Epidemiology of FMD in vaccinated dairy herds: Transmission dynamics & persistence of carrier state

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USDA

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Introduction

- FMD is endemic in India, with more than 2000 outbreaks reported over a span of 5 years .

- **Research objective:** to study transmission dynamics during an outbreak and the length of carrier stage post-outbreak in natural conditions in vaccinated dairy herds in India

(Biswal et al., 2012; Subramaniam et al., 2013)

Overview

- Outbreak 1: Within-herd transmission dynamics
  - Chattisgarh, India
- Outbreak 2: Post-outbreak dynamics
  - Mukteshwar, India

Within-farm transmission dynamics in a vaccinated dairy farm

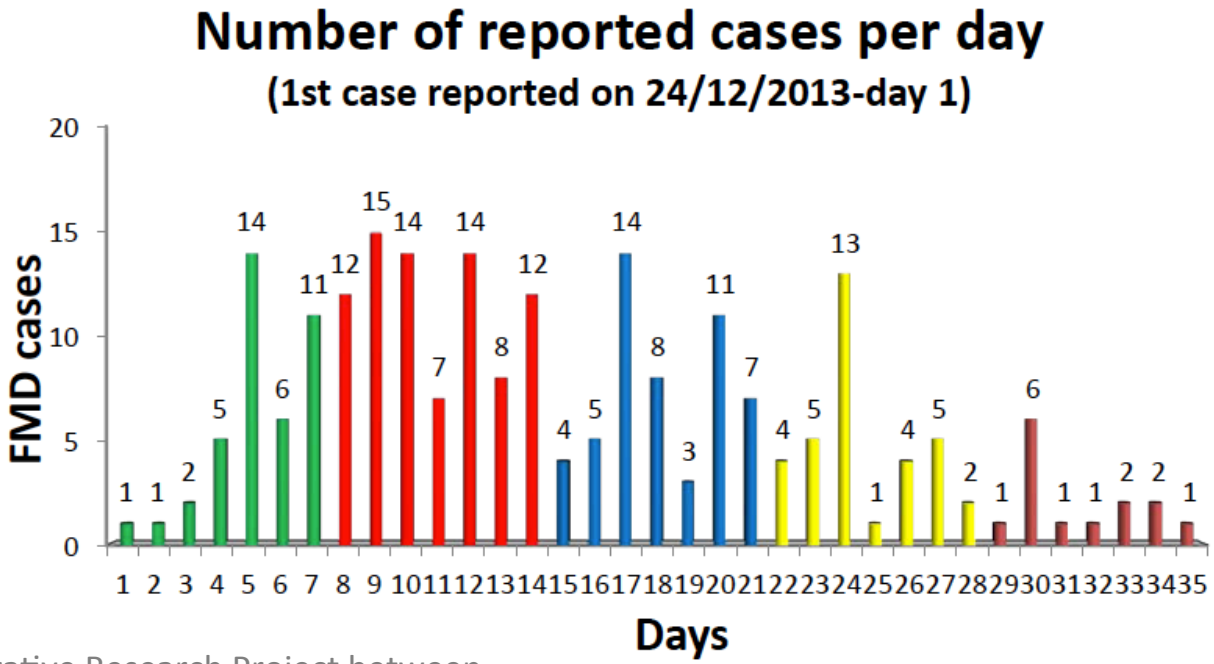
Background

– A large dairy farm consisting of 1836 adult dairy cattle located in Chattisgarh, India experienced an outbreak of serotype O
  - 24th December, 2013 to 31st January 2014 (36 days)

– All animals were vaccinated 47 days prior to the outbreak and were regularly vaccinated 3-4 times per year before that

Within-farm transmission dynamics in a vaccinated dairy farm

- Objective: **We use data from an outbreak of FMDV in a vaccinated dairy farm to estimate β and vaccine protectiveness**
  - Most estimates of within-herd transmission coefficients, or β, are based on lab experiments.

