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Analysis and Data Challenges Associated with Risk-Based Sampling Programs

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Overview

- Issues common to inspection operations
  - “Approach rates”
  - Inspectional efficiency
- Issues related to risk-based sampling (RBS) plans
  - By type of plan
  - By timing (pre- and post-implementation)
- Largely conceptual; not *quantitative* per se

Common Inspections Issues

- All operations affected

1. “Approach rates” – quantifying pest entry
2. Inspectional efficiency – how often are present pests found?

Approach Rates (1/4)

- Bare minimum: Action rate
  - = No. risk-related actions / No. consignments
  - Coarse means of targeting
  - Every organization should be able to use this
- Ideal: Infestation rate
  - = No. infested units / No. inspected units
  - Enables much more precise predictions, better targeted programs, and analysis of outcomes

Approach Rates (2/4)

- Infestation rate (IR) 1,000 consignments

Combo	IR	Mn. Qty. (no.)	Infested Qty / Cnsgnmt (no.)
1	0.1	50	5
2	0.01	500	5
3	0.001	5000	5

  - Targeting: Directly predict infested units; adjust sampling intensity
  - Monitoring: Estimate leakage; perhaps overall ‘value’ of system

Approach Rates (3/4)

- Action rate (AR) 1,000 consignments

Combo	AR	Estim. Problem Cnsgnmts (no.)	Mn. Qty. (no.)
1	0.10	100	1000
2	0.10	100	500
3	0.01	10	100
4	0.01	10	10,000

  - Targeting: >AR infers >risk, but true risk unclear; may mislead even knowing quantity
  - Monitor: Missed consignments, **not** missed pests (“leakage”); system value unclear

Approach Rates (4/4)

- Why is action rate more prevalent?
  - Cost of collecting the data
  - Data collection geared more to characterizing the pathway than to inspections (e.g., total quantities)

- PPQ: Newly able to estimate infestation rates (propagative), but **only** w/ uncertainty

Inspectional Efficiency

- Definition = likelihood of finding a present pest
- Important because it influences…
  - System effectiveness
  - Leakage estimates
- Why are estimates rare/limited/poor?
  - Sensitive information
  - Rarely studied explicitly
  - Variable…not a point estimate
    - Mode: Visual inspection or some other test?
    - Pest: Adult insect, weed seed, or asymptomatic pathogen?

RBS-Specific Issues

- Two types of RBS plans, with different reliance on analysis
  1. Continuous sampling
  2. Ratings-based
- Two phases to consider: pre- and post-implementation

Pre-Implementation [Plan Preparation]

Description	Continuous Sampling	Ratings-Based
Consignment/commodity analysis	✓	✓
Specifying incentives	✓	✓
Sampling scheme(s)	✓	✓
Collect risk data for rating		✓
Ratings development/validation		✓
Ratings revision/update plan		✓

Pre-Implementation (1/3) [Both plan types]

- Consignment/commodity analysis
  - Understanding the trade pathway
- Specifying incentives
  - Number of levels
  - Inspection reduction method (lower frequency or intensity, or some combination of both)
  - How do these affect overall inspectional efforts?
- Sampling scheme(s)
  - Frequencies and intensities (sub-sampling?)
  - Affects confidence and risk rate detected

Pre-Implementation (2/3) [Ratings-Based only]

- Risk data collection
  - Metric/scheme determines exact needs
  - Period = long enough but not too long
- Ratings development/validation
  - No standard approach exists
  - How is uncertainty treated?
  - Subject to review/critiques
  - Rating type issues (contd. next)
- Ratings revision/update plan
  - Complicated: timing and periodicity, data needs, ratings type effects (one or all?), impact on incentives/operations

Pre-Implementation (3/3)

- Rating type issues

Item	Empirical (e.g., 'Empirical Bayes')	Fitted (e.g., 'Bayesian generalized linear model')
Specificity	Single combo	All combos
Rating derivation	Direct	Indirect
Rating factors	Standardized	Dynamic / variable
Explicability	Standard	Ambiguous
Updating/revisions	One rating	All ratings
Data pool(s)	All available; Bayesian updating possible	Restricted (e.g., for validation, by periods)

Conclusion: Fitting needs to justified by accuracy gains

Post-Implementation (Plan Monitoring/Maintenance)

Description	Continuous Sampling	Ratings-Based
Evaluate outcomes	✓	✓
Incentives adjustment	?	?
Sampling scheme adjustment	?	?
Collect risk data for rating		✓
Ratings revisions/updates		✓

Post-Implementation (1/3)

- Evaluate outcomes
  - Metrics: inspectional effort, cleared consignments, total detections, status/ratings changes, estimated leakage
  - Ratings-based: performance by rating; accuracy

Post-Implementation (2/3)

- Adjust 1) Incentives or 2) sampling scheme
  - As needed
  - Rationales: improve outcomes; changes in resources/capabilities

Post-Implementation (3/3) [Ratings-based plans only]

- Collect risk data for re-rating
  - Periodicity
  - Time span
- Ratings revisions/updates
  - *Follow previous plan w/ adaptations*
  - Communication of results and ratings changes

Conclusions: All Inspections (1/2)

- Approach rates
  - Understand their implications
  - Goal = infestation rate
- Inspectional efficiency
  - Coarse approach unlikely to change soon
  - ‘Ripe’ for research/collaboration

Conclusions: RBS-specific (2/2)

- Continuous sampling plans
  - Simpler data and analysis needs
  - Analysis focuses on monitoring and outcomes
  - Maintenance is primarily automatic
- Ratings-based plans
  - **Much greater** data and analysis needs
  - Less flexible (esp. *fitted* ratings)
  - Ratings and outcomes more open to criticism
  - Maintenance is primarily manual

Good luck!


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