

A One Health View of Biosecurity: Pathway to Research Needs Prioritization

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One Health / One Biosecurity

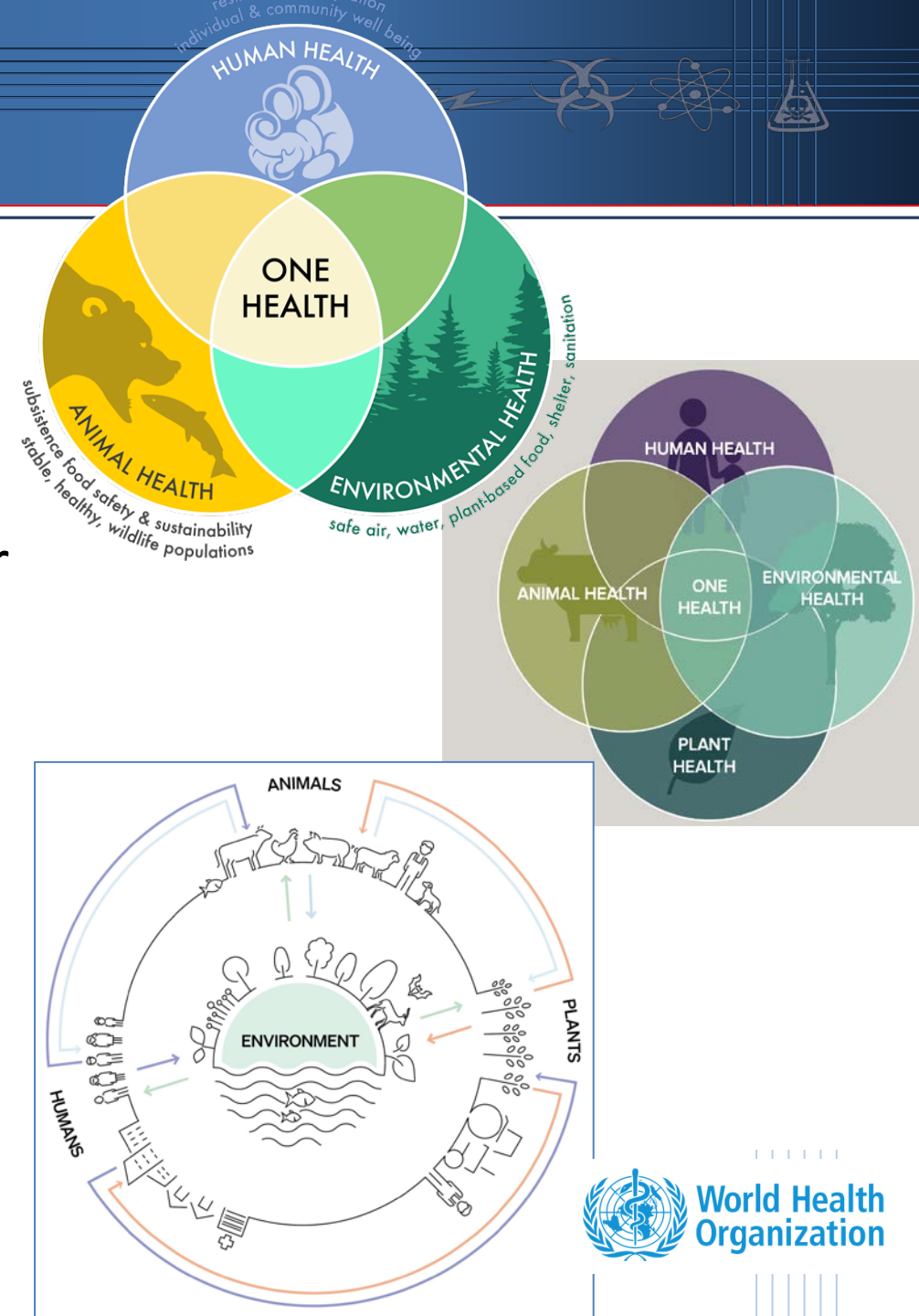
- Evolving Perspectives

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One Health

- **One Health (OH)** often shown as a Venn diagram, containing 3 overlapping circles (**human, animal, environmental health**)
- Original concept based on shared disease threats for humans and animals (zoonotic diseases/spillover)
- **Global OH Initiative Impact Report (2020)**: plant health is equally important but still depicts humans, animals and plants as *separate from* rather than *a component of* the environment
- **WHO** reconsidered the visualization of OH to prioritize **integration and systems thinking**, rather than segregation



