# The Penn State Method for Pathogen Matching

Forrest W. Nutter, Jr.

Epidemiologist

Department of Plant Pathology

Iowa State University

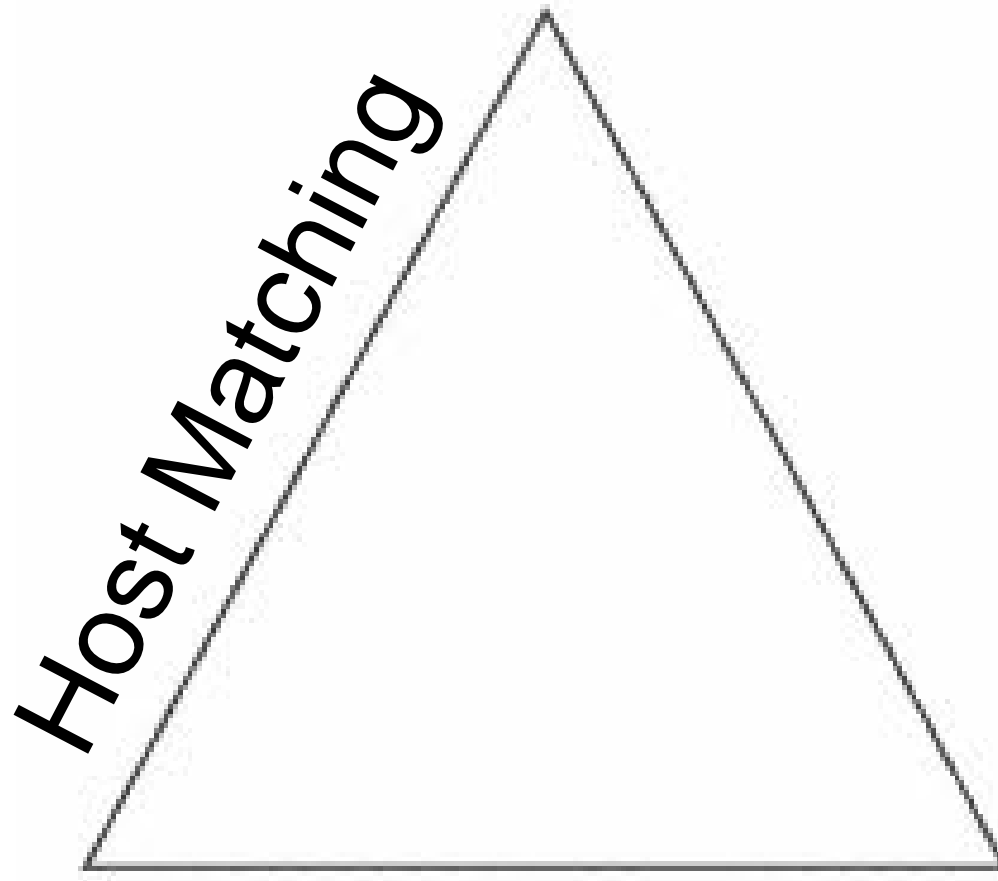National Plant Disease Recovery System Meeting
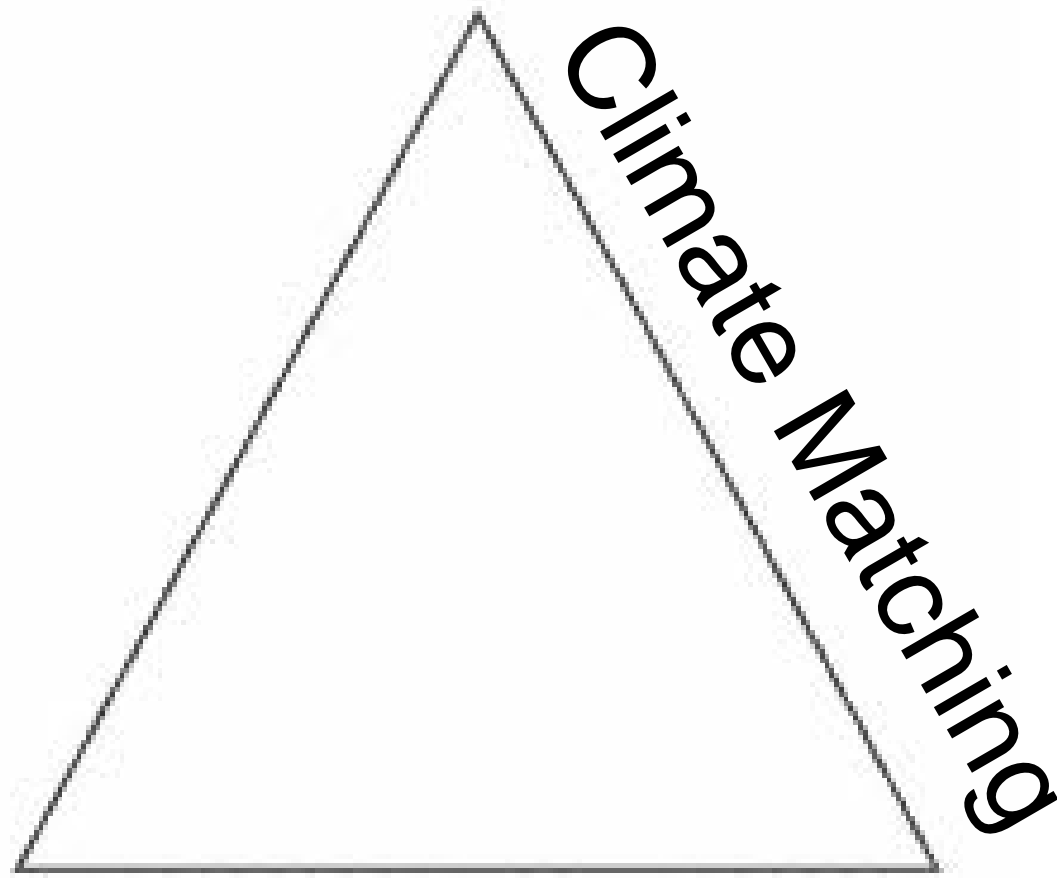
March 6-8, 2011

