Cooperation is the key to combat grapevine viruses

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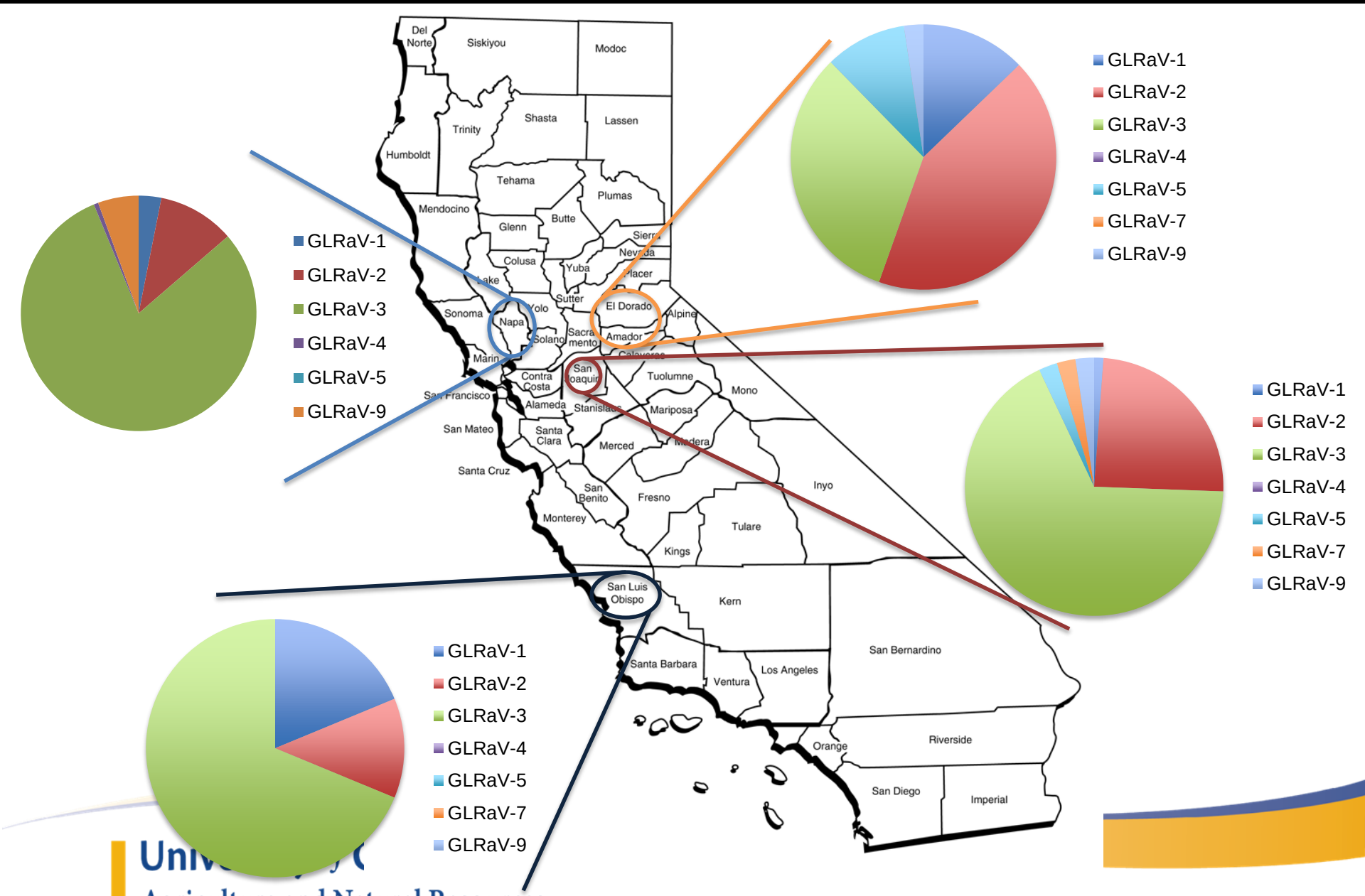
Activities since 2010

- Developed model for ***within***-block spread of GLRaV-3
  - –Basis of advice about leafroll management in new plantings
  - –Basis of sampling schemes for disease detection
  - –Provide sampling support (design/analysis) to growers and nurseries
- Sensitivity analysis of production system to sources of infected material and spread ***between*** blocks
  - –Used to prioritize research/outreach work
- Characterized attitudes to virus management and clean planting stock
  - –Used to highlight obstacles to cooperation for area-wide control
  - –Help to facilitate and support Oakville LAMBA mealybug management group
- Expert input to grape R&C program re-write

What did we find?