One Health → One Biosecurity



- Strong sectorial identities (“silos”) still exist within biosecurity
 - Associated with specific international standards, economic interests, research communities & stakeholder interests
- **One Biosecurity:** An interdisciplinary approach to biosecurity research & policy
 - Builds on interconnections among human, animal, plant & environmental health
 - Involves a systematic approach

P. Hulme. 2020.
Emerg Top Life Sci 4:539-549.



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Emerging Topics in Life Sciences (2020) 4 539–549
<https://doi.org/10.1042/ETLS20200067>



Review Article

One Biosecurity: a unified concept to integrate human, animal, plant, and environmental health

Philip E. Hulme

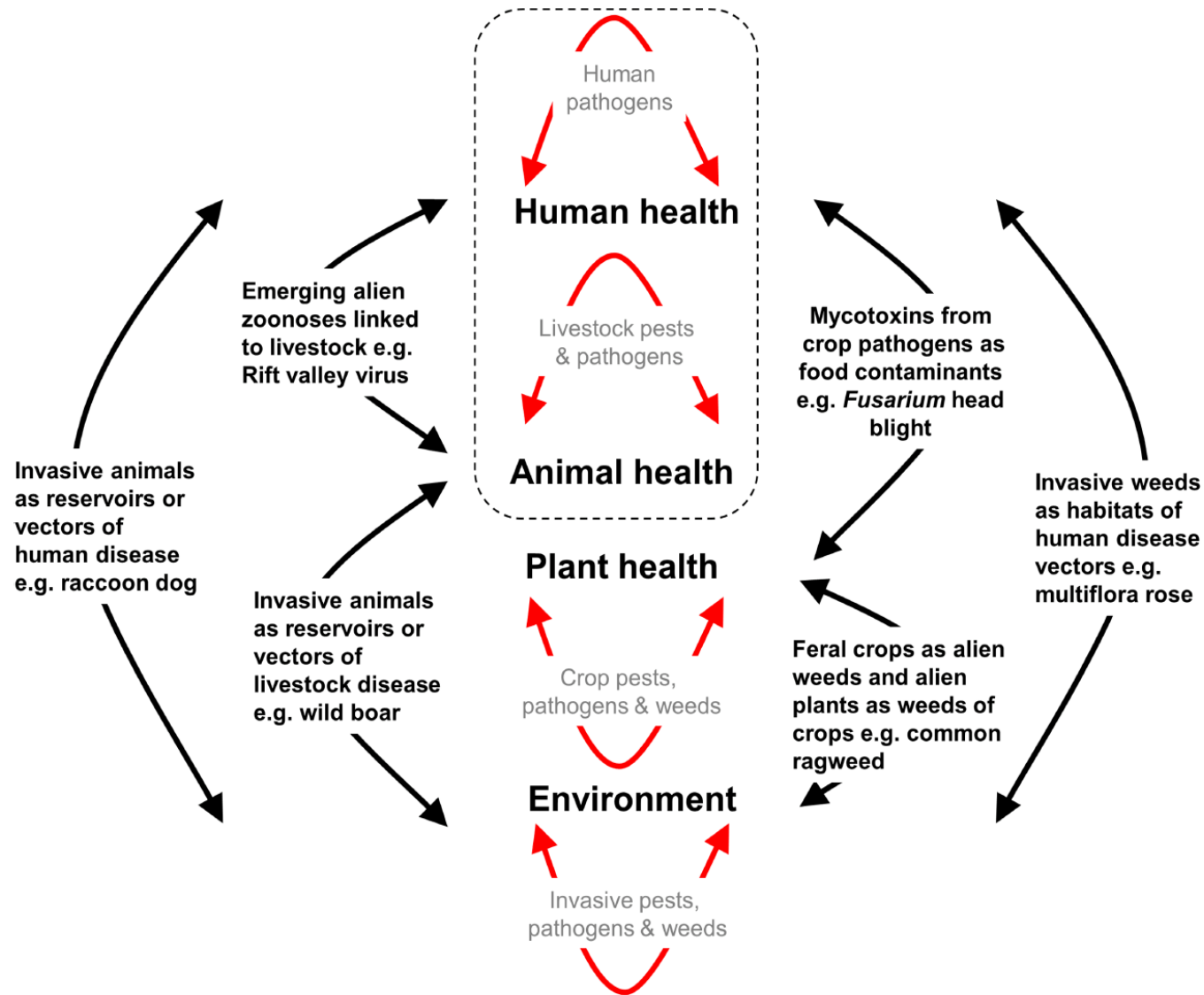
The Bio-Protection Research Centre, Lincoln University, PO Box 85084, Canterbury, New Zealand

