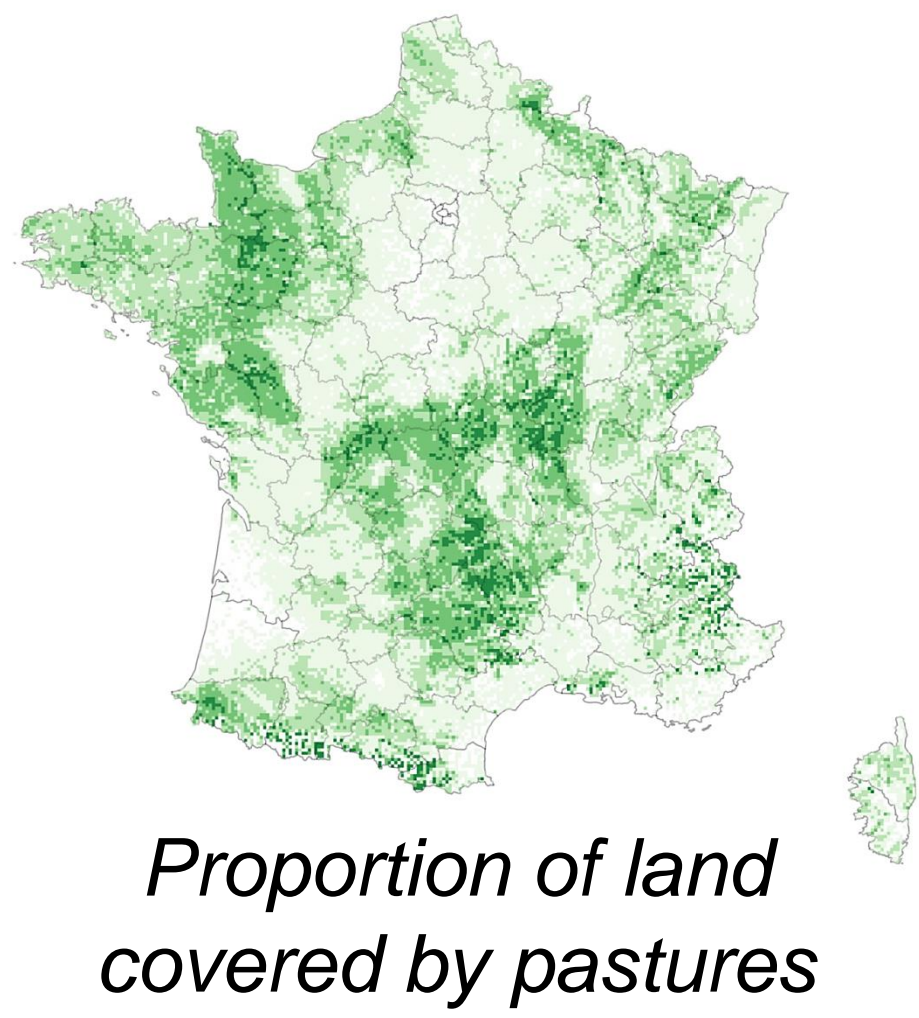


Can a pathogen invade France through pathogen transmission at pasture?