Assistance From:

Alan Biggs

Larry Madden
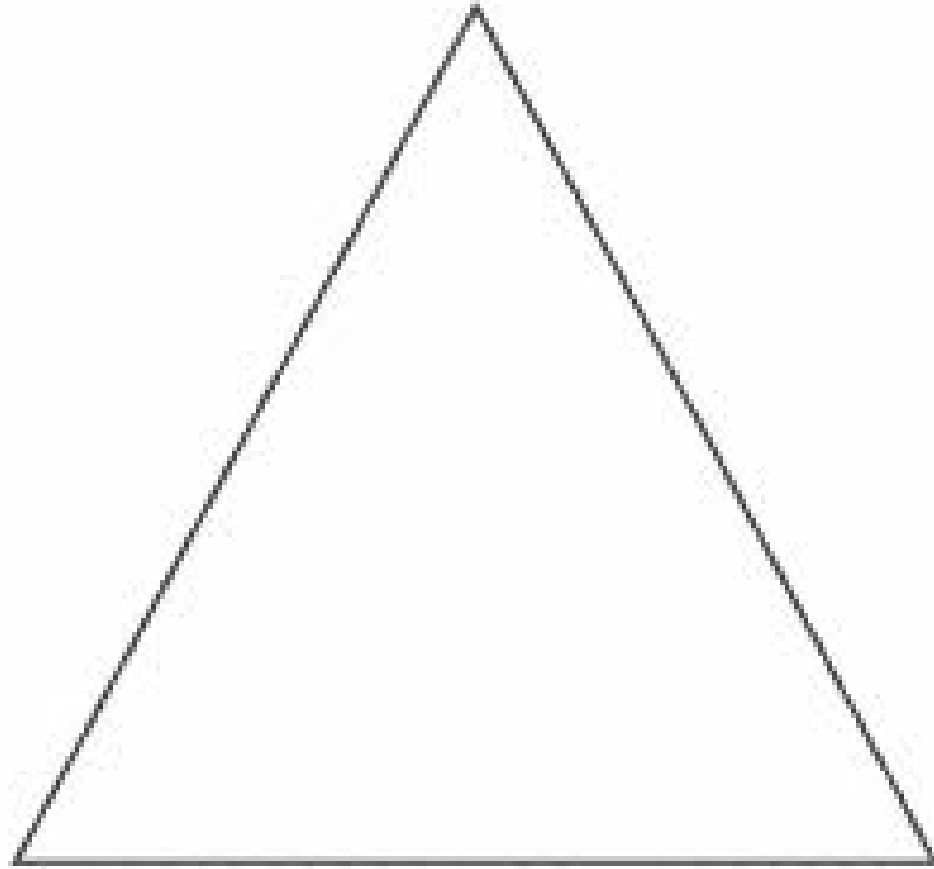
# Vulnerability Assessment

# Vulnerability Assessment

Climate Matching

# Vulnerability Assessment



Pathogen Matching

# Geospatially Overlay Risk
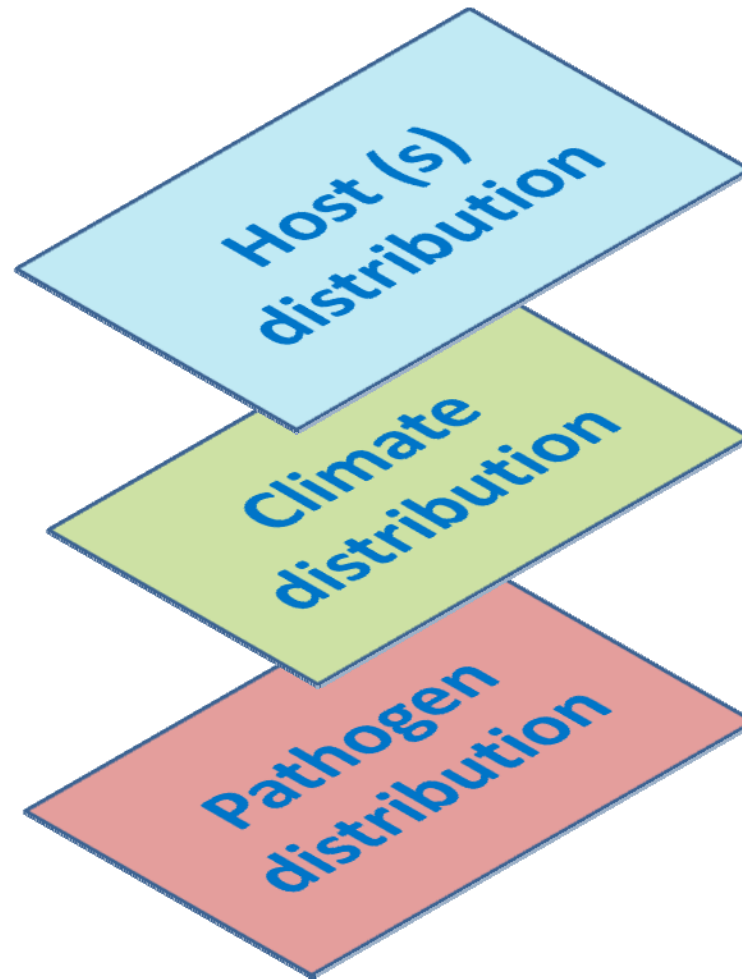
# The Penn State Concept of "Pathogen Matching"

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# Response

# (mitigation)

Based Upon 16 Model Pathosystems that:

"Epidemiologically Match"
a Penn State reference pathosystem
with other pathosystems that have
knowledge gaps

# Penn State 16 Pathosystems

| MSc. | PhD. |
|---|---|
| Apple Scab | Powdery Mildew |
| Bacterial Wilt | Root Knot Nematode |
| Brown Rot of Stone Fruit | Southern Corn Leafblight |
| Cedar Apple Rust | Soybean Cyst Nematode |
| Chestnut Blight | Take-All of Wheat |
| Dutch Elm Disease | Tobacco Mosaic Virus |
| Fireblight | Verticillium Wilt |
| Potato Late Blight | Wheat Stem Rust |

Epidemiology!

Epidemiology!

Epidemiology!