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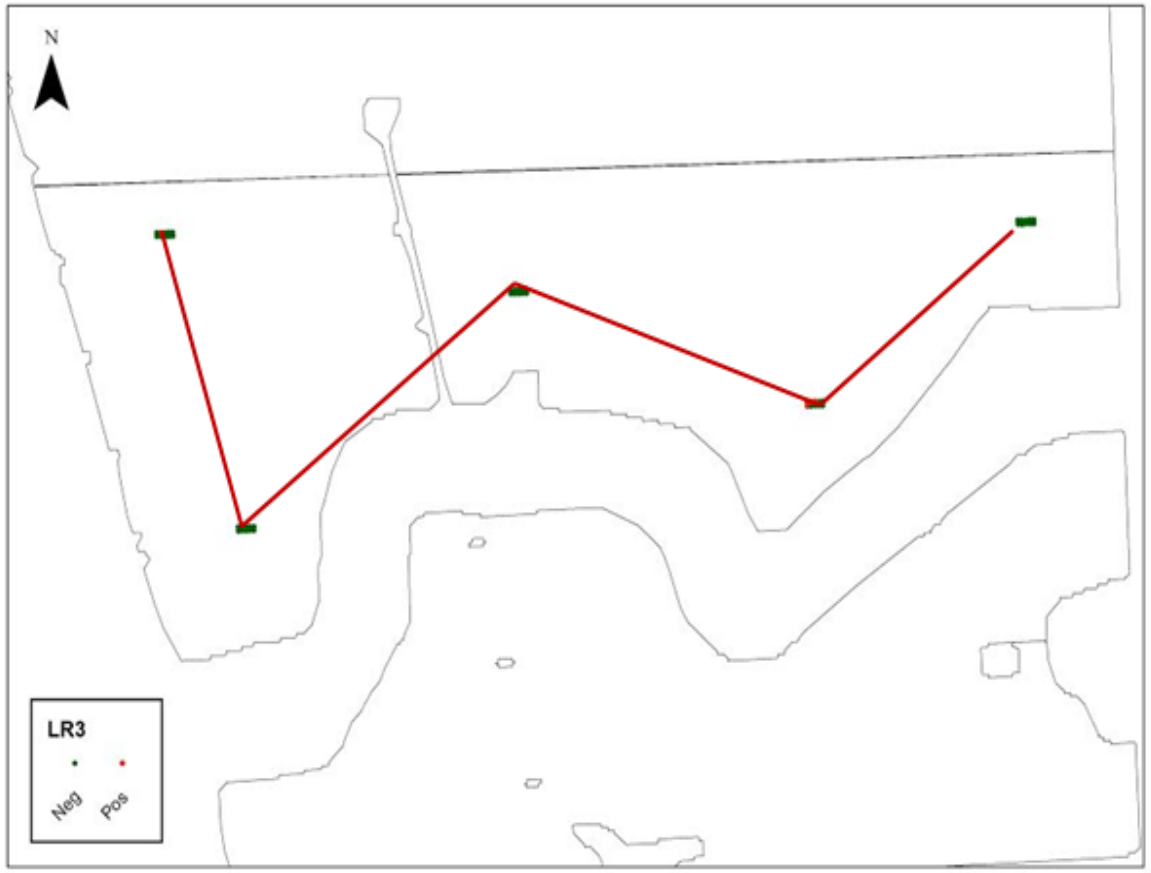
Data from Dr Rodrigo Almeida, UC Berkeley

Case Study



Grower decided to test using this structure:

- 5 sets (quadrats)
- 10 samples (n=10) in each set

Row	XXXXX
Row	XXXXX

- Each vine individually tested
- "W" formation throughout field block
  - "X" works too

Where are the positives?

GRBaV

15 positive of 50, approx. 15%

5 Quadrats of 10:

Quadrat	# Positive
1	3/10
2	2/10
3	0/10
4	0/10
5	10/10

GLRaV-3

5 positive of 50, approx. 5%

5 Quadrats of 10:

Quadrat	# Positive
1	1/10
2	0/10
3	0/10
4	0/10
5	4/10

GRBaV in the given samples

BINOMIAL

Fit Statistics	
-2 Log Likelihood	43.9
AIC (smaller is better)	45.9
AICC (smaller is better)	47.2
BIC (smaller is better)	45.5

Label	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
p	0.3	0.06481	5	4.63	0.0057	0.05	0.1334	0.4666

BETA-BINOMIAL

Fit Statistics	
-2 Log Likelihood	19.4
AIC (smaller is better)	23.4
AICC (smaller is better)	29.4
BIC (smaller is better)	22.6

Label	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
p	0.3519	0.1738	5	2.02	0.0988	0.05	-0.09483	0.7986
alpha	0.1928	0.1709	5	1.13	0.3105	0.05	-0.2465	0.6321
beta	0.3551	0.3511	5	1.01	0.3582	0.05	-0.5474	1.2576
rho (intraclass corr.)	0.646	0.2017	5	3.2	0.0239	0.05	0.1277	1.1644

If you don't find it, is it really not there?

$$\Pr(X = 0) = (1 + n\theta)^{-N\frac{p}{\theta}}$$

Probability of not detecting disease if true vine incidence is p, group size is n and N groups of tests are made

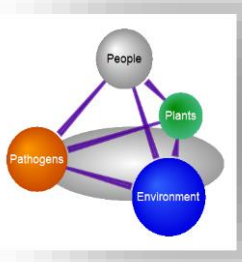
$$p = -\theta \cdot log(P)/N \cdot \log(1 + n\theta)$$

Maximum true vine disease incidence that could result in zero positives, given group size n, N groups, with probability P.

$$N = -\theta \cdot log(P)/p \cdot \log(1 + n\theta)$$

Sample size required to generate zero positives, given group size n and true disease incidence p, with probability P. Larger samples will give one or more positives