Aurore PALISSON^{1,2}, Aurélie Courcoul², Benoit DURAND²

BACKGROUND

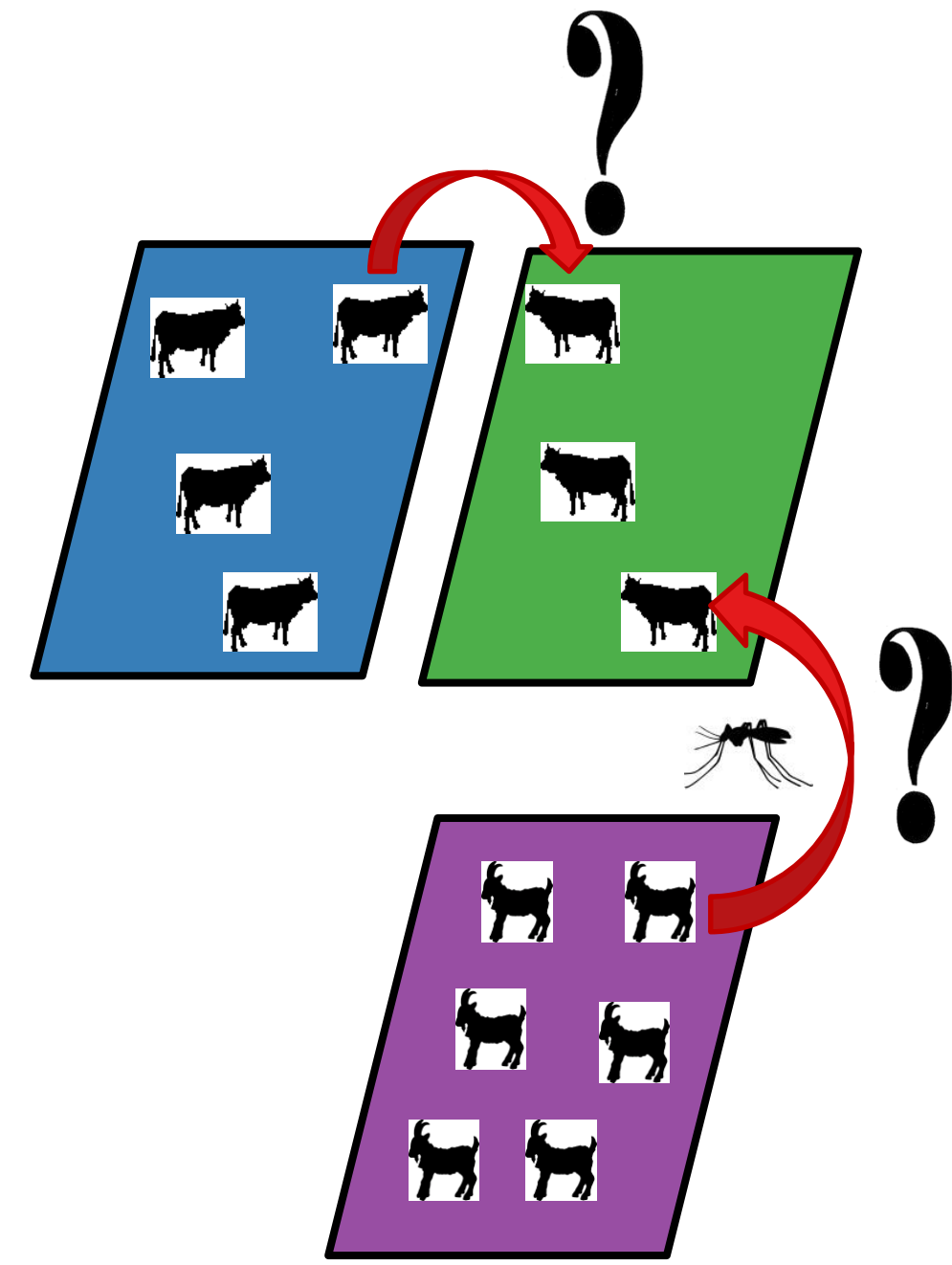
Grazing animals: possibility of direct and indirect contacts with animals located on distinct parcels of pasture
⇒ **potential transmission of a pathogen**