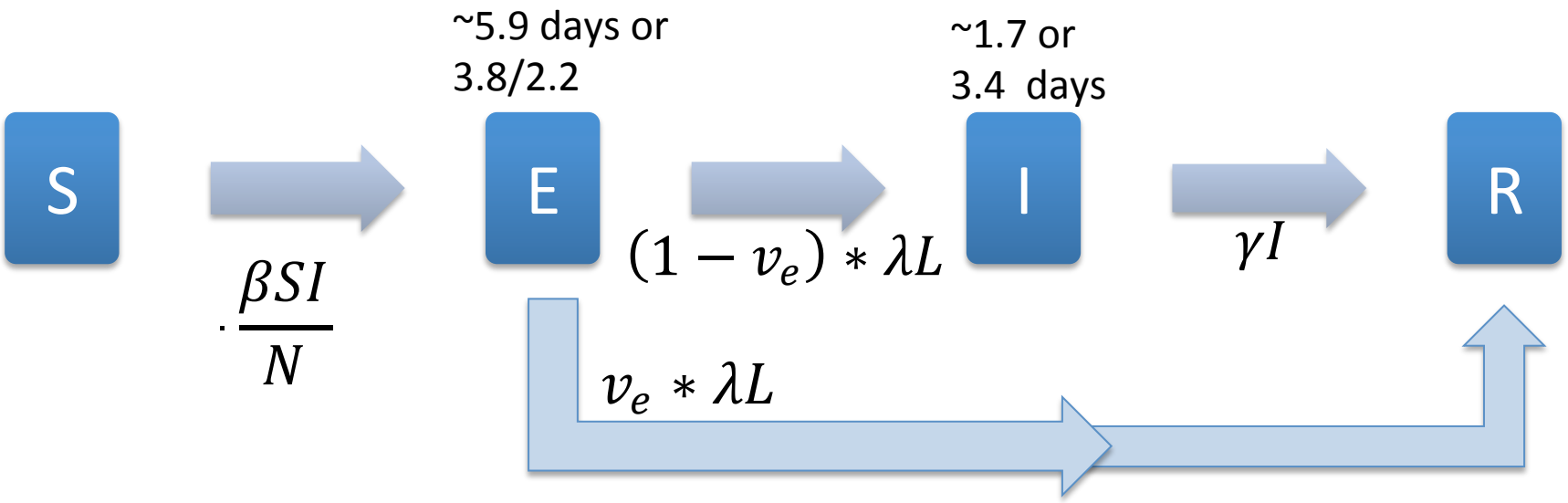


Figurefrom: *FMD Summary Report,* Collaborative Research Project between
The Project Directorate on Foot-and-Mouth disease (PDFMD), ICAR and the Agricultural Research Service (ARS), USDA

Within-farm transmission dynamics in a vaccinated dairy farm

Methods

- An SEIR model was fit to the observed daily incidence using maximum likelihood approaches



(Charleston et al. 2011; Mardones et al. 2010)