Yountville-Oakville neighborhood group



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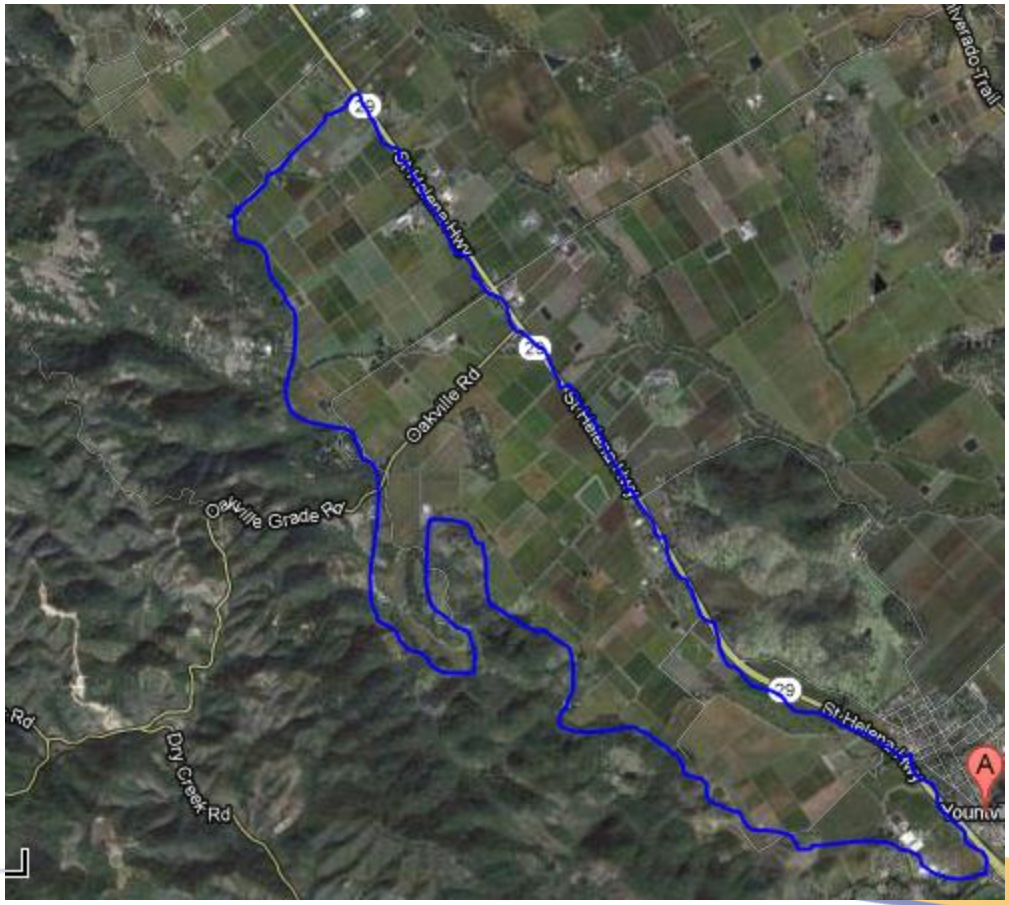

Mealybug counts
Discussion on control
Interest in virus testing and detection

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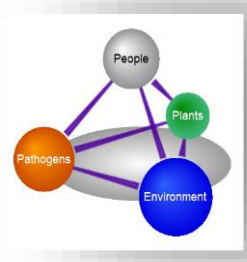

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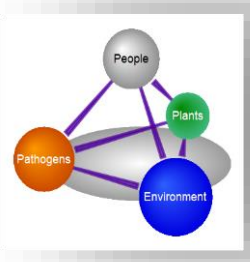
Grape leaf roll

Spatial and temporal progress



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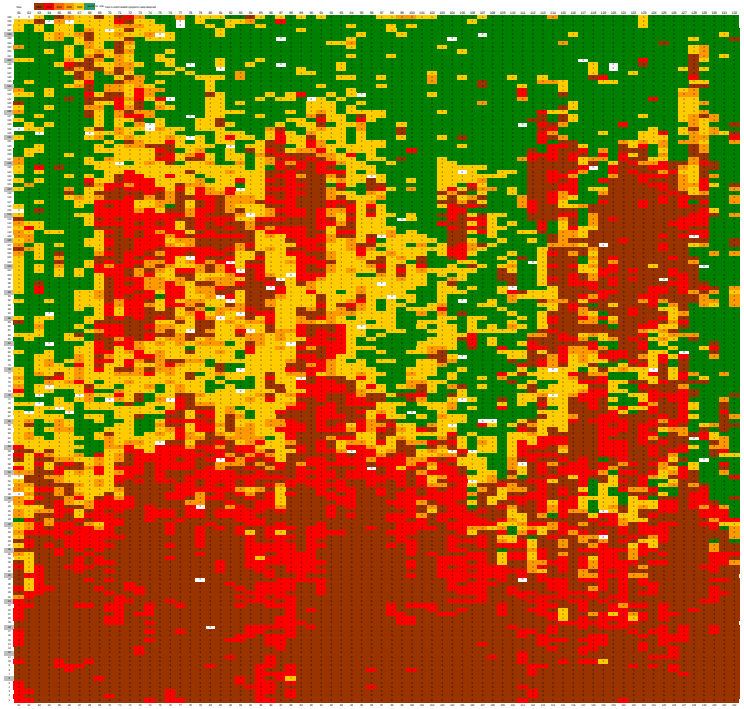
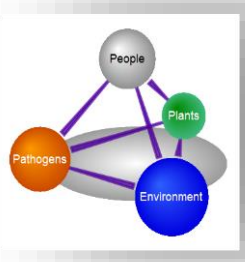
2007 Oakville study



