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CDG Poultry & Eggs, Brussels

VACCINATION OF POULTRY AGAINST HPAI – PART 1

AVAILABLE VACCINES AND VACCINATION STRATEGIES

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EUROPEAN FOOD SAFETY AUTHORITY

TERM OF REFERENCES

1. Update on the available vaccines against HPAI for poultry
2. Vaccination strategies

→ **publication in Oct 2023**

3. Surveillance in the vaccinated zone and/or vaccinated establishments
4. Restrictions and risk mitigation measures to be applied in a vaccinated establishment or a vaccination zone

→ **by March 2024**

https://open.efsa.europa.eu/study-inventory/EFSA-Q-2022-00550

TOR 1 – AVAILABLE VACCINES

TOR 1 – AVAILABLE VACCINES

- **Inactivated vaccines** or **vaccines based on technologies other than live attenuated AIV**
- Prototypes of vaccines still in an early stage of development have been only mentioned when relevant

- **Data sources**:
  information retrieved by the literature review,
  pharmaceutical company websites,
  responses to the survey and network consultation

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EUROPEAN MEDICINES AGENCY
SCIENCE MEDICINES HEALTH

efsa
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TOR 1 – VACCINE CHARACTERISTICS

Vaccines retrieved were described according:

- Virus subtype
- Vaccine type/technologies (replication competence, development method, production technology, GMO status, and maternal immunity interference)
- Administration protocol (poultry species, administration route, number of doses)
- Onset and duration of immunity
- Antigenic distance
- Vaccine efficacy parameters

TOR 1 – VACCINE CHARACTERISTICS

Technology	Poultry species (experimental data)	Administration route	Vaccine name	Estimated antigenic distance (AU)	Lineage, clade	Predicted efficacy of a vaccine to stop sustained HPAIV transmission in a vaccinated population (VE_T)
Inactivated full virus	Chickens (Pekin ducks, turkeys)	Subcutaneous or intramuscular	Nobilis Influenza H5N2(NL)	4.37	Eurasian H5	< 0.5 in chickens after 1 dose
Inactivated full virus	Poultry (Muscovy ducks)	Subcutaneous	Vaxigen Flu H5N8(IT)	2.32	2.3.4.4b	in chickens >0.9; in Muscovy ducks <0.5 after 1 dose, >0.9 after 2 doses
Subunit	Chickens (Muscovy, Pekin, mule ducks, turkeys)	Subcutaneous	Volvac B.E.S.T. AI + ND(FR, IT)	4.18	2.3.2	In mule duck > 0.9 (after 2 doses); in Muscovy ducks 0.8-0.9 after 1 dose, >0.9 after 2 doses; in Pekin ducks >0.9
Live vector	Chickens (ducks, turkeys)	In ovo or subcutaneous	Vectormune AI(IT, NL)	4.18	2.2	in chickens > 0.9; in turkeys 0.5-0.8
Replicon	(ducks, geese, chickens, zoo birds)	Intramuscular	Duck H5-SRV vaccine®(FR, HU)	2.32	2.3.4.4b	> 0.9 in mule ducks
Nucleic acids (DNA)	(chickens, turkeys)	Intramuscular	ExactVac – Vaxliant ENABLE adjuvant(IT, NL)	2.51	2.3.4.4a	<0.5 in chickens after 1 dose

The only authorised in the EU

DIVA strategies

TOR 1 –VACCINE TYPE AND TECHNOLOGIES

Large array of **vaccine types and technologies** available with only a small proportion produced commercially and used in the field outside of scientific studies:

- classical **oil-adjuvanted inactivated whole virus** vaccines remain the most widely used (not bound to poultry species-specific limitations, allows for easy manufacturing and offers potential versatility in strain adjustment) but not for DIVA strategies differently from the **recombinant** ones that can rely on already commercially available and consolidated serological assays
- Although there is no specific experience with AI **vectored vaccines** in the EU, the same vector backbone technology (e.g. recombinant HVT) is widely used for prevention of other diseases (e.g, IBD, NDV, ILT)
- **Nucleic acid-based** vaccines hold promise for the poultry sector particularly for their characteristic to allow for a smooth adaptation to the circulating strains compared with whole virus vaccines

TOR 1 – AVAILABLE VACCINES AND CHARACTERISTICS

- There is a significant **lack of usable and harmonised data** regarding the **characteristics** of available vaccines
- Most available poultry vaccines are designed for and evaluated in **chickens**
- Most of the available vaccines **administered through injection**

TOR 1 - AVAILABLE VACCINES AND CHARACTERISTICS

- Minimum **age for the first administration** varies, ranging from 1 day to 6 weeks of age, with some live vectored vaccines administered *in-ovo*/in the hatchery
- Knowledge of the **time** required to confer **protection** and of the **duration** of the immunity induced is often lacking as well as the influence of **maternal immunity** on schedule and the number of doses
- Certain live vectored vaccines (**HVT**) are less affected by maternal immunity and can be given early even in the presence of maternally derived antibodies
- **Humoral immunity** has been measured from **10 to 14 days** following primary vaccination, however more time or even successive vaccine doses may be required to obtain full protective immunity; for HVT there is slower onset of immunity (4 weeks)
- Benefits of vaccination are extremely limited for **short-lived poultry** such as broiler chickens

TOR 1 - AVAILABLE VACCINES AND CHARACTERISTICS

Vaccine types and technologies – recommendations

- Generate **suitable and harmonised data** :
  - the **onset and duration of immunity** particularly for long living poultry types
  - the **impact of maternal immunity**
  - the indications of vaccines for **poultry species other than chickens** and considering **different poultry production types**

