Towards a multi-objective approach to design effective biosecurity plans for livestock epidemics

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The epidemic spread in livestock farm systems is a major concern, causing the culling of a large number of animals and negative economic and social impacts. Thus, to prevent and control livestock epidemics it is crucial to design effective biosecurity plans, accounting for a multiplicity of objectives. In this context, quantitative epidemiological studies can help explain the possible disease transmission patterns and assess the role of farms in the diffusion process.

Here, we evaluated the potential functional role played by farms in shaping the pattern of epidemic spread. As a focal case study, we considered the dairy system in the Emilia Romagna region (Northern Italy). We developed a data-driven daily temporal network model with nodes representing farms, the epidemiological units, and links describing the potential routes of pathogen transmission. We grouped links in two layers, one for *direct contacts* due to the movement of live cattle and the other for *indirect contacts* generated by contaminated trucks visiting several farms. We simulated the diffusion of epidemics on the network through a Boolean Susceptible-Infected model.

The role of each farm was assessed with respect to a set of objectives focusing on different aspects of the infection process. Then, in a multi-objective space, we identified the set of the most critical farms, where the implementation of biosecurity measures may reveal to be more effective. Trade-offs between the objectives did emerge, showing that the identification of key farms is not trivial and may crucially depend on the specific measures applied.