Leafroll Incidence

2002	23.3%
2003	41.2%
2004	45.8%
2005	49.8%
2006	66.1%

Between block infection causes shared costs and responsibilities



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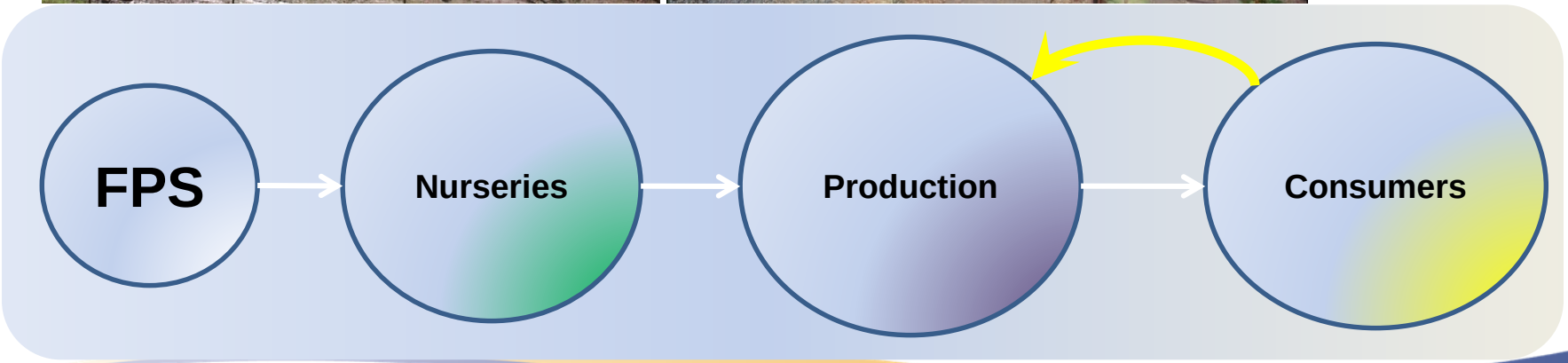
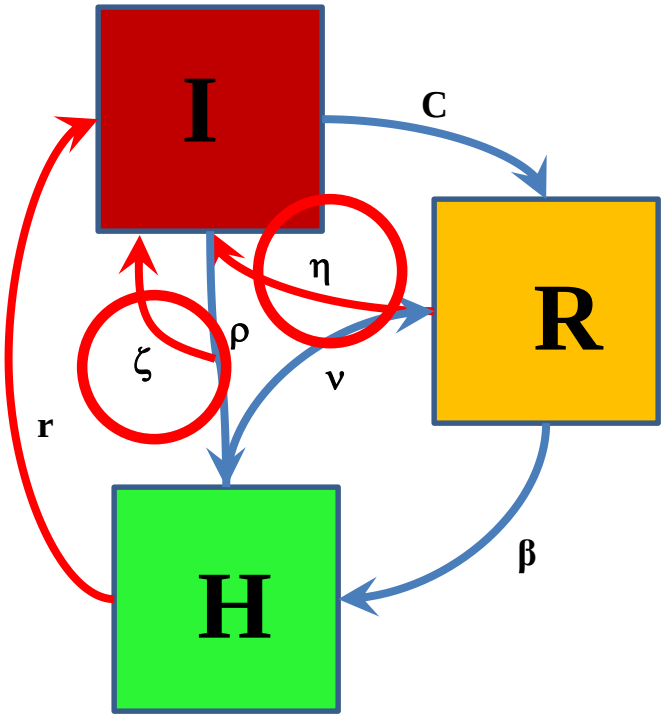


Inter-block meta-population model



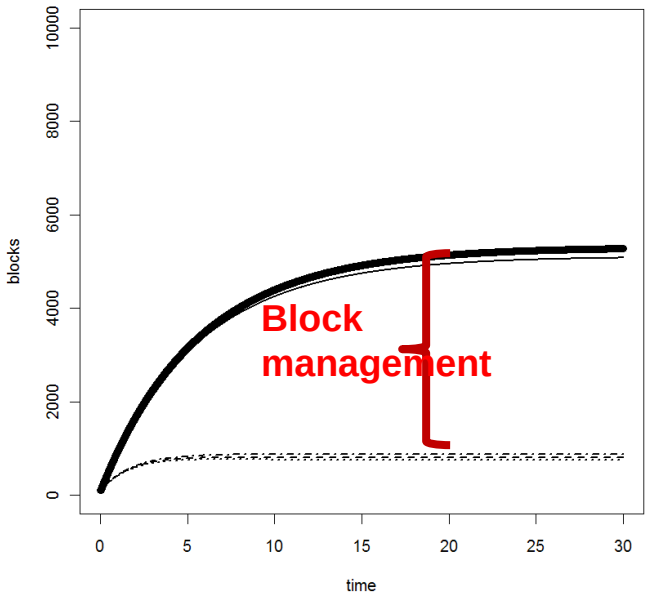
$$\frac{dI}{dt} = rH + \eta R - cI - (1-\zeta)\rho I$$