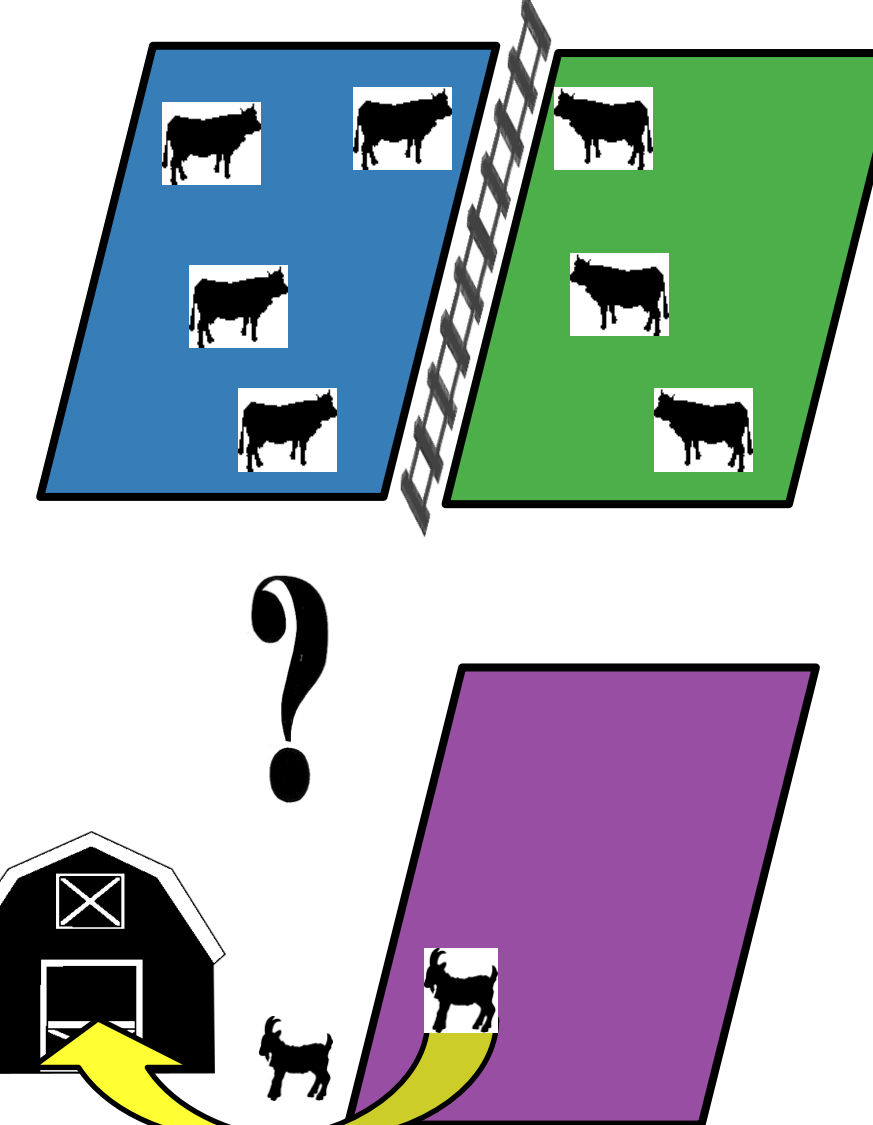
Proportion of land covered by pastures

In France, 3.2 millions parcels of pasture owned by 288,000 premises

QUESTIONS

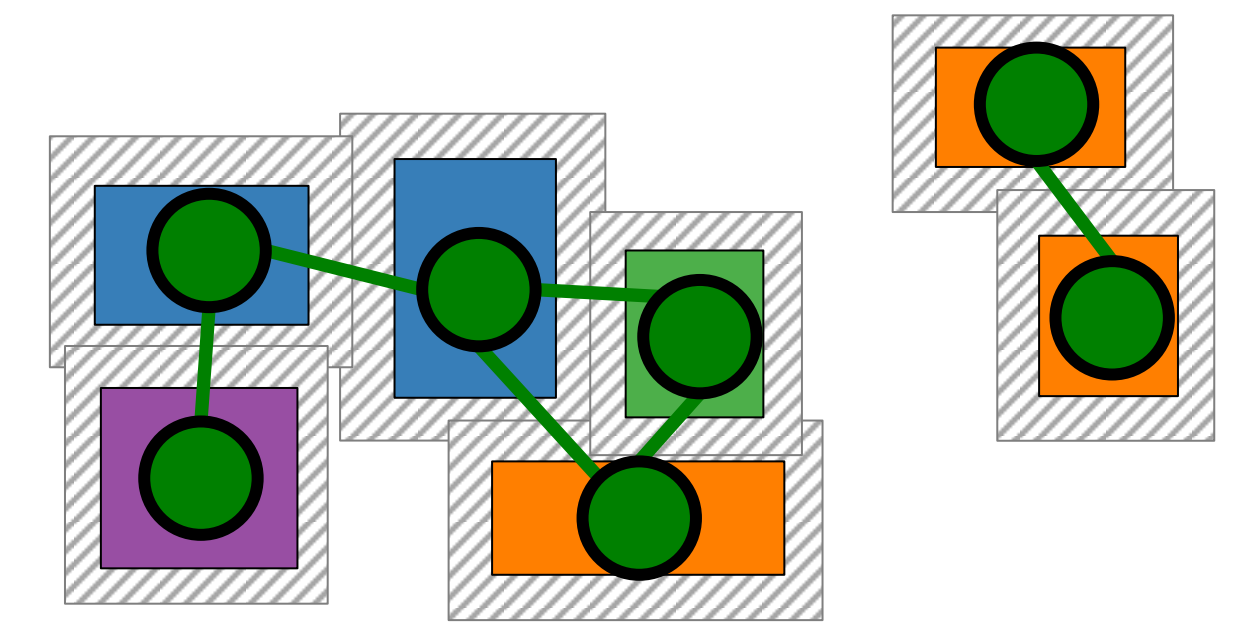


