Increasing realism in modelling pathogen transmission in poultry production and distribution networks: a novel agent-based modelling framework

Francesco Pinotti

ISVEE16, Halifax, 12/08/2022













SPECIAL ISSUE ARTICLE

Factors influencing chicken farmers' decisions to implement prevention and control measures to reduce avian influenza virus Intensification of fragility: Poultry production and spread under endemic conditions distribution in Bangladesh and its implications Suman Das Gupta, Guillaume Fournié, Md. Ahasanul Hoque, Joerg Henning 😰 for disease risk First published: 16 August 2020 | https://doi.org/10.1111/tbed.13757 | Citations: 3 Article Open Access Published: 07 October 2021

Hub goals

- Characterise networks through which chickens are produced and distributed (PDNs)
- Identify points of high disease risk
- Understand transmission and evolution of pathogens
- Improve sustainability and safety of poultry systems



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Preventive Veterinary Medicine Volume 191, june 2021, 105367



Mathew Hennessey ^{5, 5}名甲, Guillaume Fournié¹, Md, Ahasanul Hoque⁴, Paritosh K Ayako Ebata *, Rashed Mahmud *, Mahmudul Hasan ¹, Tony Barnett ^{4, b, b, h}

Avian influenza transmission risk along live poultry trading networks in Bangladesh

Natalie Moyen 🖾, Md. Ahasanul Hoque, Rashed Mahmud, Mahmudul Hasan, Sudipta Sarkar, Paritosh Kumar Biswas, Hossain Mehedi, Joerg Henning, Punam Mangtani, Meerjady Sabrina Flora, Mahmudur Rahman, Nitish C. Debnath, Mohammad Giasuddin, Tony Barnett, Dirk U. Pfeiffer & Guillaume Fournié



Mapping PDNs



Hennessey et al, Prev Vet Med, 2021





Avian influenza in PDNs



PDN elements are interdependent

Need for a comprehensive modelling framework





Generating synthetic PDNs - an ABM approach





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Synthetic farm population



10

Cycles / year

20





15 Trade duration (days)



Middlemen activity









Vendor activity





Inter-market mobility



- Dense

- Sparse

- Hierarchical

How does vendor mobility affects mixing of chickens?

Experiments with tunable network model

(50 farming areas, 20 markets)





Epidemic spread







Within-flock transmission





Between farm transmission





Multi-strain dynamics

Seed each region with own strain







Conclusions

Take home messages:

- Novel, data-driven framework to simulate epidemic dynamics in PDNs
- Interdisciplinarity: integrates knowledge from other studies
- Easy to extract quantities of interest
- Relevant for a range of epidemiological and ecological questions

Research Questions

- Impact of PDN configuration on pathogen persistence, emergence, ...
- Linking simulations to phylodynamics studies

In the making...

- Behavioural mechanisms (compliance with biosecurity)
- Public health interventions (market closure, ring culling, ...)



Collaborators

- Sunetra Gupta
- José Lourenço
- Guillaume Fournié
- One Health Poultry Hub



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Contacts

- Website: francesco-pinotti.netlify.app
- Mail: <u>francesco.pinotti@zoo.ox.ac.uk</u>













francescopinotti92