FEDERAL INSTITUTE FOR RISK ASSESSMENT

BfR
Bundesinstitut für Risikobewertung

Tracing back and forward – source identification in foodborne outbreaks

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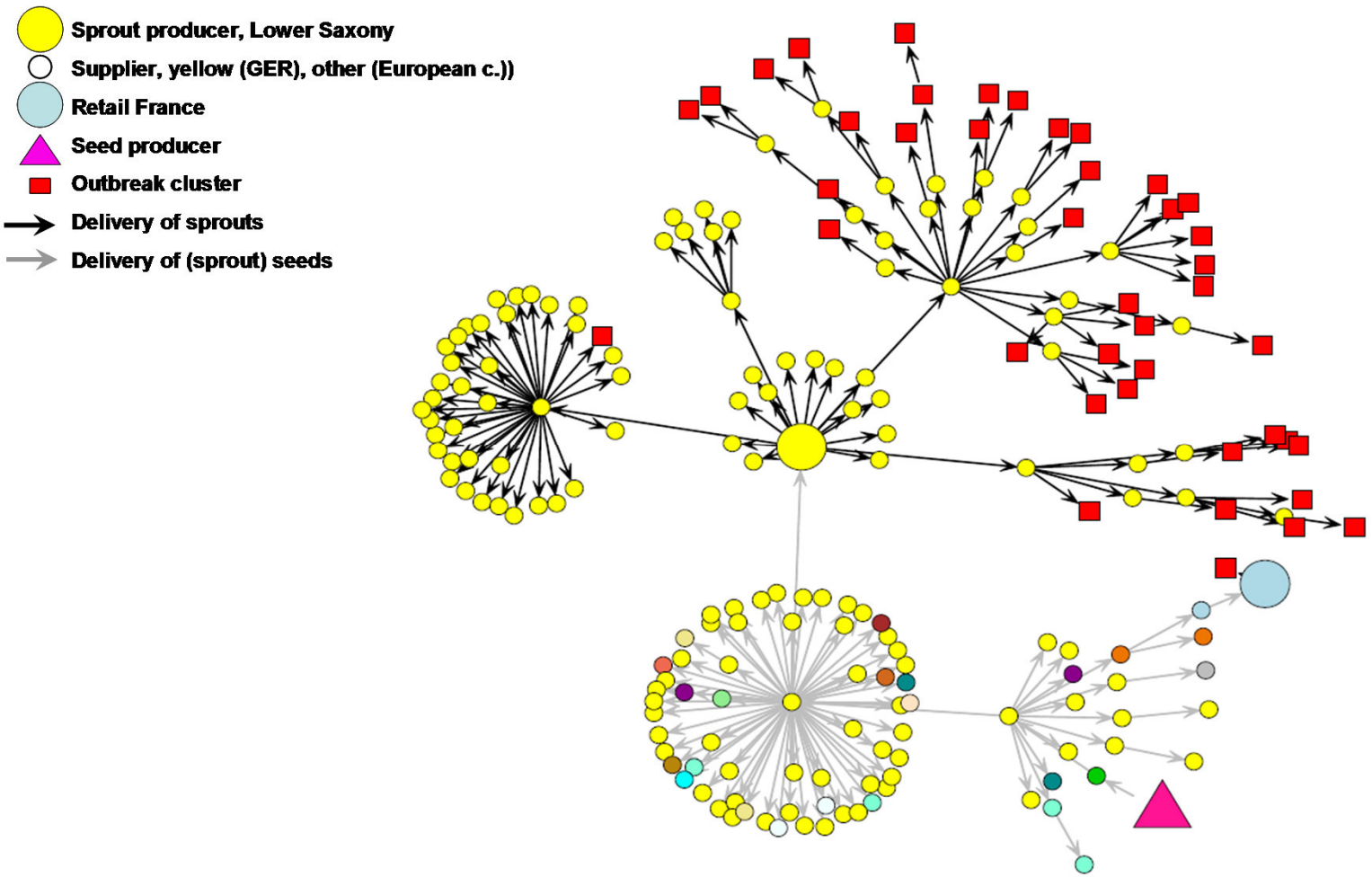
Principles and measures: How to overcome a life-threatening crisis in the food chain
Berlin, 14-15 November 2013