Is the spatial configuration of parcels of pasture favourable to pathogen spread?

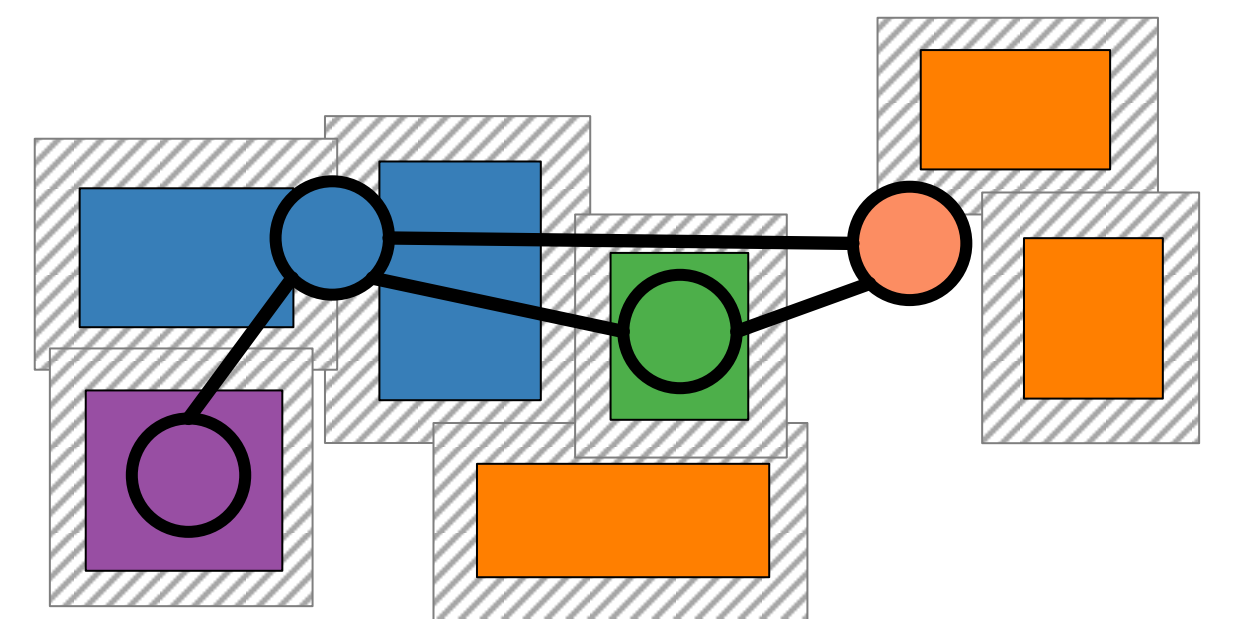


Which biosecurity measures would allow limiting pathogen spread?