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In the wake of the SARS-CoV-2 pandemic, the world has woken up to the importance of biosecurity and the need to manage international borders. Yet strong sectorial identities

One Health -> One Biosecurity



- The One Biosecurity concept showing links between human, animal, plant and environmental health...
- ...arising from the impacts of invasive alien plants, animals and pathogens

– Hulme 2020

One Biosecurity



- Example: Giant African snail
 - Invasive, introduced widely throughout the tropics (incl FL & HI)
 - Significant **crop loss (feeding)**
 - Vector of **plant pathogenic fungi** (*Phytophthora* spp)
 - Outcompetes **native gastropods**
 - Intermediate host in transmission of *Angiostrongylus* spp, agent of eosinophilic meningoencephalitis in **livestock & humans**
- To be effective, biosecurity policies must be based on a universal approach that
 - Seeks synergies between health, agriculture and environmental sectors
 - Considers local, regional, national and international levels
 - Shifts traditional focus from regulating individual organisms and sectors to building an overall risk management framework





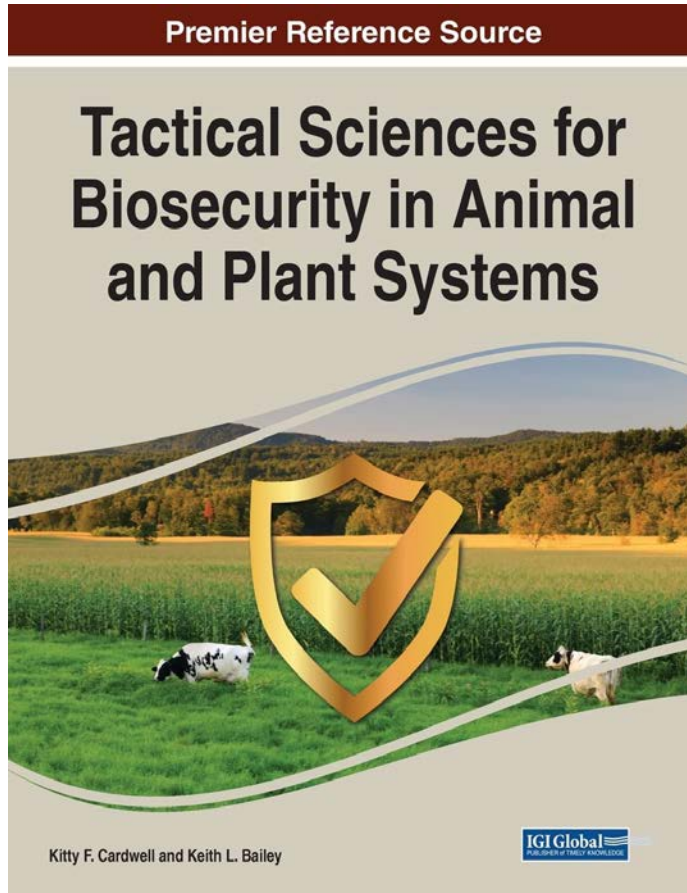
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Needs for Biosecurity Research for Animal and Plant Systems

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Capturing Research Needs



K Cardwell and K. Bailey, Eds. 2022. IGI Global

- Many sources, references, lists exist
- Recent example: A comprehensive look at the **tactical sciences** behind current biosecurity measures and opportunities for improvement for **both** plant and animal systems.
- Highlights the **interoperability** of many of the tactics for animals and plants, and identifies synergies, gaps, and needs.
- **Case studies** illustrate overlapping concerns and operations during biosecurity-relevant events.