- The development of **mass applicable** AI vaccines

- In the **planning of a vaccination programme** it is recommended:
  - to **avoid interference** with maternal and vector-related immunity
  - to **overcome immunity waning** over time (subsequent use of different vaccines)

TOR 1 - AVAILABLE VACCINES AND CHARACTERISTICS

Antigenic distance - recommendations

- When relying on vaccines that primarily induce **strain-specific humoral immunity**, antigenic distance should be given strong consideration
- Standardised continued **in silico antigenic distance calculations** and **HI assay-based antigenic cartography** of relevant HPAIV strains and variants circulating in Europe should be carried out
- Recommendations on the **most relevant strains to be included in AIV vaccines** in Europe should be issued from harmonised vaccination-challenge experiments which are based on strains selected from antigenic distance evaluations
- The authorised vaccines should be **rapidly updated** if required based on the match with the circulating strains; for this purpose, continuous surveillance efforts to **monitor virus evolution** are needed

TOR 1 - AVAILABLE VACCINES AND CHARACTERISTICS

Vaccine efficacy - recommendations

- **Harmonised data** should be generated and collected on VE to reduce R_0<1 under **experimental** condition and to assess **effectiveness in field trials** taking into account regional differences

- For long-lived poultry types, the **duration of immunity** to reduce transmission and immune waning should be studied

TOR 2 – VACCINATION STRATEGIES

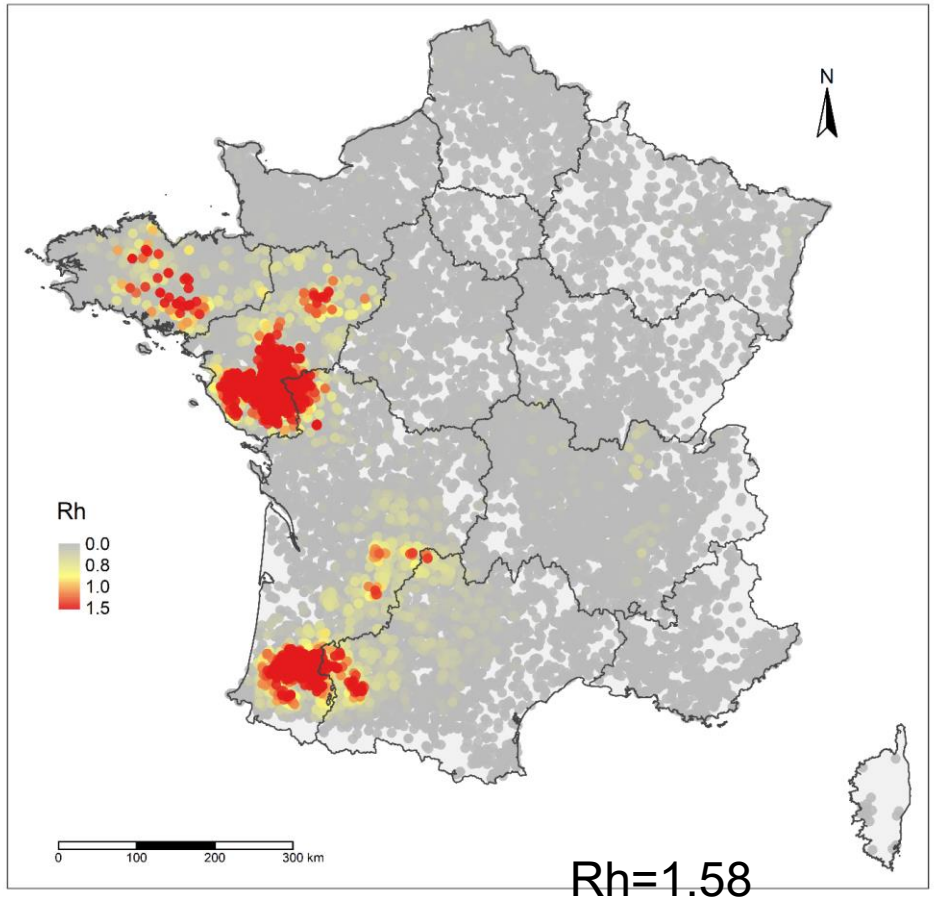
TOR 2 – VACCINATION STRATEGY SCENARIOS

- A number of specific **vaccination scenarios** focussing on the main domestic poultry species - **ducks**, **turkeys**, **chickens** - were defined using data from **France, Italy and the Netherlands** as case studies
- The virus was assumed to be introduced via wild birds into **densely populated poultry areas**, where the risk of between-farm transmission is the highest
- The **between-farm transmission** and the **impact of the vaccination scenarios** were then investigated using a **SEIR** model framework incorporating a **spatial kernel** for between-farm transmission dynamics

likelihood of virus transmission between farms is dependent on the distance between the source farm i and the destination farm j and the corresponding poultry type