NETWORKS



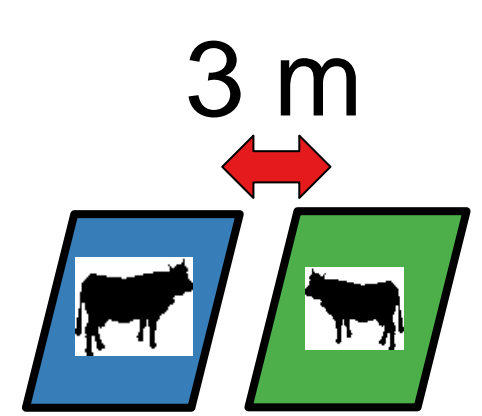
Pasture network
(a node = a parcel of pasture)



Premise network
(a node = a premise)

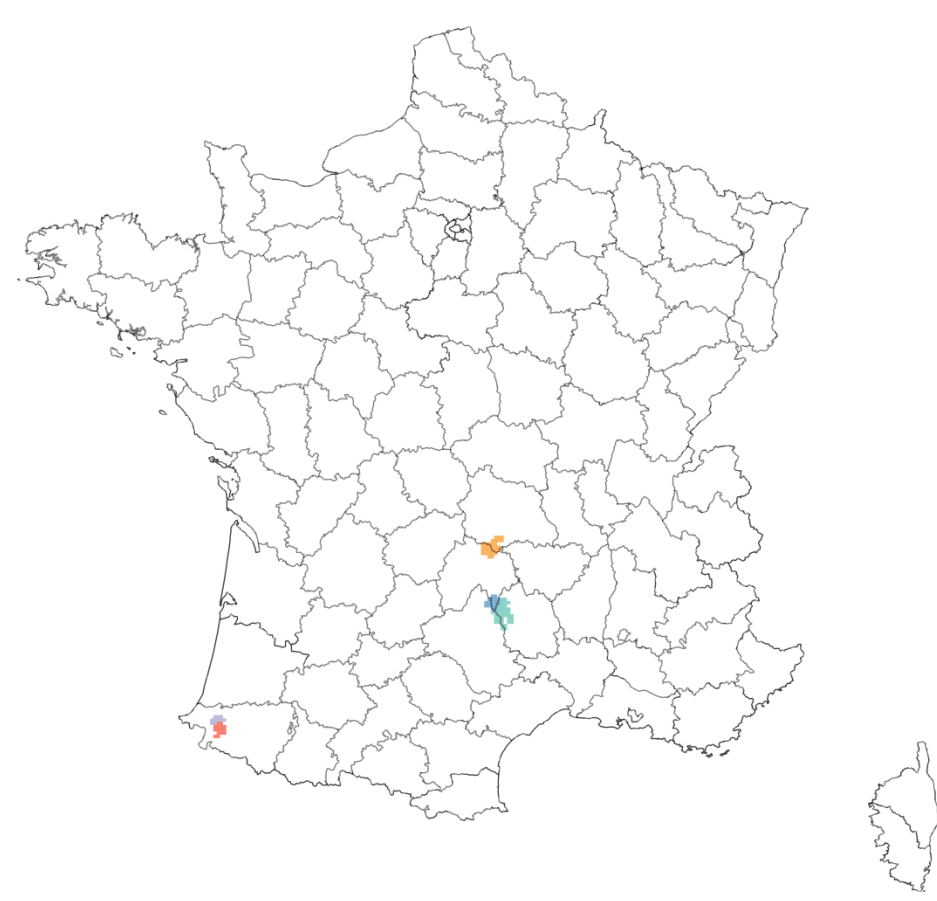
VULNERABILITY OF THE PASTURE NETWORK

DIRECTLY-TRANSMITTED PATHOGENS (OVER THE FENCE)



Pasture network: 3.2 millions nodes and 2.4 millions links. A node is connected on average to 1.5 other nodes.