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Tactical Sciences for Biosecurity in Animal and Plant Systems

- **Economics of Animal and Plant Biosecurity**
- **Genetic Processes of Pathogen Emergence**
- **Risk Analysis - Human Mediated Movement of Pests and Pathogens**
- **Safeguarding Agricultural & Environmental Biosecurity Before Entry**
- **Surveillance for Detection of High-Consequence Pests and Pathogens**
- **Emergency Response: Organizational Structure and Coordination**
- **Response and Recovery Tactics**
- **Microbial Forensics in Agricultural and Environmental Biosecurity**



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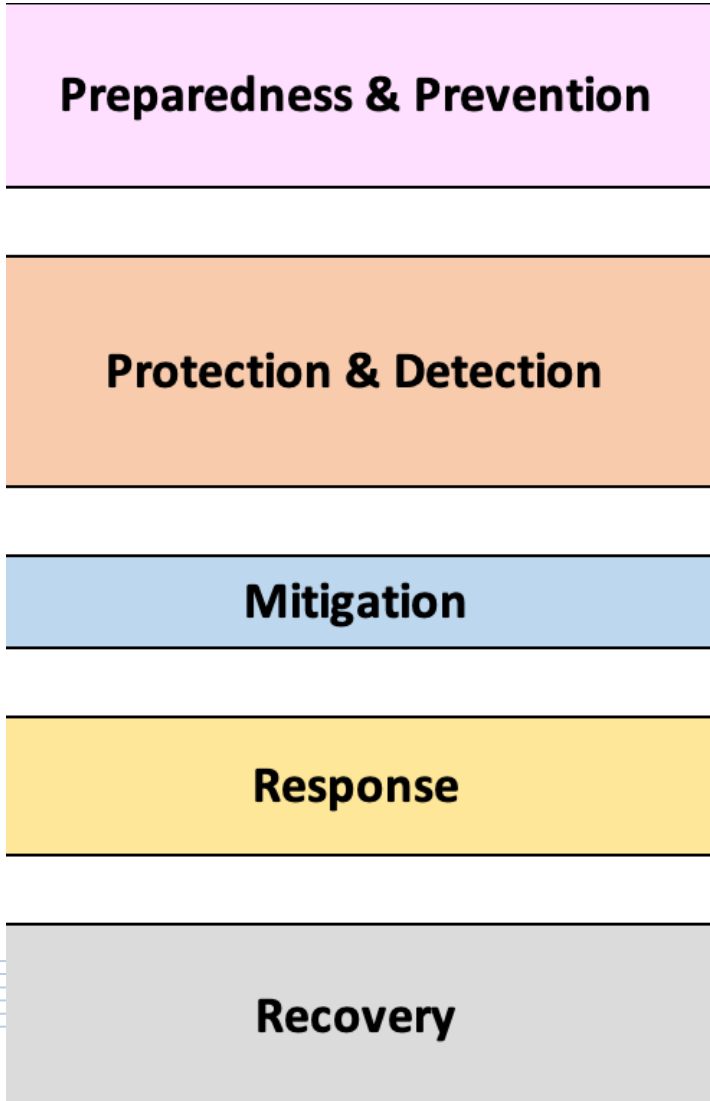
Biosecurity Research Prioritization

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One Possible Tool: Biosecurity Research Prioritization Matrix

PILLARS



ONE HEALTH APPROACH TO BIOSECURITY: PRIORITIZING RESEARCH

| PILLARS | FUNCTIONS | RESEARCH NEEDS |
|---------------------------|-------------------------------|--|
| Preparedness & Prevention | Policy / Strategy Development | Scientific underpinning of policies: regulatory, trade, border (import/export) |
| | Risk Assessment / Forecasting | Disease modeling & epidemiology, economic modeling & forecasting, pest risk analysis |
| | | Communication & sociological rsch; public skepticism and compliance reluctance; |

- Begin with the major **pillars** of a biosecurity plan (these 5 are from the HFAR-Sandia capabilities matrix)
- For each, identify the essential components or functions
- Each function must be underpinned by sound science
- Identify research needed to provide that science



