difficult to control pest

low dispersion - *variance* (fumigation)

relatively easy to control pest

Diaphorina citri – Asian citrus psyllid

Need to be removed from fruit



"ACP packinghouse project" (domestic quarantine implications)

Table 1. Adult ACP treatment results for several commercial protocols for cleaning and packing in California.

Treatment	*n* trials	*n* psyllids	*n* psyllids on fruit	*n* psyllids alive on fruit	*n* psyllids escaping (lids/walls)	% mortality
[1]Dunking						
Dunking only	40	2000	6	6	--	0.997
[2]Soaking						
Ambient water	40	2000	0	0	26	0.987*
Ambient chlorine	40	2000	0	0	18	0.991*
Heated soda ash	40	2000	0	0	10	0.995*
[3]Brushes						
Brushes only	36	1782	27	9	--	0.995
w/flooder	40	2000	11	8	--	0.996
w/pressure washer	106	5120	5	0	--	1
[4]Rollers						
Rollers only	40	2000	103	10	--	0.995
w/flooder	40	2000	2	2	--	0.999
w/pressure washer	100	5000	0	0	--	1
[5]Hot air						
t = 30 s	6	136	--	54	--	0.603
t = 60 s	6	140	--	12	--	0.914
t = 90 s	6	141	--	4	--	0.972
t = 135 s	28	738	--	14	--	0.981
t = 165 s	14	342	--	3	--	0.991

[1]Removal of adult ACP by dunking infested fruit in soak tank water for 1 s

[2]Adult ACP removal from fruit into recirculating tanks containing (1) ambient tap water, (2) an ambient solution of 100 ppm chlorine

Systems evaluation

joint events	% mort. (95% LOC)	$P(E_1+E_2+E_n)$ (95% LOC)	probit (95% LOC)
Σ soak + brushes	99.999560	4.4 E-6	9.44
Σ soak + rollers	99.999577	4.2 E-6	9.45
Σ soak + dryer-135s	99.998520	1.5 E-5	9.18
Σ soak + brushes + dryer-135s	99.999987	1.3 E-7	10.15
Σ soak + rollers+ dryer-135s	99.999987	1.3 E-7	10.16

Exceeding “Probit 9” benchmark
without postharvest fumigation

"holistic" system example: fruit flies

Table 1. Summary of treatment results as probabilities and probit analyses

Event $(E)_x$		$P(E_x)$ (95% CL)	Mortality (%) (95% CL)	Probit (95% CL)
(E_1) standard management practices (SMP)*		≤ 0.4589‡	-	5.10
(E_2)	24-h PH3 fumigation	0.0203	97.97	7.05
(E_3)	48-h PH3 fumigation	0.0059	99.41	7.52
(E_4) 24-h PH3 fumigation → 5-d cold at 10°C		0.00033	99.97	8.41
(E_5) 48-h PH3 fumigation → 5-d cold at 10°C		0.00008	99.99	8.79

*[protein-bait trapping surveillance of tephritids; insecticide sprays; grove sanitation, packline procedures to remove surficial insect and fungal pests, safeguarding packed limes]

‡ Probability of a mating pair in a container based on an infestation rate of 0.000021, 1 fly in 45,959 limes.

"classical" multiplication of independent probabilities					Landolt-Poisson!	
	Joint events	$P(E_1 + E_x)$	Mortality (%) (95% CL)	Probit (95% CL)	P Infest & treatment	Probit (95% CL)
$(E_1 + E_2)$	SMP + 24-h PH3	0. 00934	99.0661	7.35	0.000615	8.23
$(E_1 + E_3)$	SMP + 48-h PH3	0. 00271	99.7290	7.78	0.000041	8.94
$(E_1 + E_4)$	SMP + 24-h PH3 → 5-d cold at 10°C	0. 000152	99.9848	8.61	1.29×10^{-7}	10.15
$(E_1 + E_5)$	SMP + 48-h PH3 → 5-d cold at 10°C	0.000034	99.9966	8.98	7.63×10^{-9}	10.66

! $P = [1 - e^{-NFT/2}]^2$ where R = 0.000021, N = 104,000, T = $P(E_X)$ from Table 1 above. reference USDA 1997, pg. 19.

Food and Agriculture Organization of the United Nations

International Plant Protection Convention

IICA

SAG

cosave
Comité de Sanidad Vegetal del Cono Sur

IPPC Global Workshop on Systems Approaches

Santiago, Chile

1 – 4 December 2025

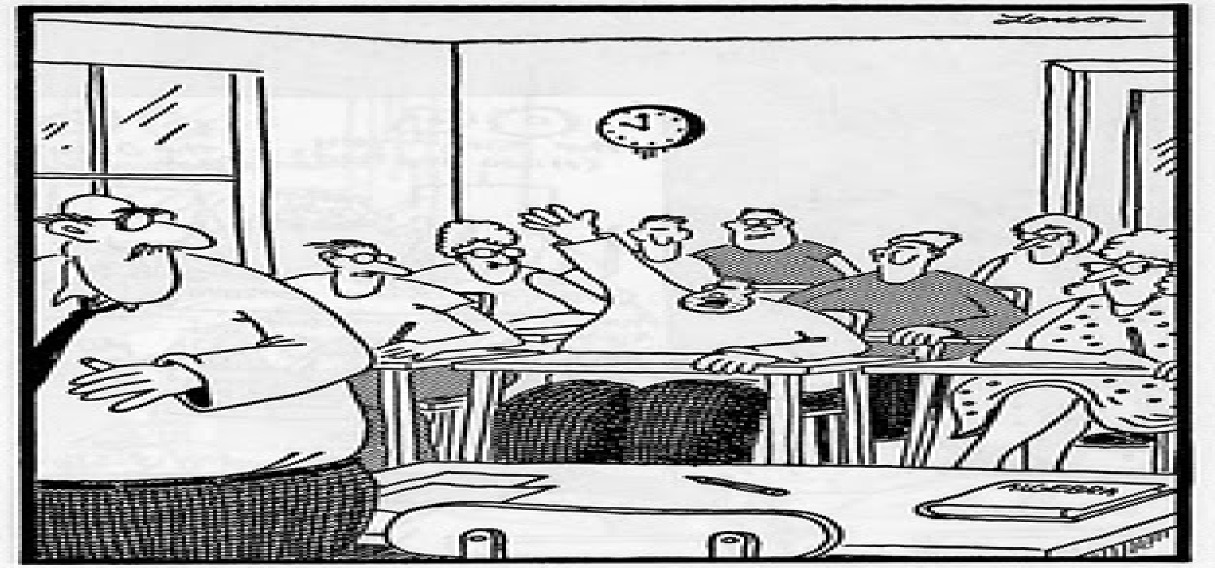
In partnership with:

USDA

Canada

Australian Government
Department of Agriculture, Fisheries and Forestry

Thank you



"Mr. Osborne, may I be excused? My brain is full."