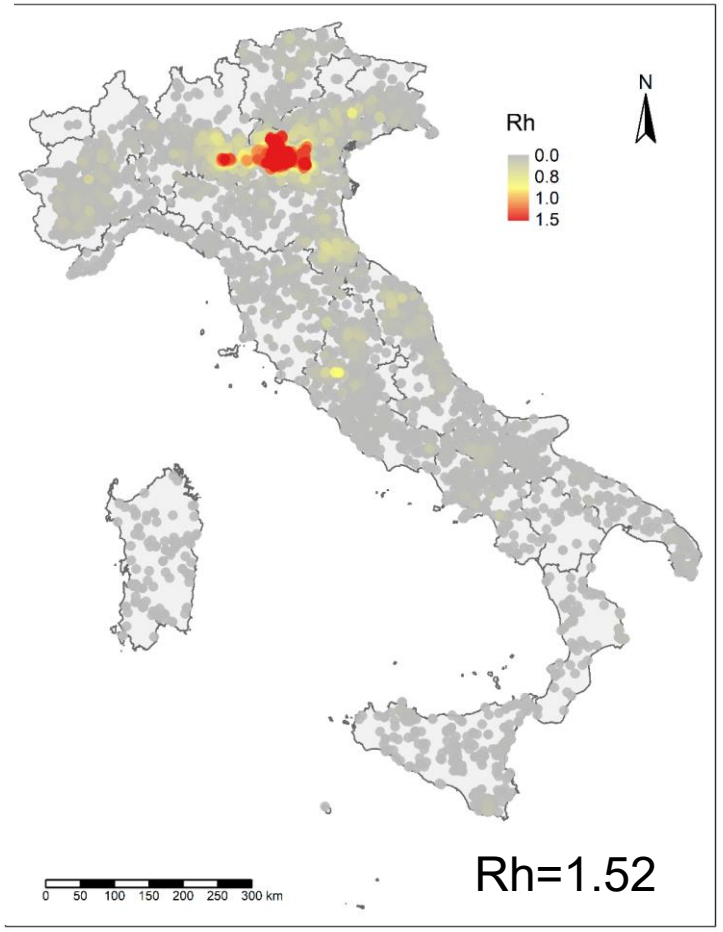
TOR 2 – TRANSMISSION MAPS

Rh are the between-farm reproduction numbers quantified using the kernel. Areas where Rh > 0.8 are considered high-risk areas for transmission



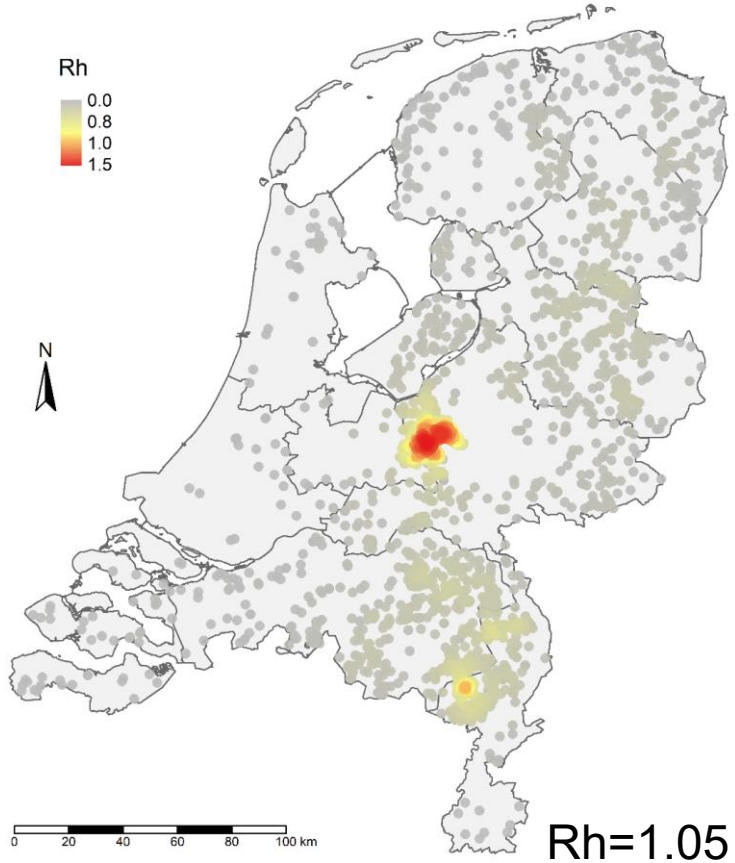
Rh=1.58

(farm density > 0.54 farm/km2)



Rh=1.52

(farm density > 0.52 farm/km2)



Rh=1.05

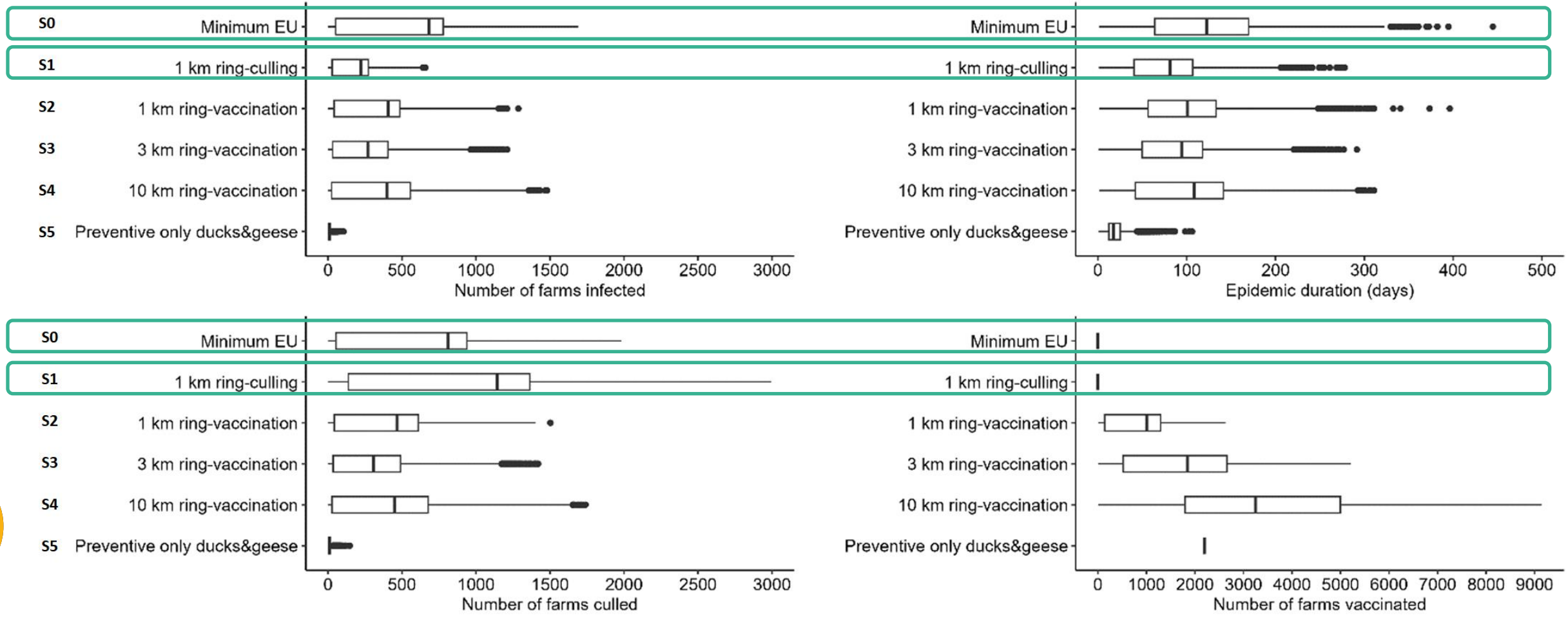
(farm density > 0.84 farm/km2)