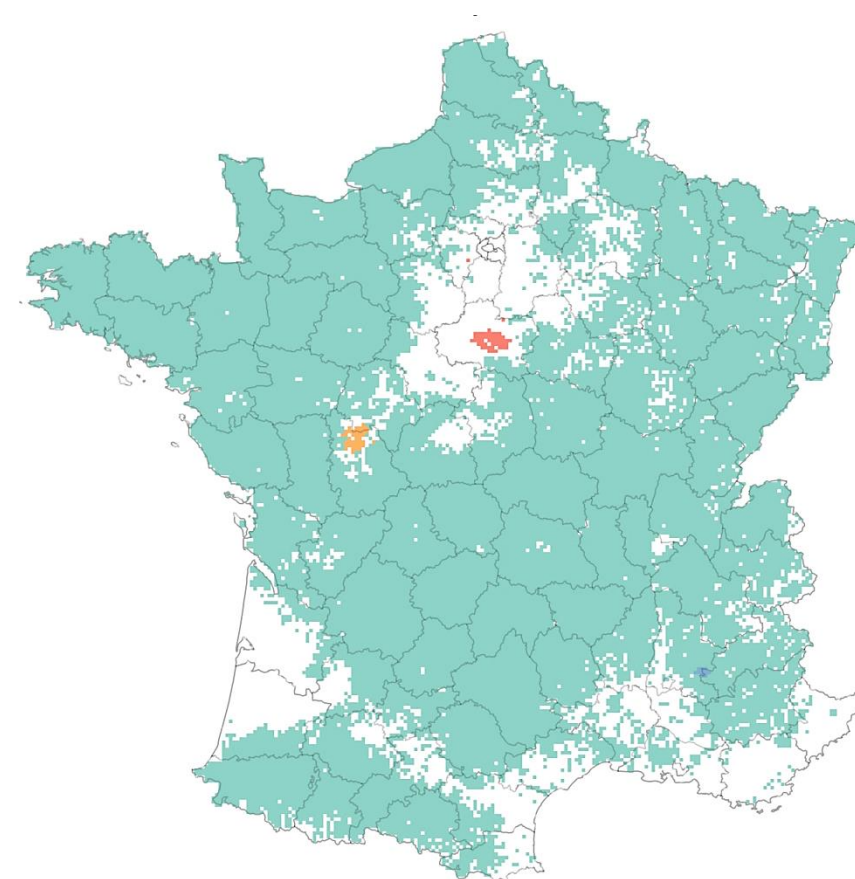
⇒ **strongly fragmented network with a largest component including less than 1% of nodes**



The 5 largest components of the pasture network

And if we add links between non-adjacent parcels of the same premise, with a probability p ?
(representing movements of animals between parcels of the same premise)

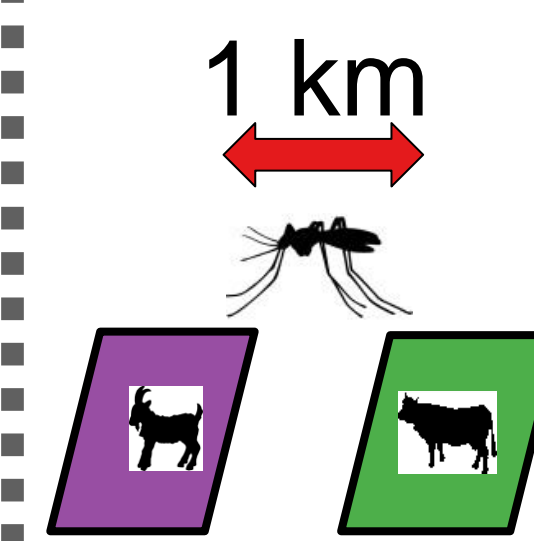
⇒ **with $p=0.2$, the largest component included 90% of nodes**
⇒ **highly connected network**



The 5 largest components of the pasture network ($p=0.2$)