The German EHEC Outbreak 2011



Clarification using scientific evidence

Outline of the presentation

Science contributions to clarification of foodborne outbreak

Identification of the vehicle

Identification of the source

Tracing in theory and practice

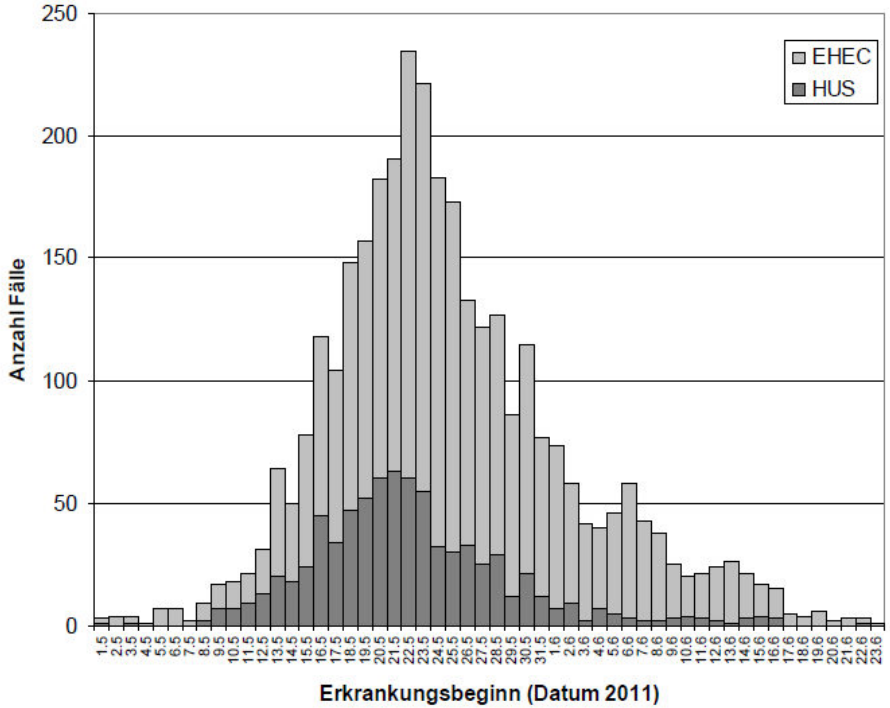
Conclusions

Science contributions to clarification of foodborne outbreak

1. Detection of the outbreak (connection between events?)
2. Identifying the vehicle (food commodity?)
3. Identifying the source (origin of contamination?)
4. Identifying the aetiology (infectious or other agent?)
5. Advising control measures (effective strategy?)
6. Predicting the epidemic (when is it over?)

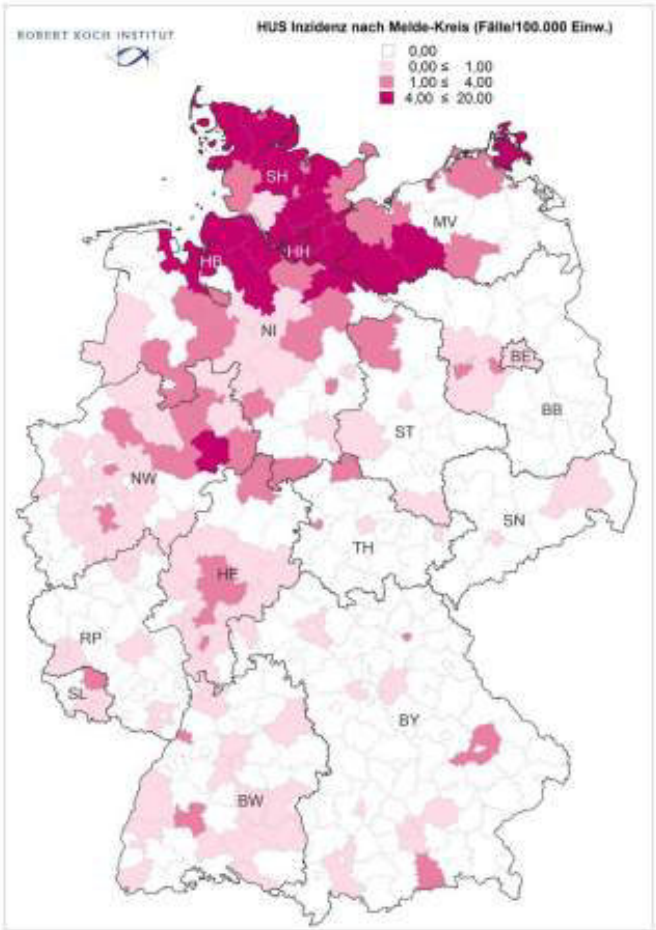
Footprint of the EHEC outbreak 2011

Temporal



Epidemic curve (EHEC and HUS) (Robert Koch-Institute, 2011)
http://www.rki.de/EN/Home/EHEC_final_report.pdf