TOR 2 – VACCINATION SCENARIOS

Scenario 0 (S0)	**No vaccination** Culling in all infected poultry farms
Scenario 1 (S1)	**No vaccination** Culling in all infected poultry farms Preventive ring **culling** in all poultry farms within **1-km** radius of infected poultry farms

TOR 2 – VACCINATION SCENARIOS

Results from the model simulation for each scenario in **France**



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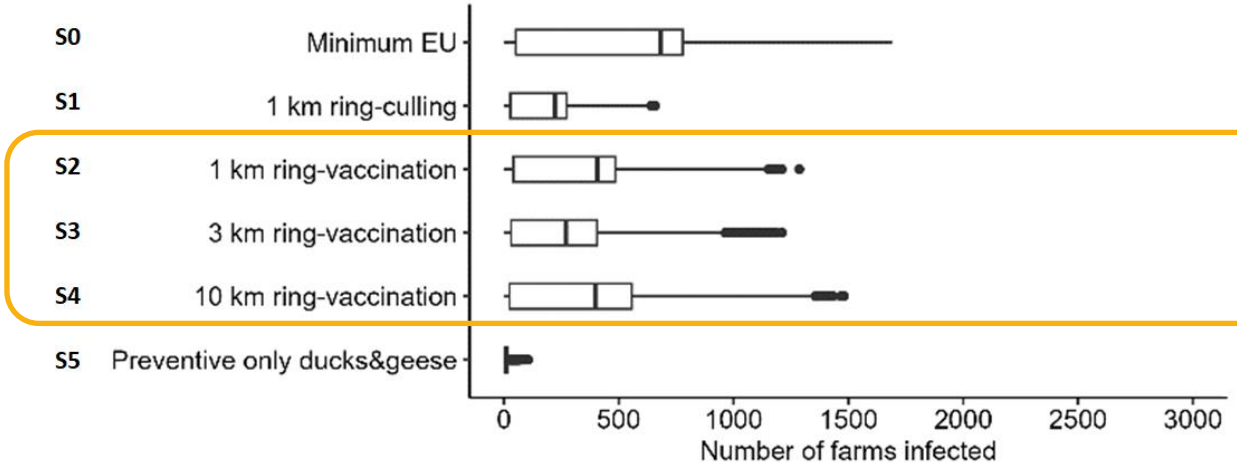