$$\frac{dH}{dt} = \beta R + (1-\zeta)\rho I - rH - \nu H$$

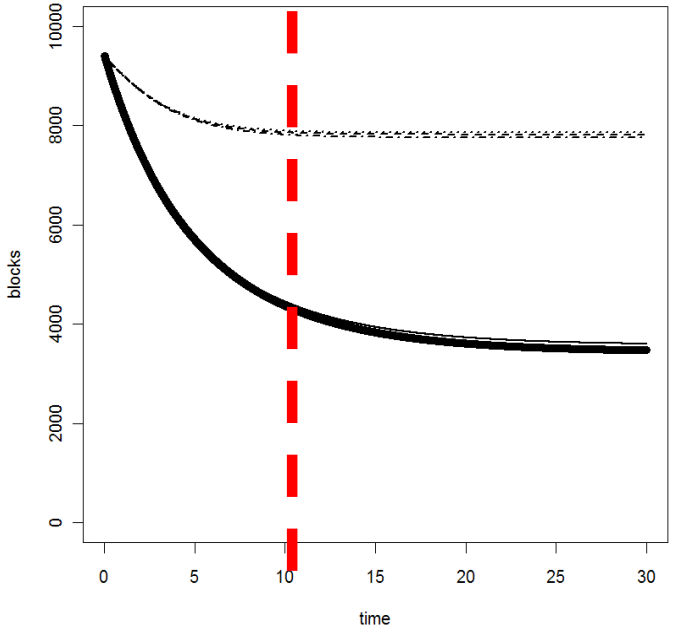
$$\frac{dR}{dt} = cI + \nu H - \beta R - \eta R$$

What drives the leafroll epidemic regionally?