Spatial



HUS incidences by resident cases per 100.000 inhabitants (Robert Koch-Institute, *13 July 2011)*
http://www.rki.de/EN/Home/EHEC_final_report.pdf

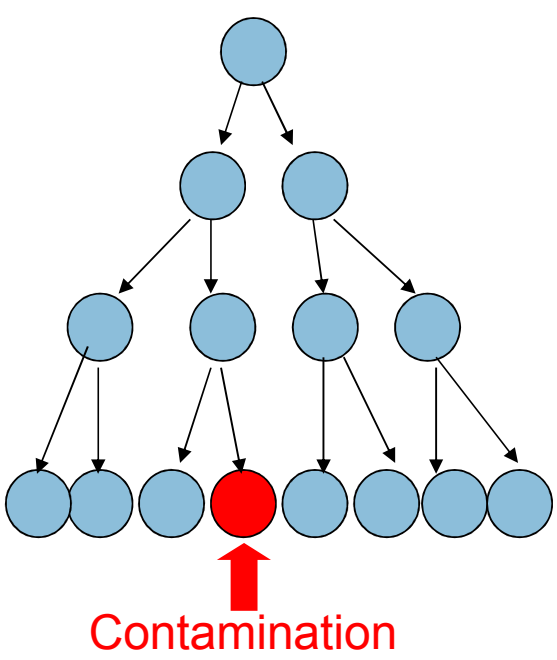
Footprint pattern related to the source of contamination

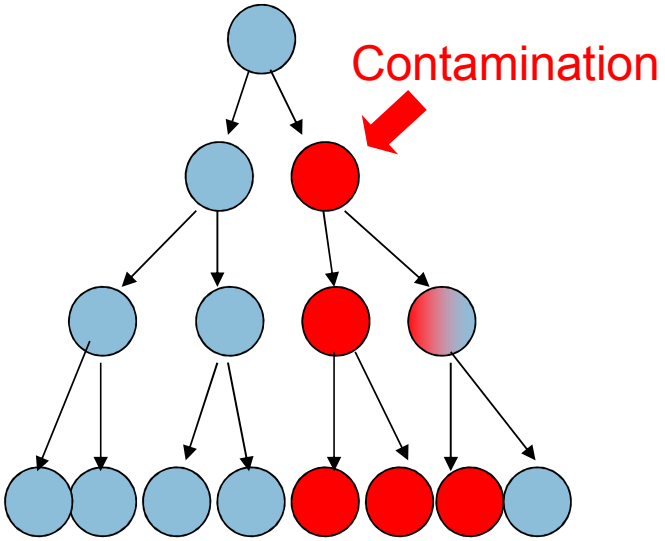
Primary production

Processing

Distribution

Final preparation





	Focal	Multifocal or diffuse
Source of contamination:	local food handling	at production or processing
Contamination dose:	high	low
Detection:	self-reporting, lab follow-up	lab-based subtype surveillance
Investigation:	local, tracing back	Complex multistate investigation Back and forward tracing

Identifying the food vehicle

Epidemiological evidence

- Who has eaten what, when, where, how much and how prepared? Consumption associated with illness?
- Using case-control studies, cohort studies, statistical modelling, odds ratios

Microbiological evidence

- Identification of the pathogen in the food (aetiology), primary or secondary contamination?
- Using food sampling and microbiological testing

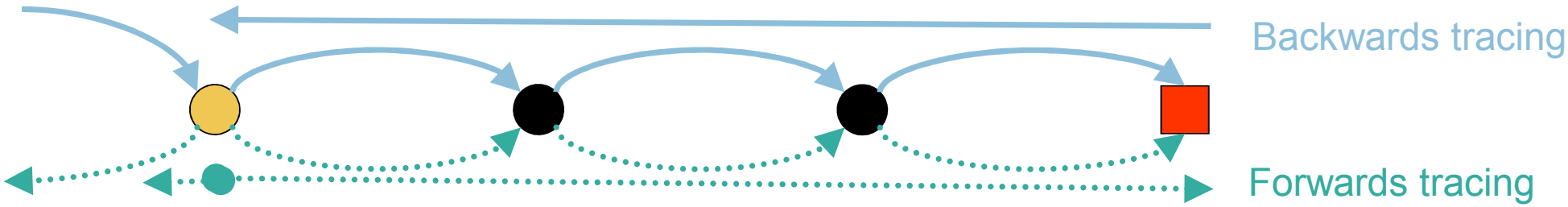
Identifying the source of the outbreak

Backwards tracing

- Which food business operators (FBO) delivered food items to the locations of cases (clusters)?