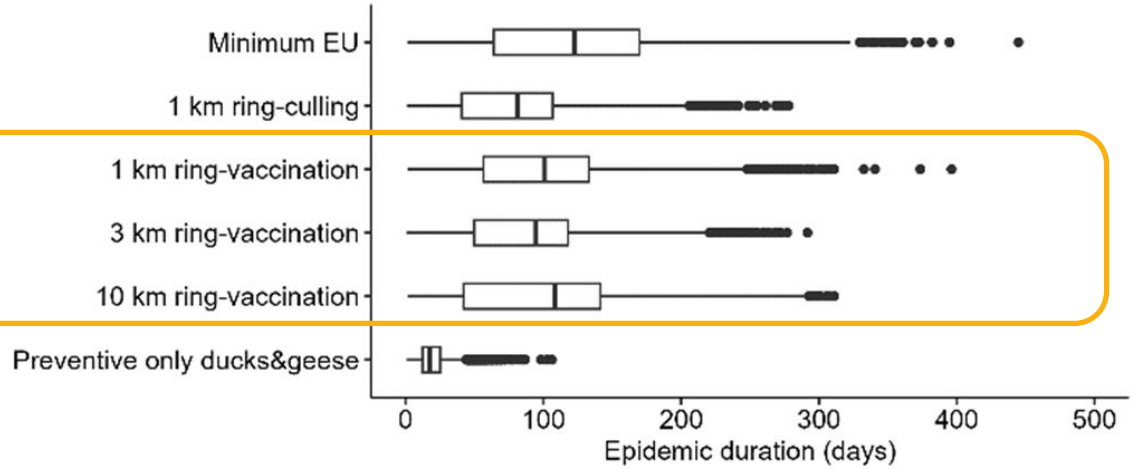

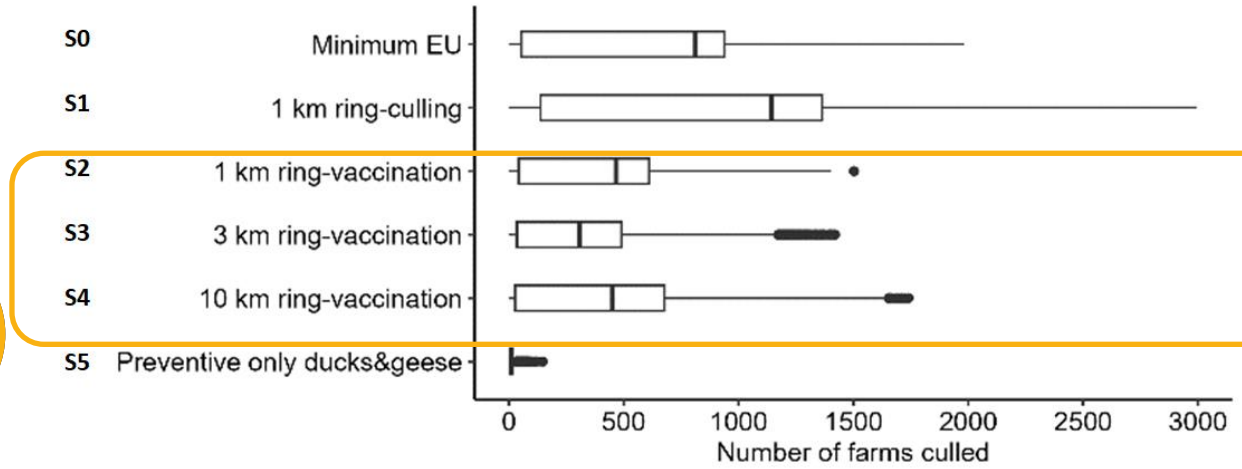

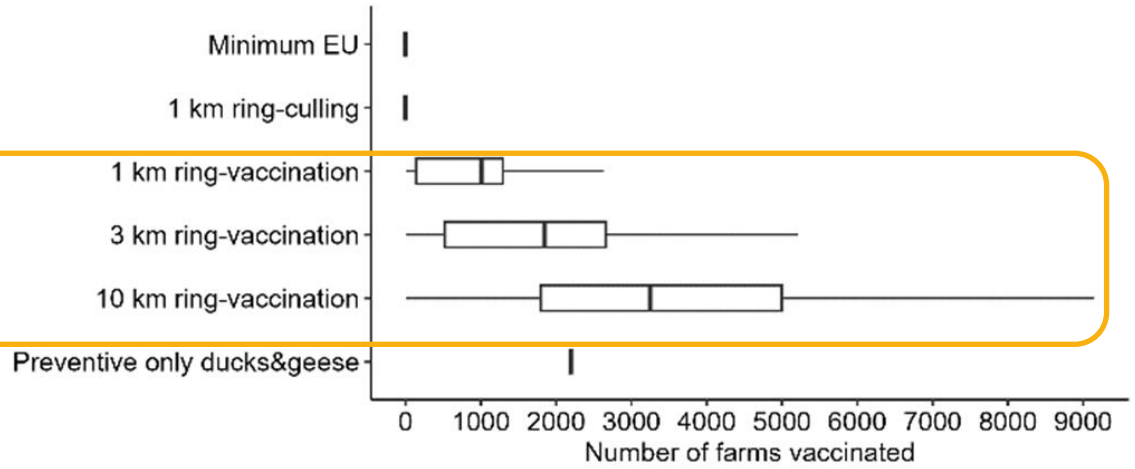

TOR 2 – VACCINATION SCENARIOS

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