Infected

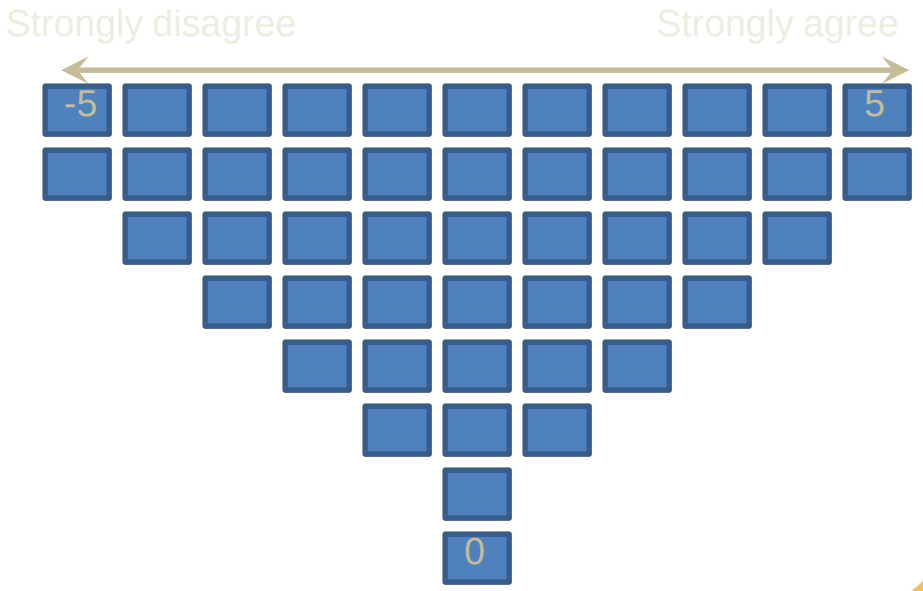


Healthy

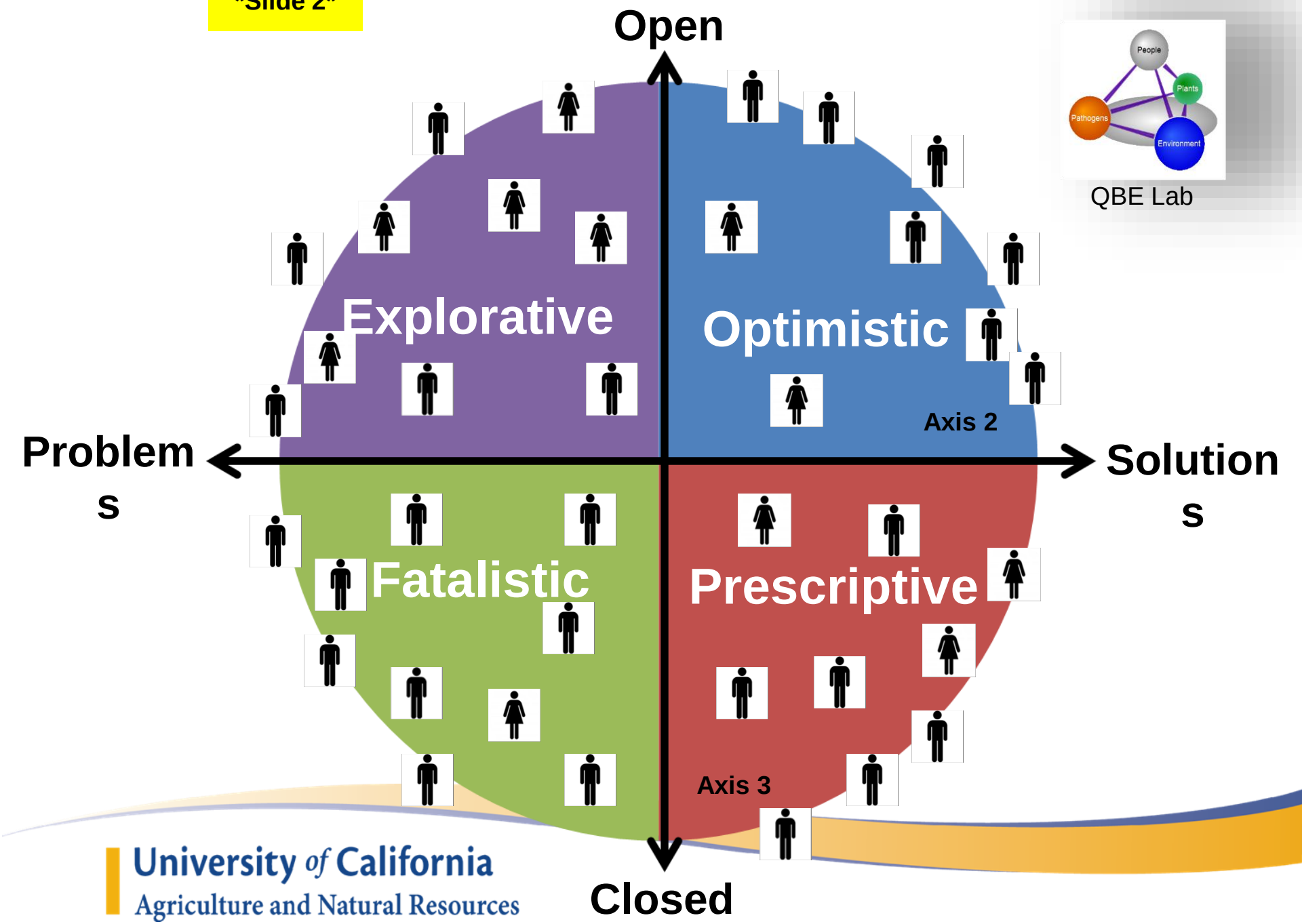


Q-method study

- Q-method: Study of subjectivity
- Workshops to generate discourse (3)
- Extraction of a set of characteristic statements (47 from discourse)
- Ranking of statements by participants in Q-sort (37)
- Statistical analysis



Slide 2



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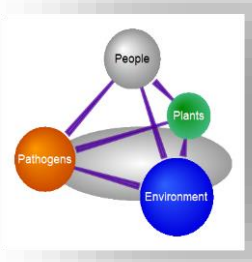
Slide 1