$\downarrow$

The $Y_0$'s and r's
of it all!

$$Dy/dt = r * y (1 - y)$$

rate (r)

initial inoculum ($y_0$)

- Departmental Requirement

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- No graduate credit

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- Learn the epidemiological concepts needed to design effective disease management programs

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- Learn the epidemiological concepts needed to design effective disease management programs

- Apply knowledge to new situations (threats)

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- No graduate credit

- Learn the epidemiological concepts needed to design effective disease management programs

- Apply knowledge to new situations (threats)

- Facilitate Student-Faculty interaction

| Pathosystem | Faculty |
| --- | --- |
| Potato Late Blight | Dr. Dave Mackenzie |
| Wheat Stem Rust | Dr. R.R. Nelson |
| Brown Rot of Stone Fruit | Dr. Alan McNabb |
| Chestnut Blight | *Dr. Bill Merrill |

- History

- Life cycle

- Disease cycle

- Monocyclic processes
  - Infection efficiency
  - Incubation period
  - Lesion size/expansion
  - Latent period
  - Sporulation capacity

# Scenario – Based
# (What if….)

- More virulent (races)

- More or less aggressive

- Wider (or narrower) host range

- Dispersal unit(s) (sizes, spores, aphids, ?)

- Mechanisms of dispersal

# **Recovery Roadmap**

Management strategies (Y, r)

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Disease Management Principles

↓

Integrated Management Tactics

# Soybean Cyst Nematode

↓

# Potato Cyst Nematode

- High survival $y_0$
- Low rate (r)
- Host Specific

↓

# Strategy: Reduce $Y_0$ to zero

|  | Strategy | |
| Disease | $Y_0 \rightarrow 0$ | Reduce (r) |
| --- | --- | --- |
| Soybean Cyst Nematode | ✓ | |
| matched with | | |
| Potato cyst nematode | ✓ | |

# Disease Management Principles
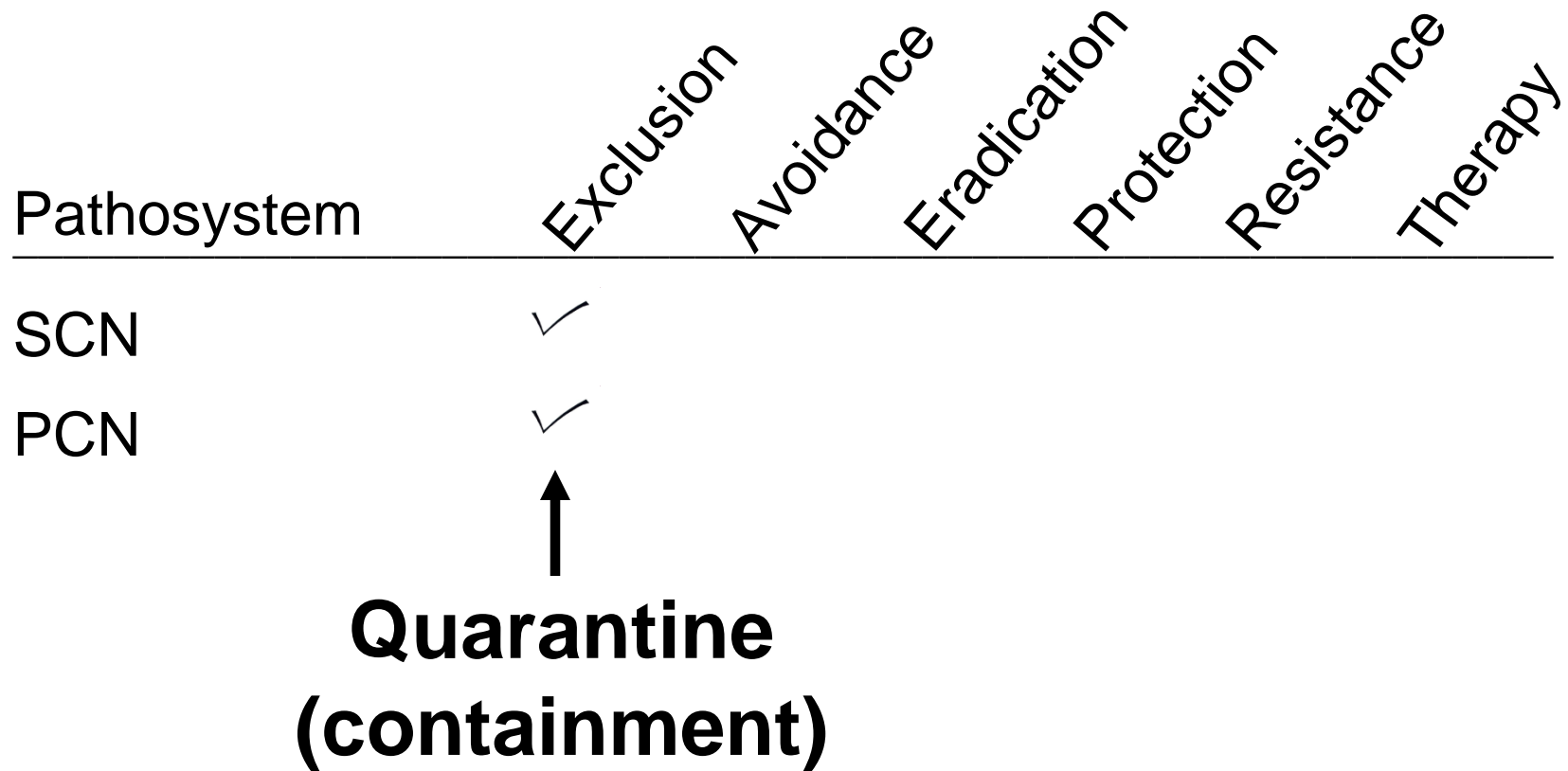
| Pathosystem | Exclusion | Avoidance | Eradication | Protection | Resistance | Therapy |
|---|---|---|---|---|---|---|
| SCN | ✓ | | | | | |
| PCN | ✓ | | | | | |

