Christian-Albrechts-University, Kiel

Faculty of Agricultural and Nutritional Science

Institute of Animal Breeding and Husbandry

Interruption of infection chains in a pork supply chain

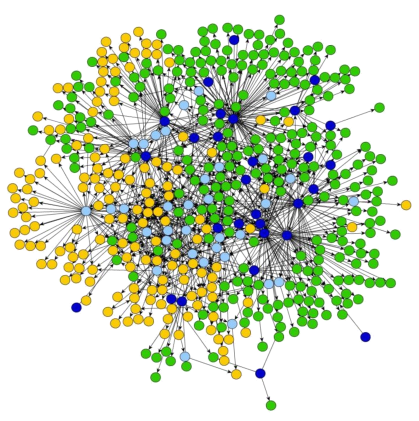
Random removal – Targeted removal – Optimal combination

Aim

- Analysing the change in the network structure with the help of random removal vs. the targeted removal of farms according to their ranking of specific centrality parameters and the comparison to the optimal combination of removed farms
- By evaluation the different changes in the network structure the best method is chosen to decompose the network into fragments and therefore to interrupt the chain of infection

Data basis

- 483 farms from a producer community in Northern Germany
- 4,635 movements in an observation period from 2006–2009
- Three different time periods with right-skewed distribution of all calculated centrality parameters
  - → Total three-year network (n = 1)
  - → Yearly networks (n = 3)
  - → Monthly networks (n = 36)