Forwards tracing

- Delivery network originating from hypothetical sources



Some details on tracing

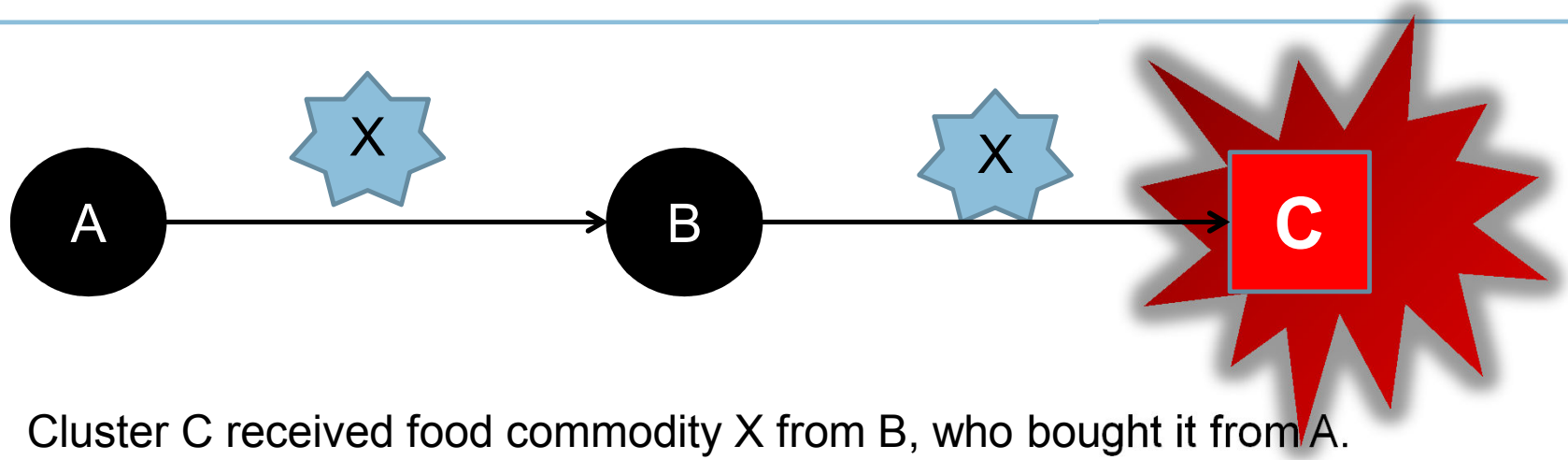
1

- Define candidate list of food commodities

Daikon sprout, Soya sprout, Wheat germ, **Lentil sprout**, Mustard sprout, Lucerne sprout, Sunflower sprout, Mung bean sprout, Cress sprout, **White radish sprout**, Red radish sprout, **Adzuki bean sprout**, **Alfalfa sprout**, Grain sprout, Rye sprout, **Barley sprout**, Maize sprout, Designation, Cress, Watercress, Cress/Garden cress/Nasturtium, All herbs, Ginger, Zedoary, Galangal, Calamus, Lovage root, Spices, Basil, Wormwood, Savory, Borage, Dill, Tarragon, Lovage leaf, Marjoram, Oregano, Pimpernel, Rosemary, Lemon balm, Sage, Thyme, Hyssop, Grand wormwood, Chervil, Rue, Blue **fenugreek**, Parsley, Chives, Leaf celery, Coriander, Lemon grass, Mint, All small leaves, Spinach, Dandelion, Sorrel, Wild garlic, Rocket, Fennel leaves, Nettles, Celery root leaves, Parsley leaves, Orache, Turnip greens, **All lettuces**, **Garden lettuce**, Lamb's lettuce, **Mixed salad leaves**, Romaine, Chicory, Endive, Dandelion, Swiss Chard, Radicchio, Iceberg lettuce, Frisee lettuce, Oak leaf lettuce, Batavia lettuce, Sugar loaf lettuce, Lollo rosso, Lollo bianco, Pak choi, Spring onion, Shallot, Onion, All Others, Ribbed/stalk/root celery, Kohlrabi, Fennel, White radish, Red radish, May turnip, **Tomato**, **Cucumber**, Courgette