**Quarantine
(containment)**

# Disease Management Principles

| Pathosystem | Exclusion | Avoidance | Eradication | Protection | Resistance | Therapy |
|---|---|---|---|---|---|---|
| SCN | ✓ | ✓ | | | | |
| PCN | ✓ | ✓ | | | | |

↑

**Avoid Infested Areas**

# Disease Management Principles

| Pathosystem | Exclusion | Avoidance | Eradication | Protection | Resistance | Therapy |
|---|---|---|---|---|---|---|
| SCN | ✓ | ✓ | ✓ | | | |
| PCN | ✓ | ✓ | ✓ | | | |

↑

**Chemical**
**Long crop rotations**
**Sanitize field equipment**
**Green manure**

# Disease Management Principles

| Pathosystem | Exclusion | Avoidance | Eradication | Protection | Resistance | Therapy |
|---|---|---|---|---|---|---|
| SCN | ✓ | ✓ | ✓ | | $Y_0$, r | |
| PCN | ✓ | ✓ | ✓ | | $Y_0$ | |

↑

**Race specific**

Stem rust of Wheat

$\downarrow$

Match with Ug99

$\downarrow$

Doubling time as high as 1.0 days

$\downarrow$

Strategy: Reduce rate (r)

Reduce $Y_0$ -> zero

|  | Strategy | |
|---|---|---|
| **Disease** | $Y_0 \to 0$ | Reduce (r) |
| Wheat Stem Rust | ✓ (R) | rr |
| matched with | | |
| Ug99 | ✓ (R) | ✓ (F), rr |

# Disease Management Principles

| Pathosystem | Exclusion | Avoidance | Eradication | Protection | Resistance | Therapy |
|---|---|---|---|---|---|---|
| Wheat stem rust | | | | ✓ | ✓ | |
| Ug99 | | | | ✓ | ✓ | |

|                    | Strategy              |
| Disease            | $Y_0 \rightarrow 0$ | Reduce (r) |
| ------------------ | ------------------- | ---------- |
| Dutch Elm Disease  | ✓                   |            |
| matched with       |                     |            |
| Ash Yellows        | ✓                   |            |

# Disease Management Principles

| Pathosystem | Exclusion | Avoidance | Eradication | Protection | Resistance | Therapy |
|---|---|---|---|---|---|---|
| Dutch Elm Disease | | | ✓ | | | |
| Ash Yellows Disease | | | ✓ | | | |

**↑**

**Tree removal**

# Thank you!

# Questions?