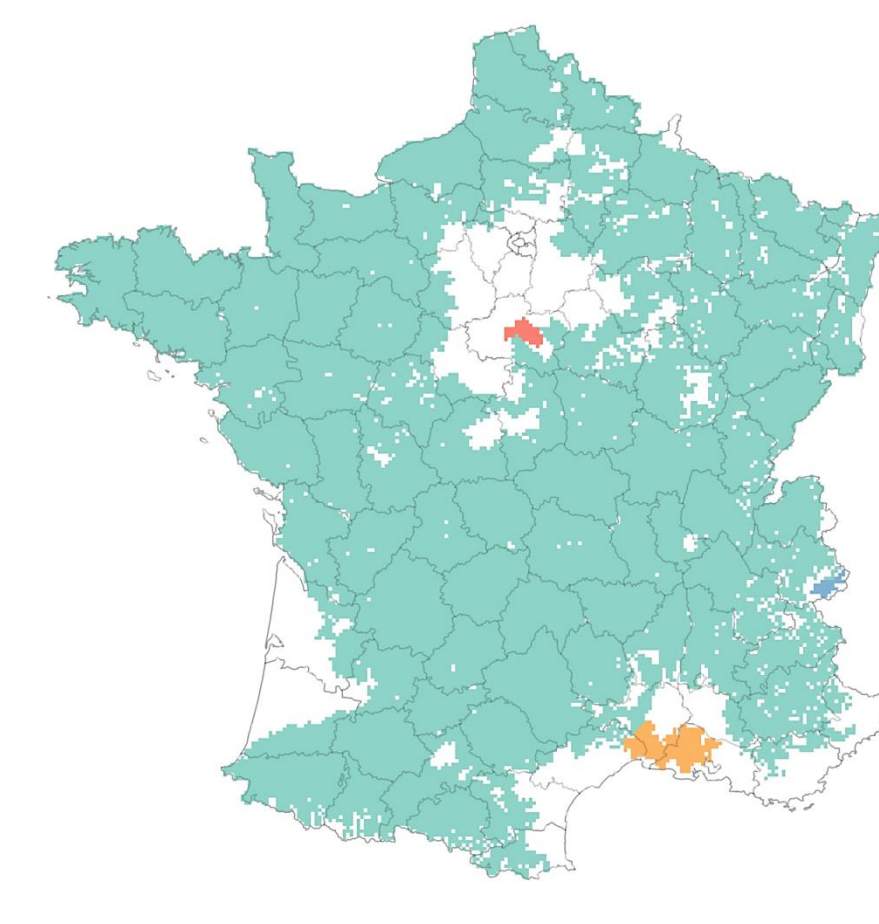
Easy spread of pathogens

VECTOR-BORNE PATHOGENS



Pasture network: 3.2 millions nodes and 102 millions links. A node is connected on average to 20.4 other nodes.

⇒ **strongly connected network with a largest component including 97% of nodes**



The 5 largest components of the pasture network

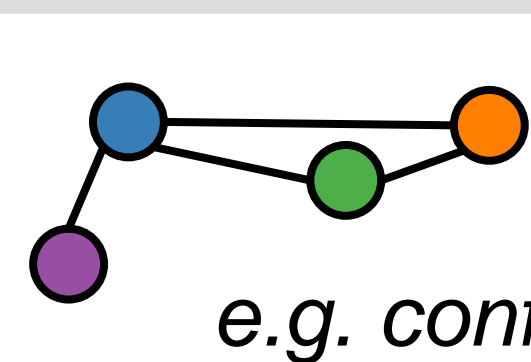
Easy spread of pathogens

BIOSECURITY IN THE PREMISE NETWORK

In the premise network, removal of nodes and/or links to mimic biosecurity measures

Prop: proportion of premises that have to adopt the biosecurity measures to make the network resilient to the spread of an infectious disease