Tracing: epidemiological details

1. • Define candidate list of food commodities
2. • Unique identification of involved FBO



Cluster C received food commodity X from B, who bought it from A.
Legal basis: One-step-up-one-step-down data collected by FBOs (Regulation [EC] No. 178/2002, Article 18)

Data collection

FBOs (nodes)

Microsoft Excel - BB_nodes2.xls

	A	B	C	D	E	F
1	ID node	trait 1 shape	trait 2 size	trait 3 edge colour	trait 4 fill colour	time
2	HB11.14	nc	0.9		black	
3	HB11.7.1	nc	0.9		black	
4	HE17.2	nc	0.9		black	
5	HE17.2.1	cluster	1.4		red	
6	HE17.2.2	cluster	1.4		red	
7	HE17.2.3	cluster	1.4		red	

Unique Identity: Address
Properties: outbreak cluster, intermediate FBO or producer

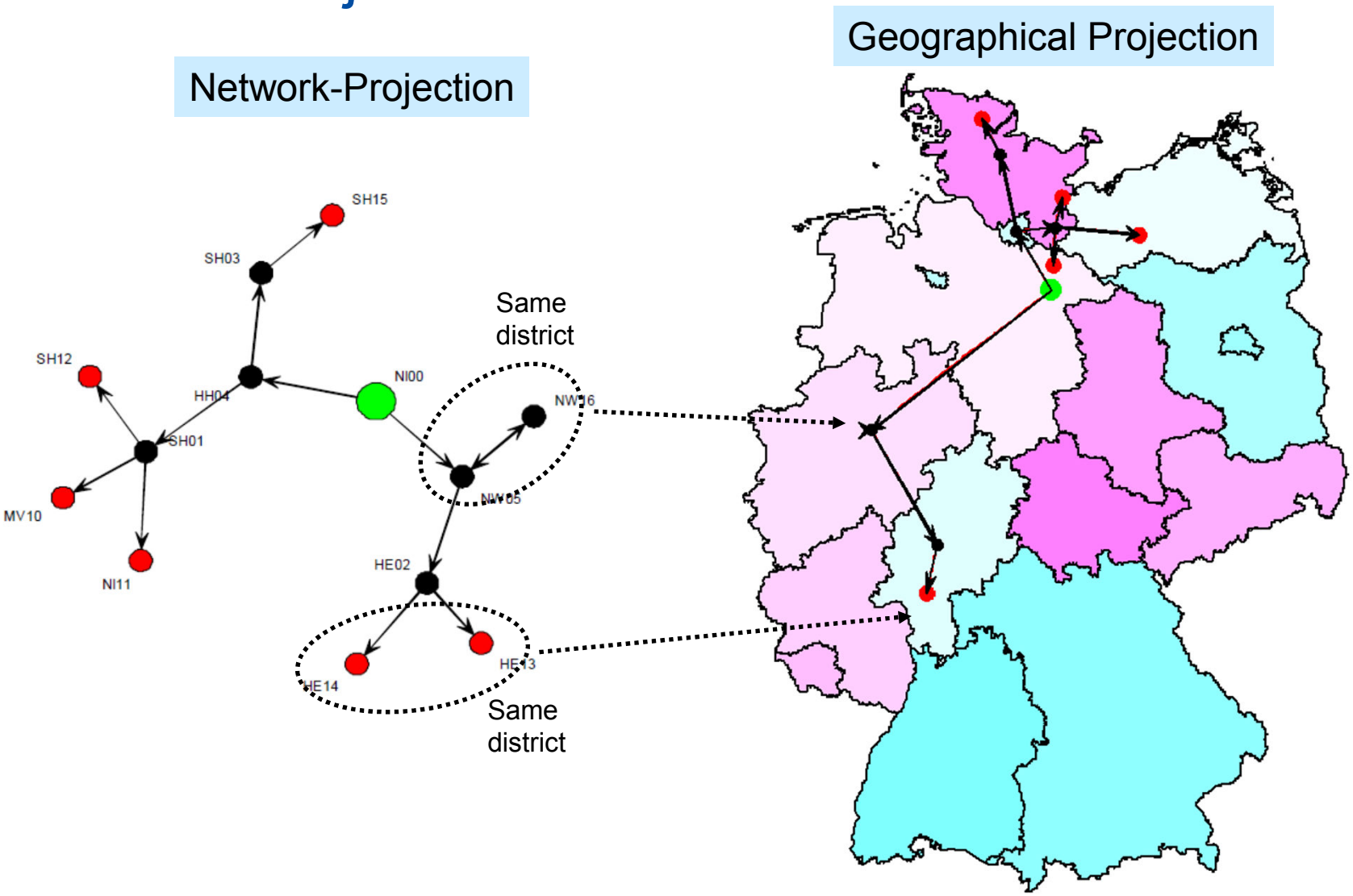
Traded commodities (edges)