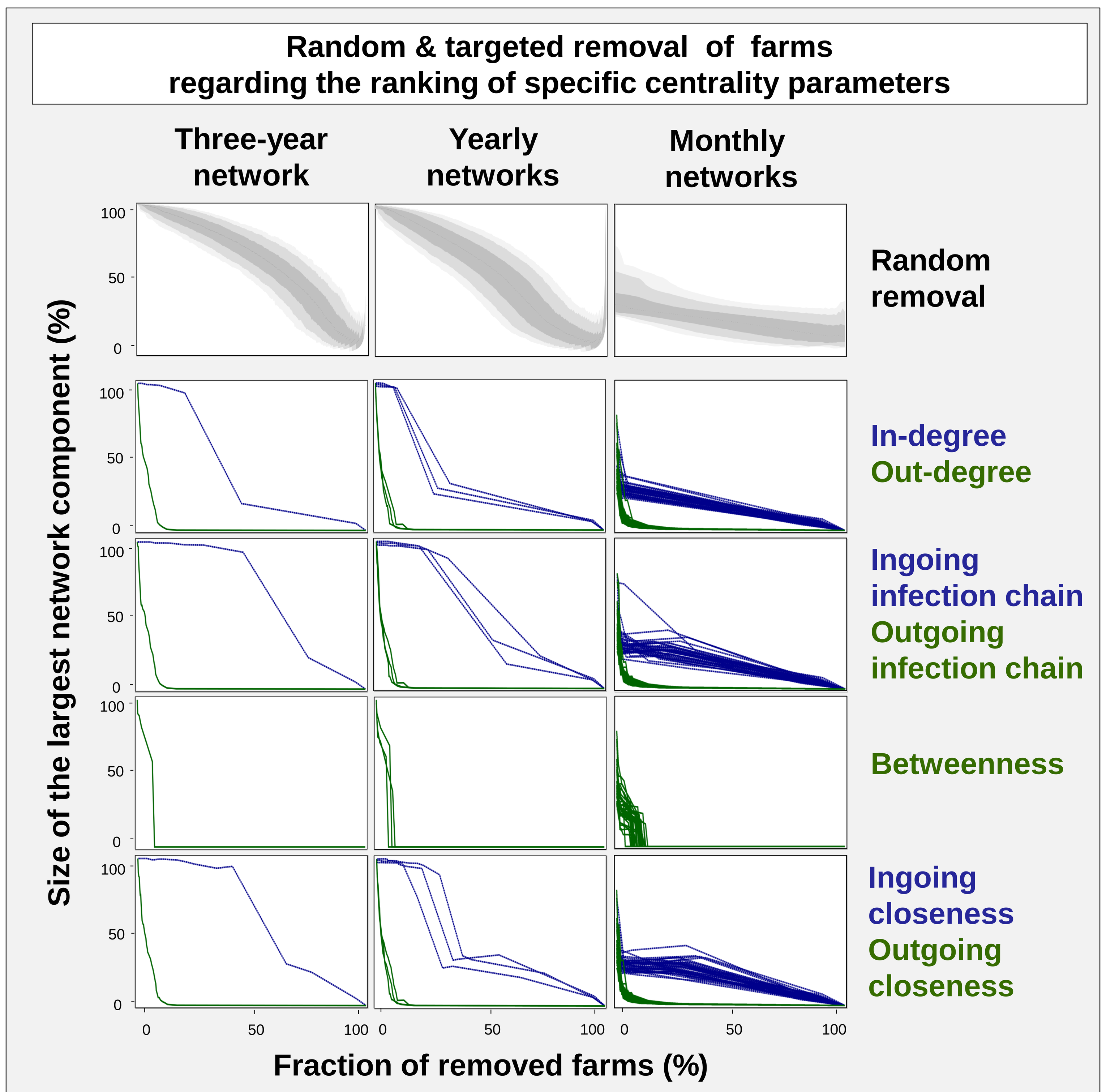
Interruption of infection chains

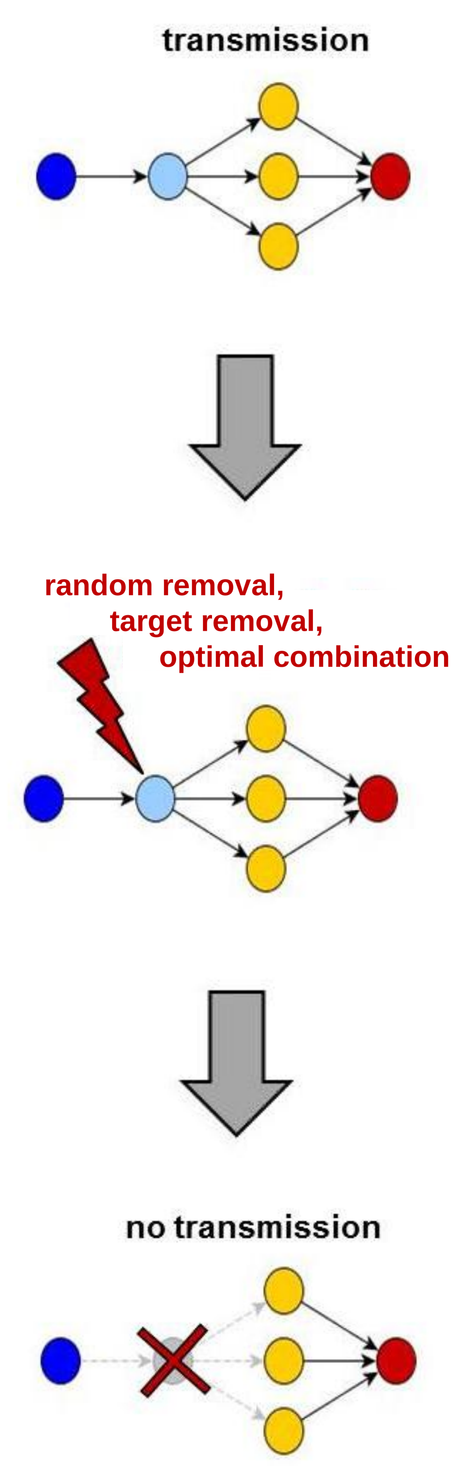
a. Random removal of farms (number of iterations = 1,000)

b. Targeted removal of farms regarding their ranking of specific centrality parameters
→ In- and out-degree, ingoing and outgoing infection chain, betweenness, ingoing and outgoing closeness

c. Optimal combination of three removed farms
→ maximum possible reduction of the size of the largest network component

Results





Proportion (%) of removed farms to reduce the size of the largest component by more than 75%

Parameter	Three-year network	Yearly networks	Monthly networks
In-degree	45.5	28.4	85.0
Out-degree	6.4	5.2	3.6
Ingoing infection chain	74.9	60.0	83.6
Outgoing infection chain	6.6	5.3	3.6
Betweenness	6.6	5.8	7.5
Ingoing closeness	65.0	33.3	83.0
Outgoing closeness	6.6	5.2	3.6

Improvement (%) of the optimal combination compared to the targeted removal regarding the centrality parameters

Parameter	Three-year network	Yearly networks	Monthly networks
In-degree	20.6	31.0	19.6
Out-degree	1.0	1.7	1.5
Ingoing infection chain	20.6	30.9	20.4
Outgoing infection chain	7.9	5.7	1.8
Betweenness	10.4	11.3	16.1
Ingoing closeness	20.6	30.9	18.4
Outgoing closeness	7.9	2.0	1.7

Conclusion

a. Random removal of farms did not induce a rapid fragmentation of the trade network

b. Targeted removal, e.g. via selective vaccination or culling, decomposed the network
→ Most appropriate parameters: Out-degree, outgoing infection chain, betweenness & outgoing closeness

c. In comparison to the optimal combination of removed farms the targeted removal of farms regarding the out-degree is the best method in all three observation periods

➢ **Most efficient interruption of the infection chain is obtained using targeted removal based on out-degree**

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