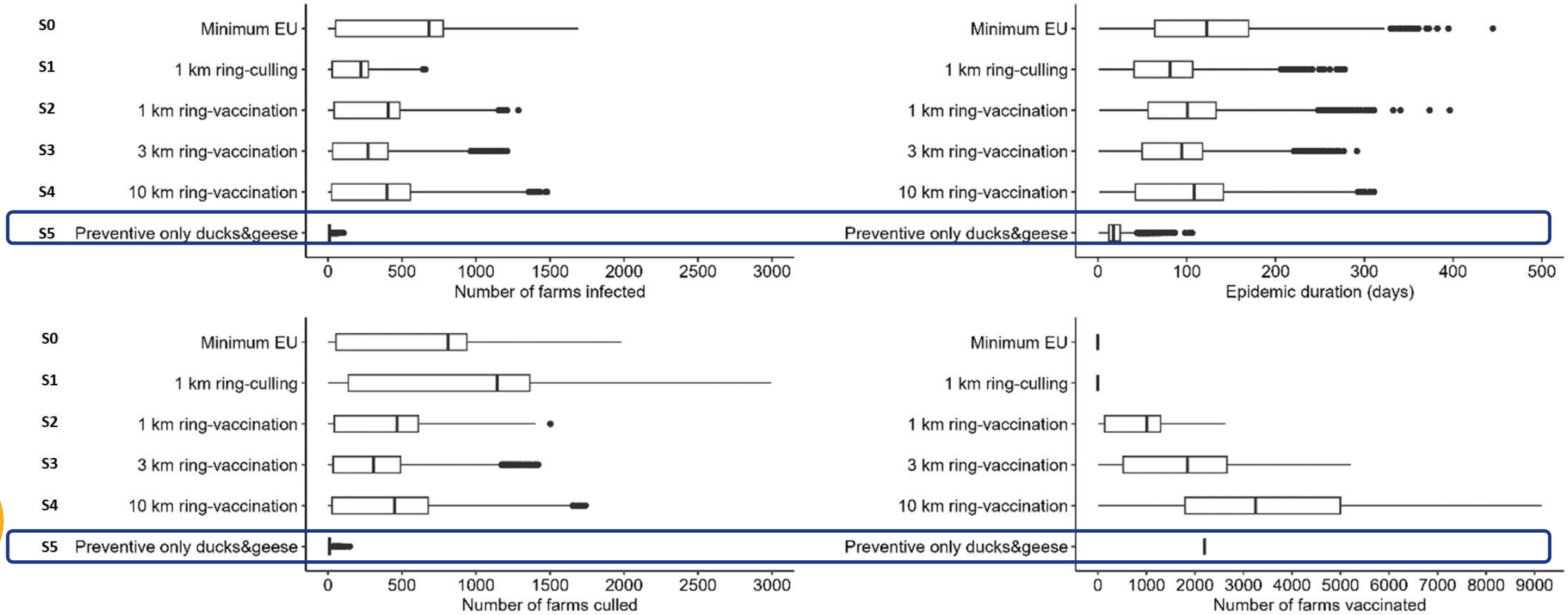
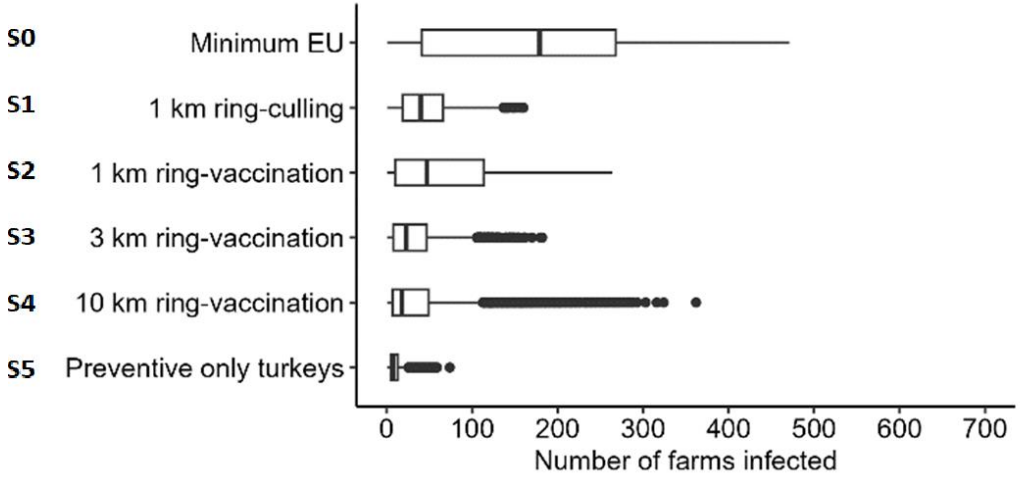
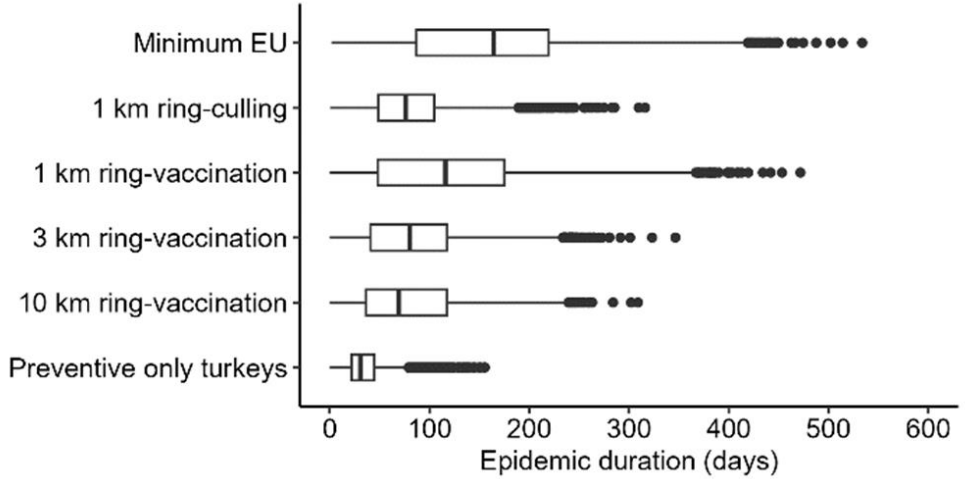
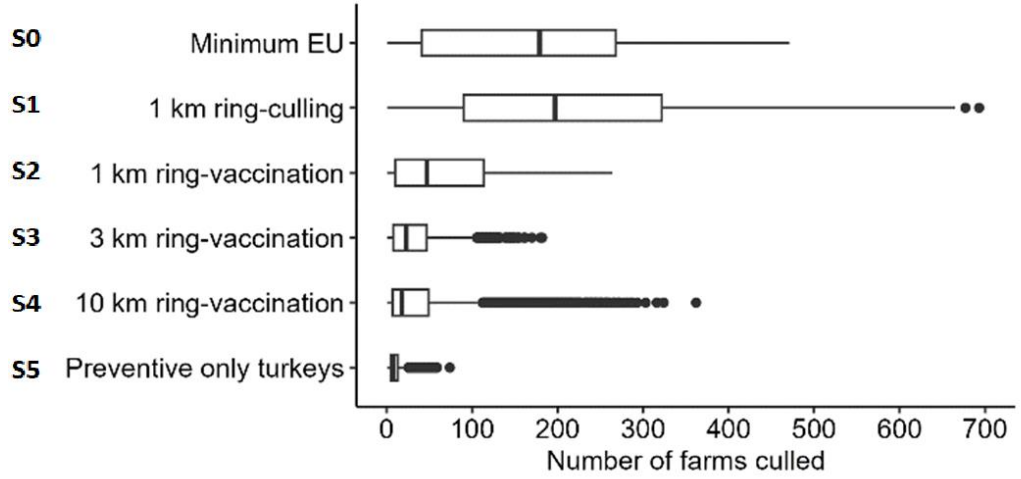