Microsoft Excel - BB_links2.xls

	A	B	C	D
1	from	to	trait 1 colour	trait 2 width
2	HB11.14	NI11.14.1	black	25
3	HB11.7.1	NI11.7.1.1	black	75
4	HB11.7.1	NI11.7.1.2	black	95
5	HE17.2	HE17.2.1	black	50
6	HE17.2	HE17.2.2	black	150
7	HE17.2	HE17.2.3	black	1500
8	HH11	SH11.1	black	10

Identity: From-to-date
Properties: direction, commodity, batch/lot, date, amount

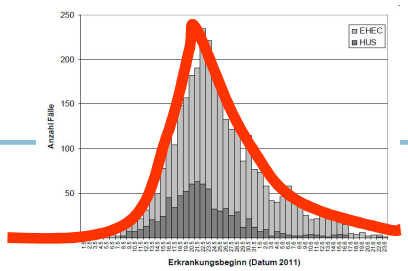
Network - Projection



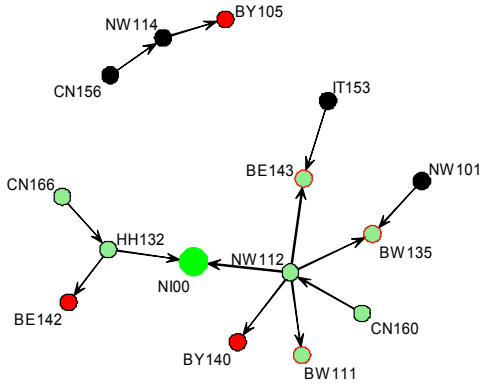
Application of mathematical graph theory

Tracing: epidemiological details

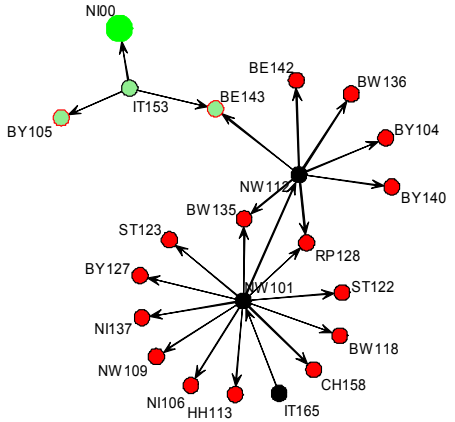
1. Define candidate list of food commodities
2. Unique identification of involved FBO
3. Consider repackaging, batches, mixtures, changing lot numbers, product-in-product
4. Define critical time period (for sending and receiving)