Biosecurity Research Prioritization Matrix

| ONE HEALTH APPROACH TO BIOSECURITY: PRIORITIZING RESEARCH NEEDS | | |
|---|---|--|
| PHASES | FUNCTIONS | RESEARCH NEEDS |
| Preparedness & Prevention | Policy / Strategy Development | Scientific underpinning of policies: regulatory, trade, border (import/export) |
| | Risk Assessment / Forecasting | Disease modeling & epidemiology, economic modeling & forecasting, pest risk analysis |
| | Awareness / Outreach | Communication & sociological research; public skepticism and compliance reluctance; management approaches; environmental impacts |
| | Availability of Appropriate Tools | Protection, mitigation, response & recovery (see below) |
| Protection & Detection | Diagnostics | Assay development (serol, molec, volatiles/canines, visual, other); taxonomy/nomenclature |
| | Surveillance | Surveillance (passive & targeted), detection tools, aerial monitoring (drones), sentinel plots, disease delimitation, spread prediction, pathogen/vector ranges, data analytics; sampling methods; |
| | Biosecurity | Biosecurity plans at all levels (local, regional, state, national, international); what works where |
| | Border Security & Commodity Inspection | Risk assessment & prioritization of inspection, rapid detection & ID, risk mitigation |
| | Cyber Security | "Smart farms": crop health monitoring systems (data collection & analysis, recommendations); crop info (cvs, planting info, pre- & post-plant treatments, yield predictions) |
| Mitigation | Prophylaxis Development & Distribution | Disease management strategies (chemical, biological, cultivation, nutrition, crop destruction); matching method to situation (effectiveness, risk to humans/environment, |
| | Continuity of Operations Planning | Analysis and modeling to understand potential impacts on cross-sector systems (transportation, water, communications, food availability & safety) |
| Response | Quarantine, Permitted Movement, Containment, Delimitation | Disease epidemiology, modeling, tool development |
| | Decontamination | Decon options, environmental & health issues |
| | Incident Investigation | Intentional vs. natural (decision tools, law enforcement tools, evidence collection, criminal investigation, forensic tools - microbial and other) |
| Recovery | Trade Recovery | Market research/restoration, commodity substitution |
| | Economic Recovery | Commodity/industry; farm/producer; design of effective assistance & counseling programs; restoration of infrastructure & facilities |
| | Environmental Recovery | Tools for damage evaluation, modeling to determine effectiveness |
| | After-Action Review & Planning | Lessons learned |

Example Matrix

- Each Pillar contains critical Functions
- Each Function contains critical Research Needs

Pillar: Protection and Detection



| | | |
|-----------------------------------|--|--|
| Protection & Detection | Diagnostics | Assay development (serol, molec, volatiles/canines, visual, other); taxonomy/nomenclature |
| | Surveillance | Surveillance (passive & targeted), detection tools, aerial monitoring (drones), sentinel plots, disease delimitation, spread prediction, pathogen/vector ranges, data analytics; sampling methods; |
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| | Border Security & Commodity Inspection | Rick assessment & prioritization of inspection, rapid detection & ID, risk mitigation |
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Where does One Health come in?