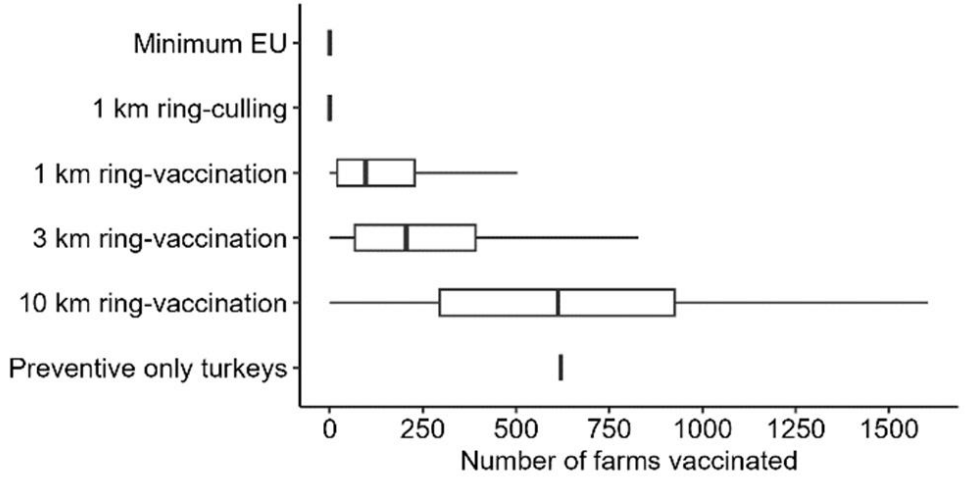
TOR 2 – VACCINATION SCENARIOS

Results from the model simulation for each scenario in **Italy**



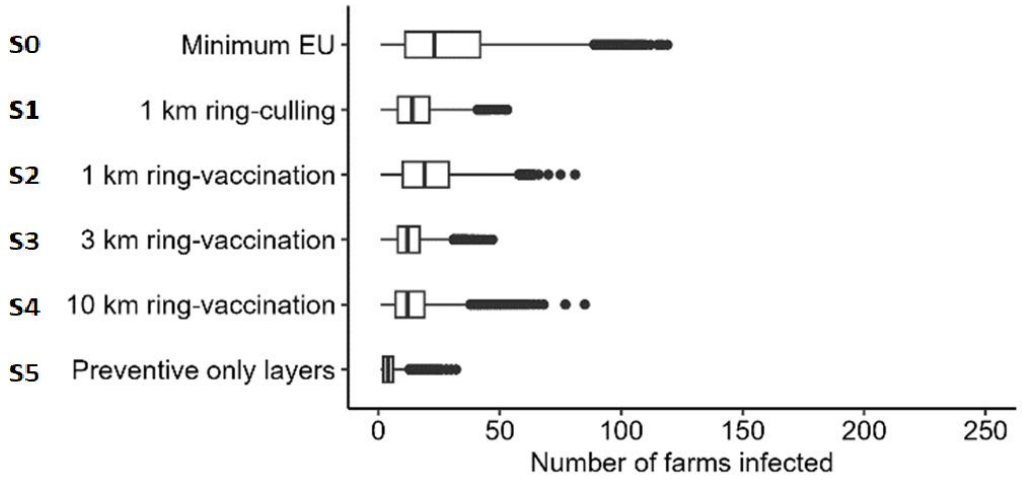


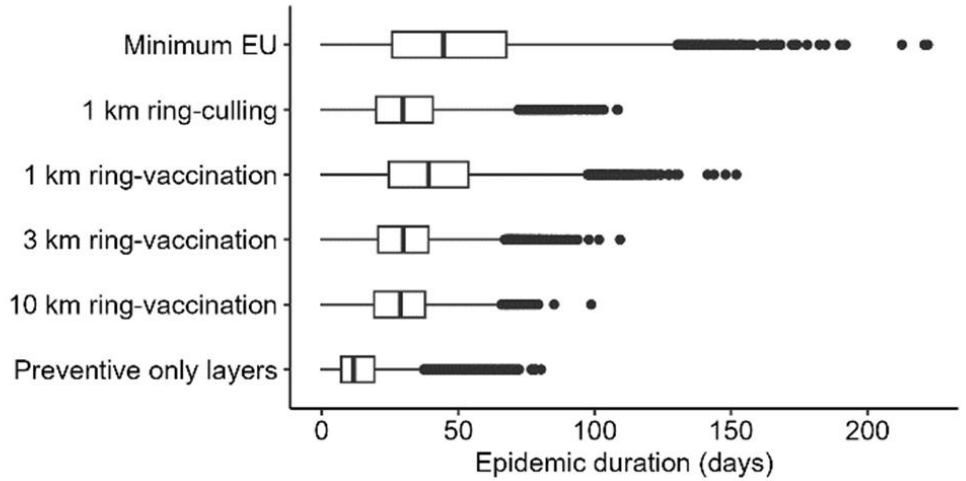


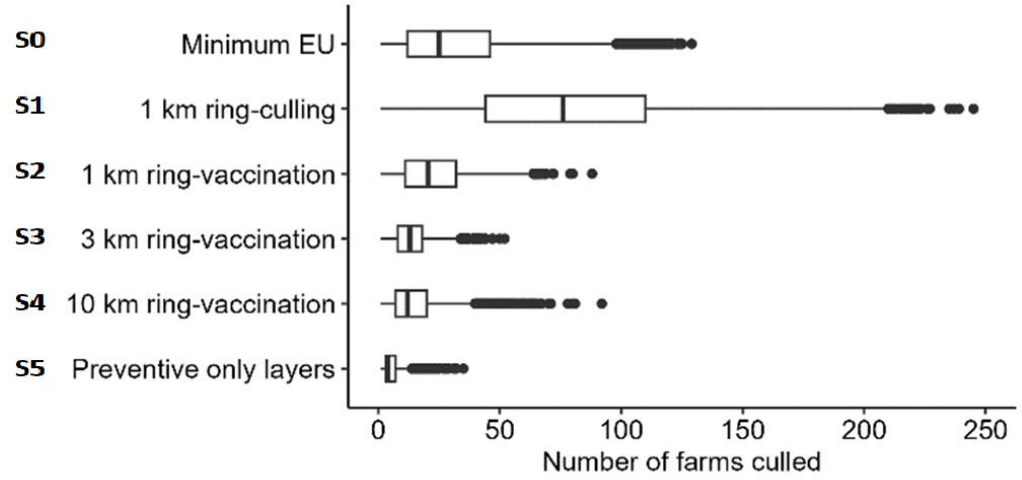


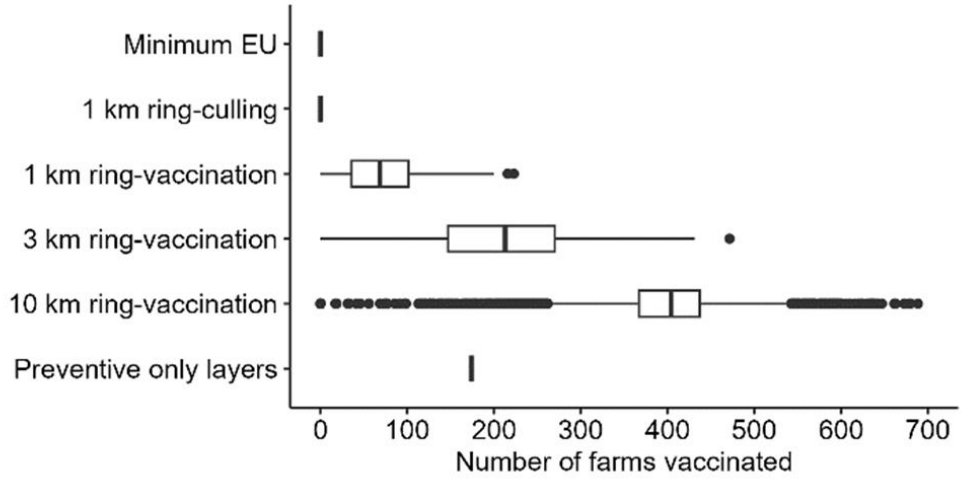
TOR 2 – VACCINATION SCENARIOS

Results from the model simulation for each scenario in **the Netherlands**









TOR 2 – VACCINE TYPE AND FREQUENCY OF ADMINISTRATION

When planning a vaccination programme, the most adequate **vaccine** type and vaccination scheme **should be selected** considering the epidemiological situation, antigenic distance from the circulating strain, population-specific parameters (poultry species, age, production type, other vaccination programs), supervision capacities and the vaccination strategy:

- **emergency protective-** inactivated vaccines that can be administered to all poultry species/production types/age, leading to rapid onset of immunity and short antigenic distance should be used, while vectored vaccines, in some cases, cannot be used due to the preexisting immunity against the vector; also, in principle, a single dose of an effective vaccine would be sufficient to curtail the between farms virus transmission
- **preventive-** this could target those species/poultry types most susceptible and/or infectious in the area at the highest risk of infection; in addition to inactivated vaccines, vectored vaccines are suitable for vaccinating *in ovo* and day-old; repeated vaccination will be needed to ensure continued protection

TOR 2 – VACCINATION SCENARIOS

- To minimise the number of infected and culled farms and epidemic duration, **preventive vaccination of the most susceptible and/or infectious poultry species is recommended** in high-risk transmission areas. Depending on the region, these species are ducks, geese, turkeys and layers chickens
- In case of an outbreak in a high-risk transmission area, **emergency protective vaccination in a 3-km radius is recommended**, as it showed to be the most effective strategy among the three emergency vaccination scenarios tested
- **Monitoring of vaccine efficacy over time** should be planned under the implementation of every vaccination strategy, due to possible changes in the antigenicity of circulating HPAI viruses, changes that can also be accelerated by the selection pressure exerted by vaccine-induced immunity

TOR 2 – VACCINATION SCENARIOS

- For **areas with high risk of introduction from wild birds and low farm density**, preventive vaccination could be considered to reduce the number of outbreaks resulting from primary introductions

- It is a crucial prerequisite that **vaccination should not replace other preventive and control measures** such as infection monitoring in wild birds, early detection and biosecurity, but complement them to reinforce their impact, so to adopt an integrated disease prevention and control approach

THANKS TO ALL THE EXPERTS INVOLVED

Working group experts

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