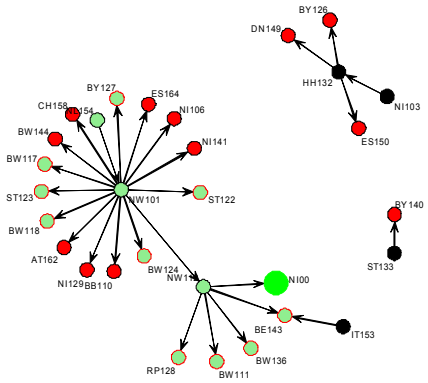
Subnets for various sprout species



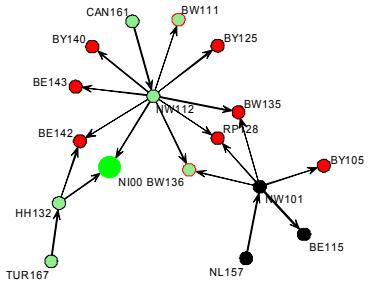
Adzuki



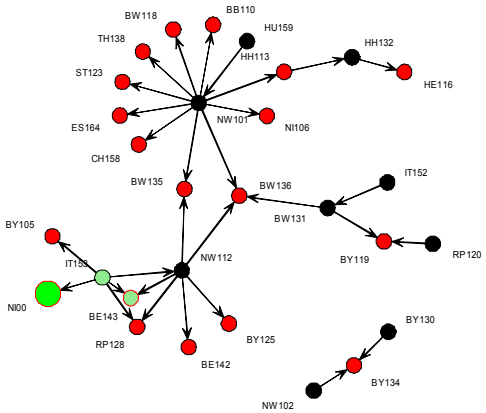
Alfalfa



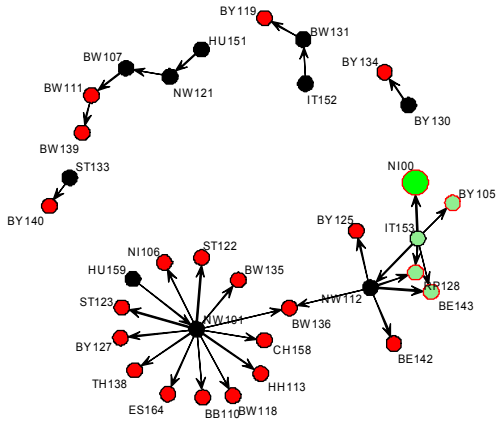
Fenugreek



Lentils



Radish

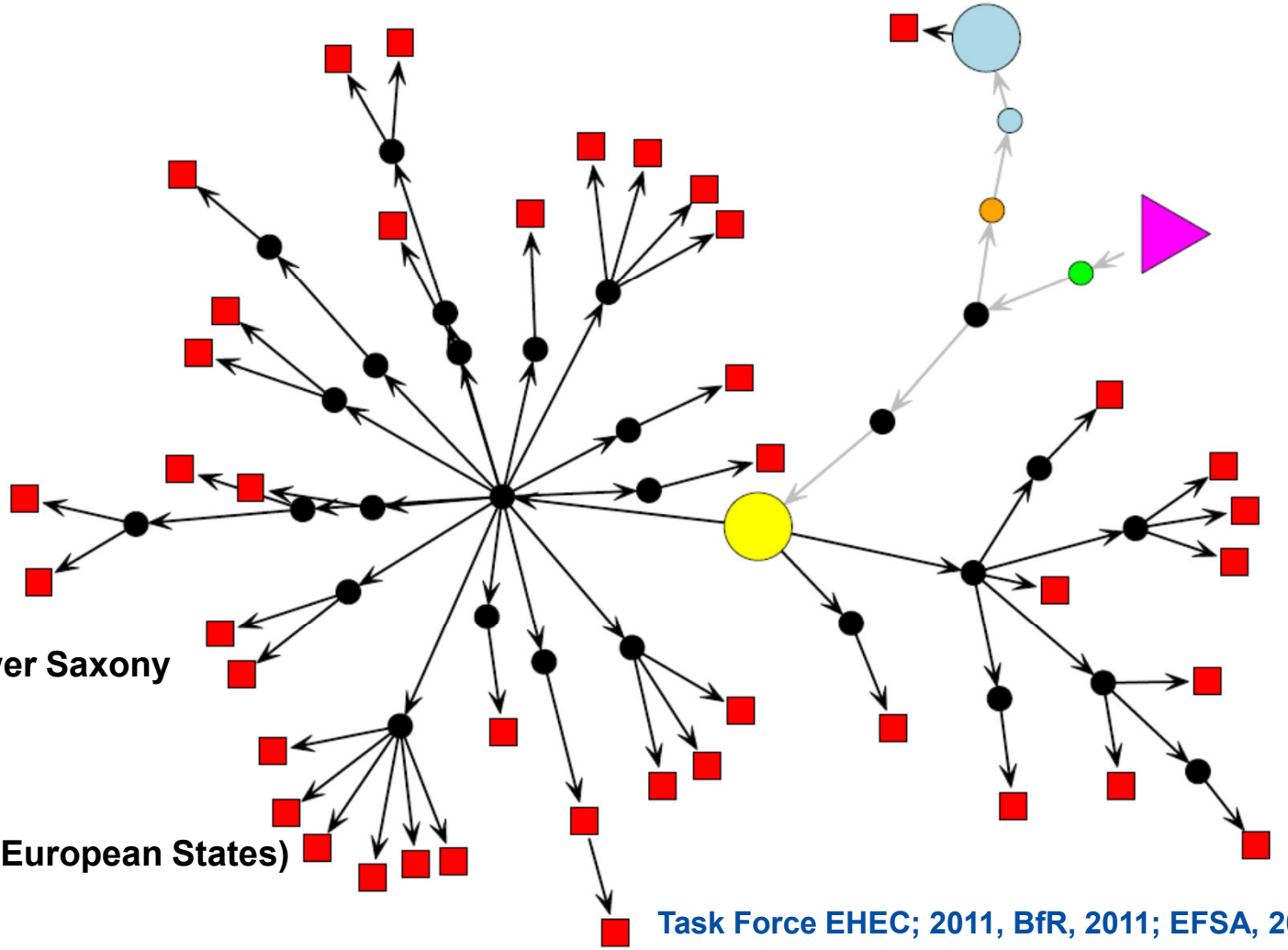


Daikon

Tracing back and forward requires …

- Observed outbreak locations (clusters)
- Candidate food commodities
- Available trade data
- Hypothetical source (for forward tracing)

Supply chains of fenugreek seeds explain German and French EHEC outbreak



- horticultural farm in Lower Saxony
- retail in France
- seed producer
- intermediaries (colours: European States)
- outbreak clusters
- sprout delivery
- seed delivery

Task Force EHEC; 2011, BfR, 2011; EFSA, 2011