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Solutions

Tacticians

Financial

Axis 1

Technical

Strategists

Axis 2

Problems

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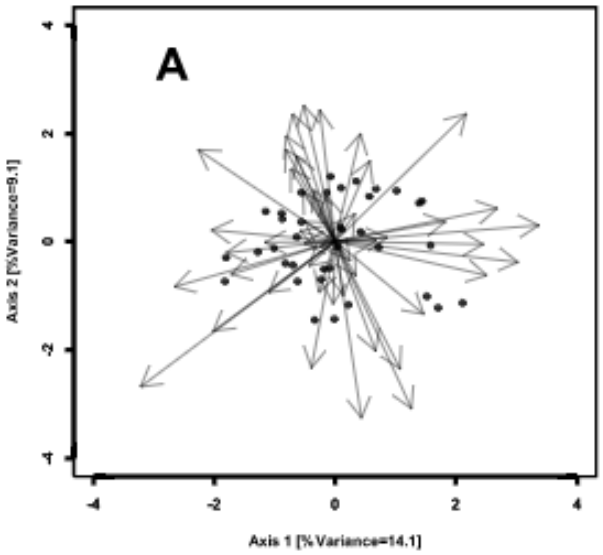
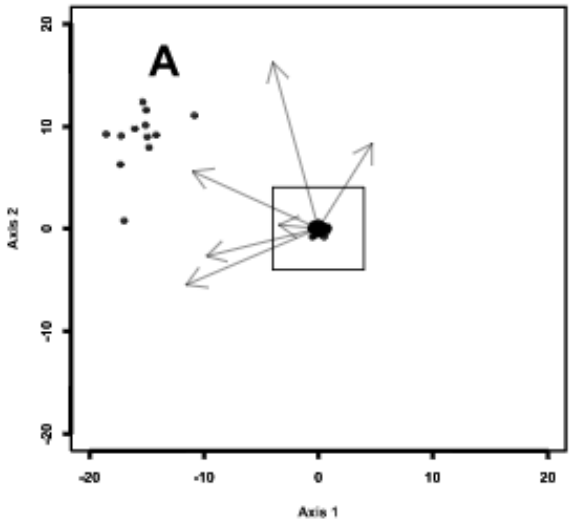
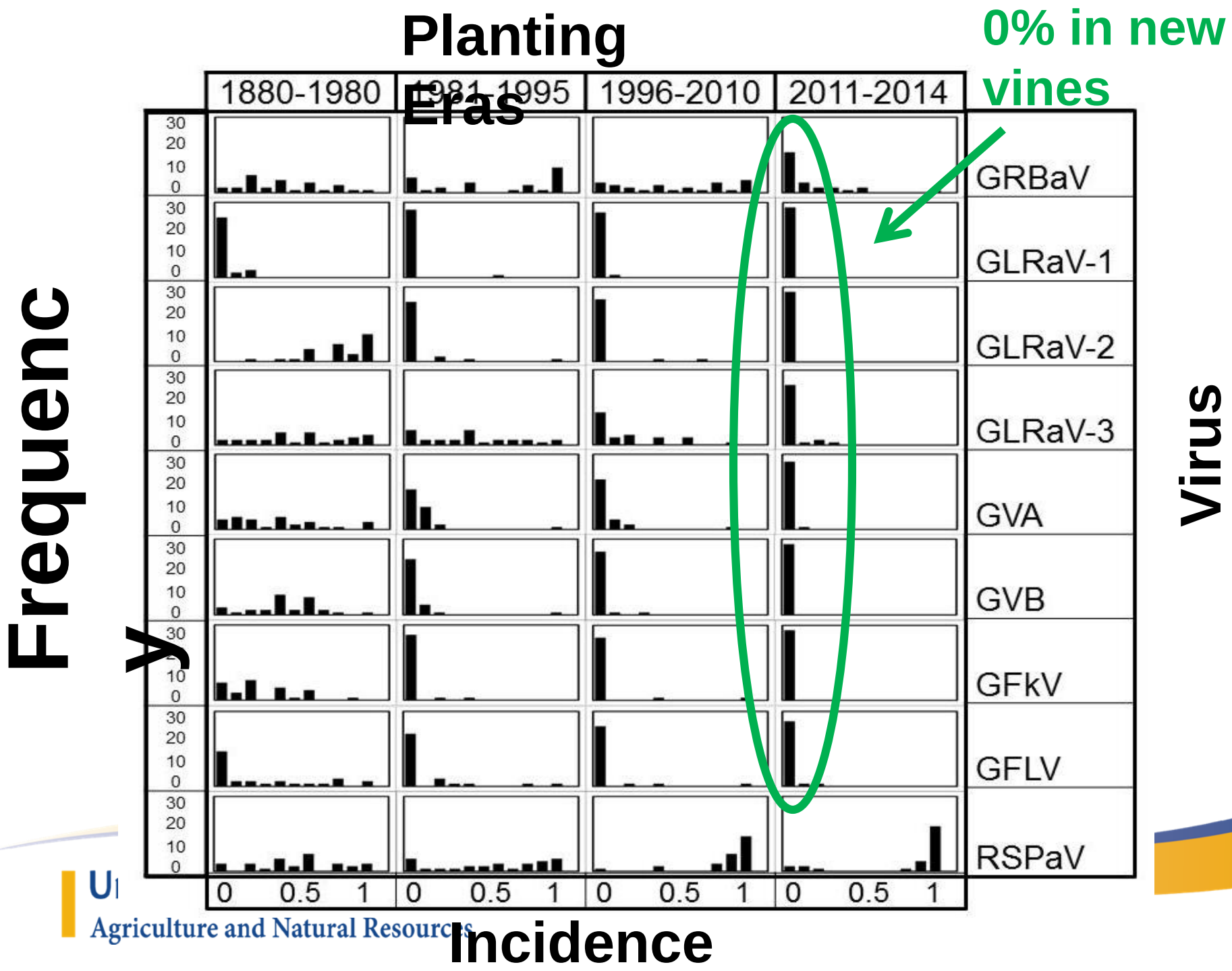
Diversity among growers/winemakers with respect to leafroll management and clean plant programs



But they're all close together when we include nursery stock producers in the same analysis





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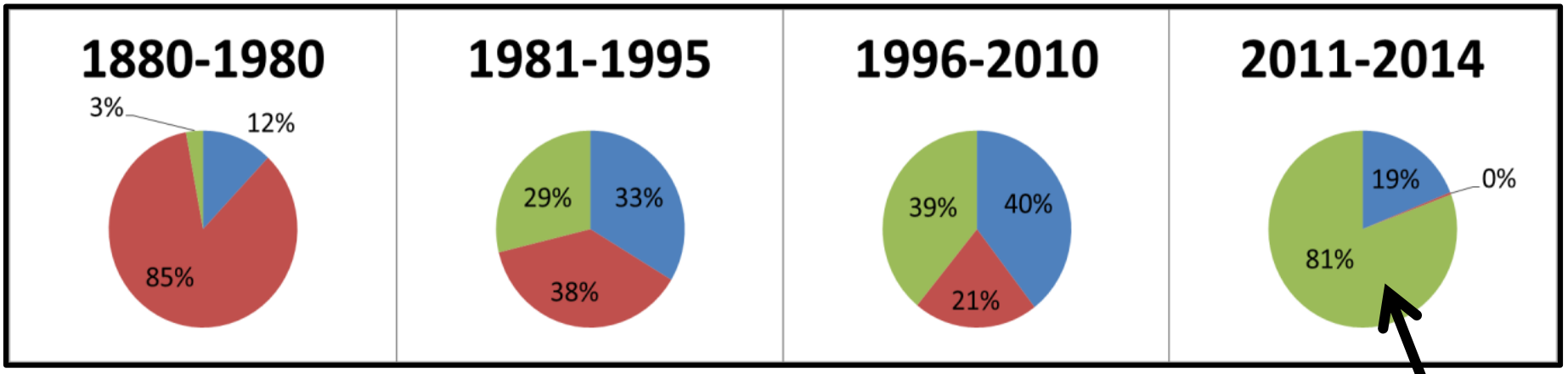
Mixed vs. Single Infections