GLOBAL BIOSECURITY

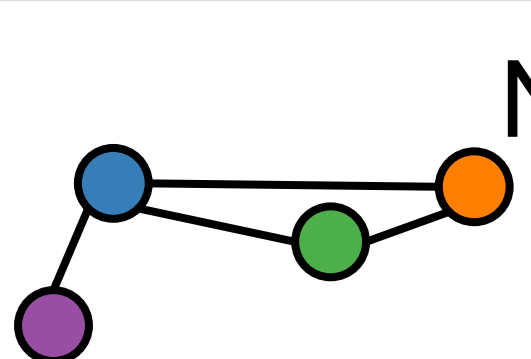
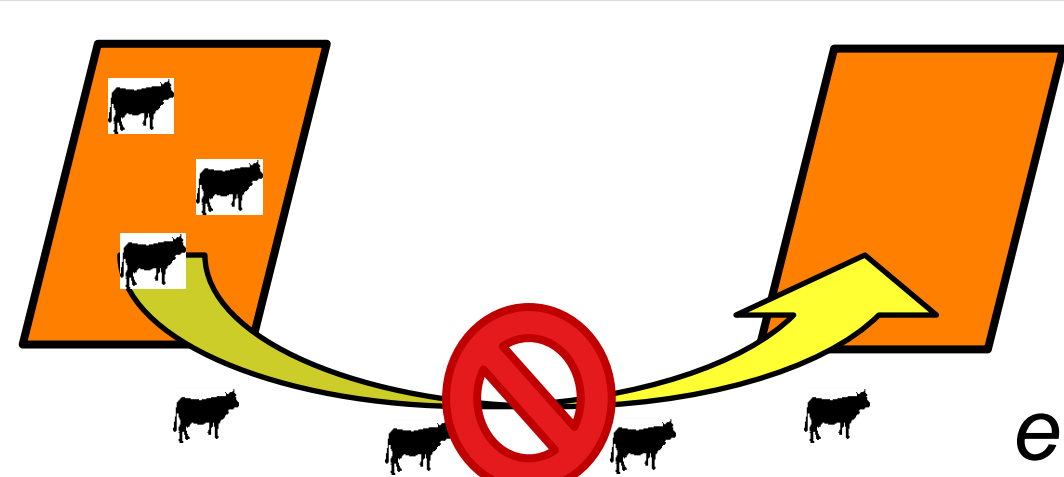


Node removal

e.g. confining animals inside buildings

Prop from 55% for directly-transmitted pathogens to 84% for vector-borne pathogens

WITHIN-HERD BIOSECURITY

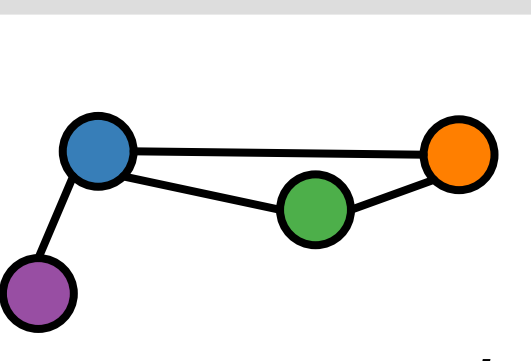


Node transformation

e.g. no animal movements between parcels of the same premise

Prop of 79% for directly-transmitted pathogens (impossible for vector-borne pathogens)

BETWEEN-HERD BIOSECURITY



Link removal

e.g. strengthening of fences, replanting hedges

Prop of 84% for directly-transmitted pathogens (not relevant for vector-borne pathogens)

CONCLUSIONS

⇒ **easy spread of pathogens through transmission at pasture**

⇒ **need of a large adoption of biosecurity measures to control directly-transmitted pathogens**



⇒ **biosecurity measures almost ineffective for vector-borne pathogens**



¹ University Paris Sud, Villejuif, France
² University Paris Est Créteil, Anses, Laboratory for Animal Health, Epidemiology unit, Maisons-Alfort, France

Contact: Aurélie Courcoul - aurelie.courcoul@anses.fr



Acknowledgements:

We thank the French Ministry of Agriculture and Paris Sud University for their financial support.

The data were provided by the "Agence de Services et de Paiements" (ASP).