http://www.bvl.bund.de/DE/01_Lebensmittel/03_Verbraucher/09_InfektionenIntoxikationen/05_EHEC/Task_Force/Task_Force_node.html

http://www.bfr.bund.de/cm/343/bedeutung_von_sprossen_und_keimlingen_sowie_samen_zur_sprossenherstellung_im_ehec_o104_h4_ausbruchsgeschehen_im_mai_und_juni_2011.pdf

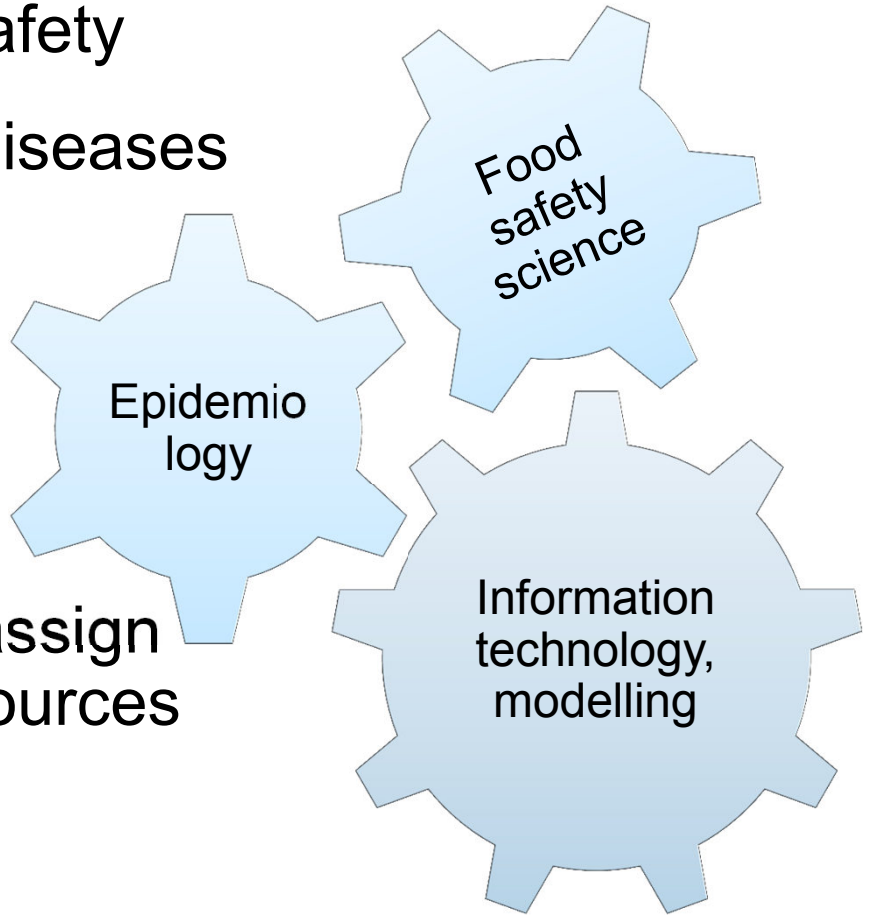
http://www.efsa.europa.eu/en/supporting/doc/176e.pdf

Conclusions

Tracing may be the key for clarification of large outbreaks

Success depends on scientific input:

- Food microbiology & food safety
- Epidemiology of infectious diseases & food production systems
- Information technology & mathematical modelling



Future work

- Computational statistics to assign “p-Values” to hypothetical sources

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Thank you for your attention!

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