Mixed

Single

Healthy

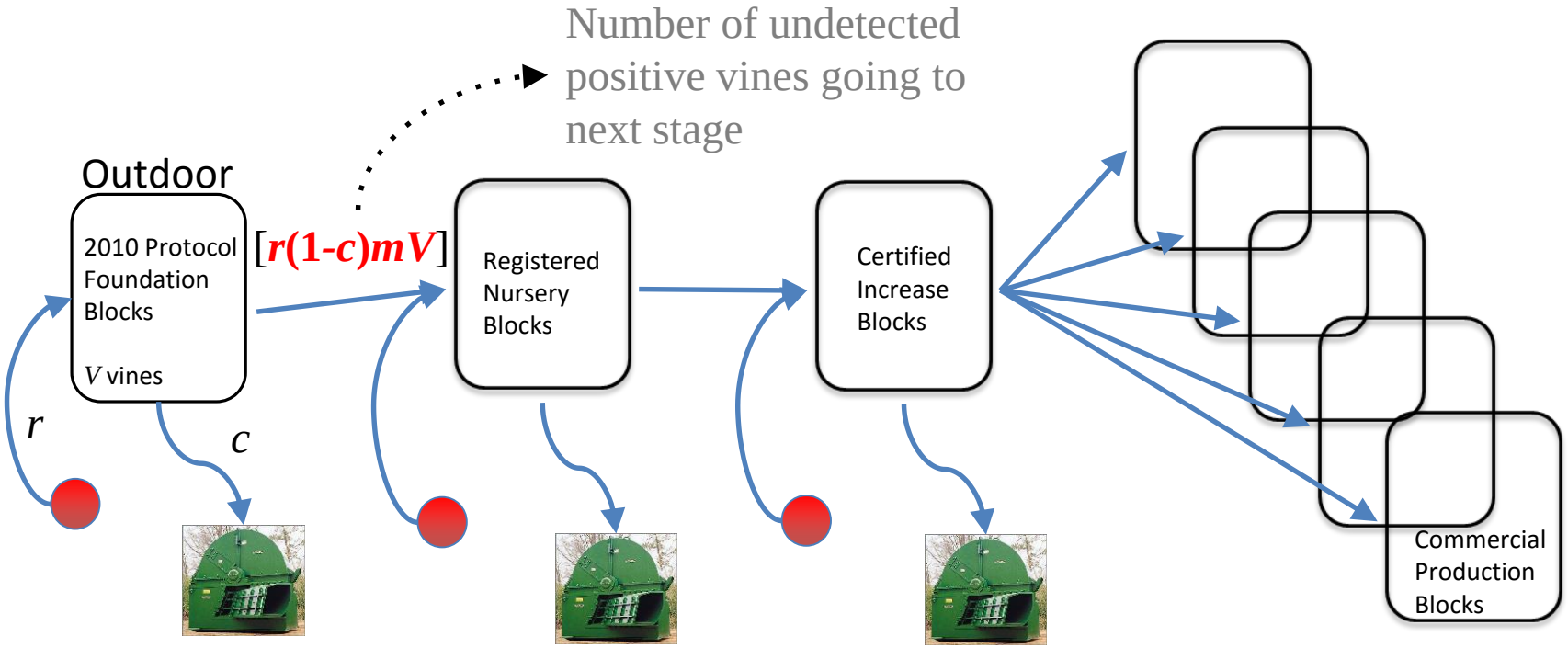
Single Infections are predominantly leafroll or red blotch

*Figure excludes RSPaV

Consistent agreement in subjectivity study

- *Virus tested nursery stocks are very important, I think we always have reservations and doubts in the back of our mind when we are sourcing material from any situation.*
- *Leafroll matters because it affects grape quantity and quality; therefore, vine quality and cost.*
- *Leafroll matters because of its possible transmission to a previously healthy vineyard, putting other blocks, growers/producers at risk.*
- *Virus tested nursery stocks play a critical role in obtaining clean plant material. The continual retesting of mother blocks is also paramount to moving toward less leafroll in the field.*
- *Planting clean stock would be a good start for an effective leafroll disease management program, and then removing any host plants in the surrounding area.*
- *Virus tested nursery stocks are extraordinarily important. I feel it should almost be mandatory and expected.*

The certification discussion and the future: Education is the key



$c = d \times tpp$

d = probability of detection (sampling) = $f(n,N,p,\theta)$

tpp = diagnostic true positive proportion

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