| ONE HEALTH APPROACH TO BIOSECURITY: PRIORITIZING RESEARCH | | | | | |
|---|---|--|-------|--------|-------|
| PHASES | FUNCTIONS | RESEARCH NEEDS | PLANT | ANIMAL | HUMAN |
| Preparedness & Prevention | Policy / Strategy Development | Scientific underpinning of policies: regulatory, trade, border (import/export) | X | X | X |
| | Risk Assessment / Forecasting | Disease modeling & epidemiology, economic modeling & forecasting, pest risk analysis | X | X | X |
| | Awareness / Outreach | Communication & sociological rch; public skepticism and compliance reluctance; management approaches; environmental impacts | X | X | X |
| | Availability of Appropriate Tools | Protection, mitigation, response & recovery (see below) | X | X | X |
| | | | | | |
| Protection & Detection | Diagnostics | Assay development (sero, molec, volatiles/canines, visual, other); taxonomy/nomenclature | X | X | X |
| | Surveillance | Surveillance (passive & targeted), detection tools, aerial monitoring (drones), sentinel plots, disease delimitation, spread prediction, pathogen/vector ranges, data analytics; sampling methods; | X | X | X |
| | Biosecurity | Biosecurity plans at all levels (local, regional, state, national, international); what works where | X | X | X |
| | Border Security & Commodity Inspection | Rick assessment & prioritization of inspection, rapid detection & ID, risk mitigation | X | X | X |
| | Cyber Security | "Smart farms": crop health monitoring systems (data collection & analysis, recommendations); crop info (cvs, planting info, pre- & post-plant treatments, yield predictions) | X | X | X |
| Mitigation | Prophylaxis Development & Distribution | Disease management strategies (chemical, biological, cultivation, nutrition, crop destruction); matching method to situation (effectiveness, risk to humans/environment, | X | X | X |
| | Continuity of Operations Planning | Analysis and modeling to understand potential impacts on cross-sector systems (transportation, water, communications, food availability & safety) | X | X | X |
| Response | Quarantine, Permitted Movement, Containment, Delimitation | Disease epidemiology, modeling, tool development | X | X | X |
| | Decontamination | Decon options, environmental & health issues | X | X | X |
| | Incident Investigation | Intentional vs. natural (decision tools, law enforcement tools, evidence collection, criminal investigation, forensic tools - microbial and other) | X | X | X |
| Recovery | Trade Recovery | Market research/restoration, commodity substitution | X | X | X |
| | Economic Recovery | Commodity/industry; farm/producer; design of effective assistance & counseling programs; restoration of infrastructure & facilities | X | X | X |
| | Environmental Recovery | Tools for damage evaluation, modeling to determine effectiveness | X | X | X |
| | After-Action Review & Planning | Lessons learned | X | X | X |

- Consider which Pillars, Functions and underlying Research Needs are applicable to each sector: Plants, Animals and Humans
- At a level “above the weeds,” ALL of these categories are relevant to all of the sectors
- Recognizes
 - Overlapping objectives and goals
 - Suggests inter- and cross-disciplinary research approaches
 - One Health / One Biosecurity

Who is Doing Research on Which Topics?



| PHASES | FUNCTIONS | RESEARCH NEEDS | CURRENT RESEARCH IN THIS AREA | | | | |
|---------------------------|-----------------------------------|--|-------------------------------|-----------------|--------------|-----------------|------------------------|
| Preparedness & Prevention | Policy / Strategy Development | Scientific underpinning of policies: regulatory, trade, border (import/export) | NC State Univ | Okla State Univ | Univ of Ark | LA State Univ | |
| | Risk Assessment / Forecasting | Disease modeling & epidemiology, economic modeling & forecasting, pest risk analysis | Kansas State U | UC Davis | Ohio State U | Penn State Univ | USDA ARS - Ft. Detrick |
| | Awareness / Outreach | Communication & sociological rsch; public skepticism and compliance reluctance; management approaches; environmental impacts | Univ of Florida | | | | |
| | Availability of Appropriate Tools | Protection, mitigation, response & recovery (see below) | See below | See below | See below | See below | See below |

- Identify common interests & research areas across institutions
- Identify potential beneficial collaborations & opportunities
- Leverage resources from multiple research & service laboratories



Prioritizing Biosecurity Research: HOW?



■ Steps

- Input from universities, private industry, USDA/NIH, other government agencies
- Consider the broad spectrum of biosecurity-related research
 - + What has already been done
 - + What is being done currently, and by whom
- Identify gaps and needs
- Utilize a risk-informed process for gap prioritization
- Identify intersections/overlaps/possible synergisms among groups & projects
- Build collaborations that leverage experience, perspectives & resources

- ***HFAR University Consortium*** – *Supports these objectives*

What's Next?



- **UC Annual Meeting 2024**

- Breakout discussions
- Collate, annotate and share input from all sessions among UC members and with DHS HFAR

- **Follow-up – nearer term**

- Form UC Subgroups that could flesh out areas of expertise during the coming year?
 - Plant, Animal, Health, Economics/Sociology, Risk Assessment, Modeling, other
- Engage other stakeholders (other universities, industry, federal partners, scientific societies)
- Refine (or re-design) Biosecurity Research Needs Matrix

- **Follow-up – out-term**

- Prepare UC recommendations & share with end users (Congress, funding agencies, other)
- Track progress and report
- Rinse and repeat



Thank You

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