Within-farm transmission dynamics in a vaccinated dairy farm

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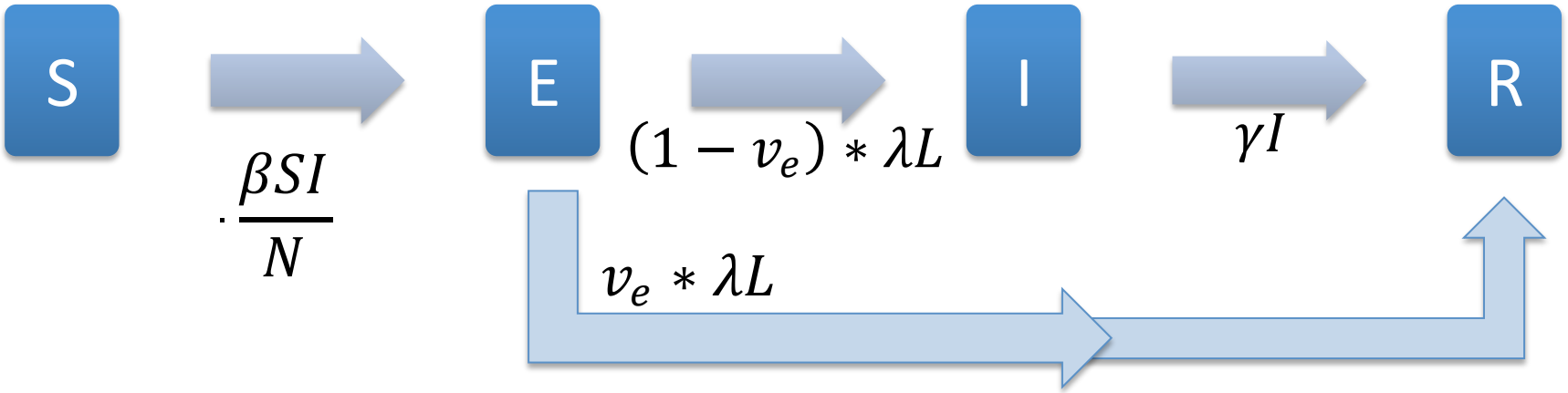
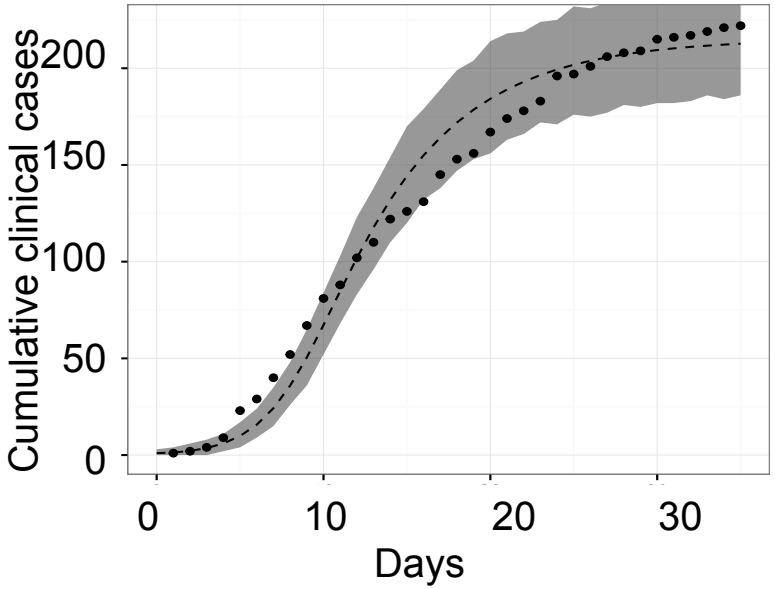


(Charleston et al. 2011; Mardones et al. 2010)

Within-farm transmission dynamics in a vaccinated dairy farm

Results

- Vaccine protectiveness (% of animals that do not experience clinical infection) = 88%
- β (frequency dependent)= 38.1 (32.5-45.1)
- β (density dependent)= 0.022 (0.018-0.025)



Within-farm transmission dynamics in a vaccinated dairy farm

Results and Conclusions:

- Risk factors for clinical disease
- Association of animal physiology with the probability of being a FMD case in a naturally infected, vaccinated herd

  – Risk factors were explored with multivariate Poisson regression

Within-farm transmission dynamics in a vaccinated dairy farm

Risk factors for clinical disease

- Association of animal physiology with the probability of showing clinical signs in a naturally infected, vaccinated herd

- The rate at which non-pregnant cows show clinical signs was 1.8 to 2.4x higher than pregnant cows ($p < 0.0001$)*
- Age and number of lactations were not significant

*Risk factors were analyzed with a multivariate Poisson regression (Lyons et al. 2015)

Post-outbreak Dynamics

Background

- 2 adjacent farms located in Mukteshwar, India
  - Farm A: 1 mo. to 2 yr old calves, steers and heifers.
  - Farm B: Adult lactating cows (> 2 years old)
  - Dates: 22nd and 27th October, 2013 (4 days post vaccination)

- **Objective: Study the dynamics of the carrier stage post-infection**

Post-outbreak Dynamics

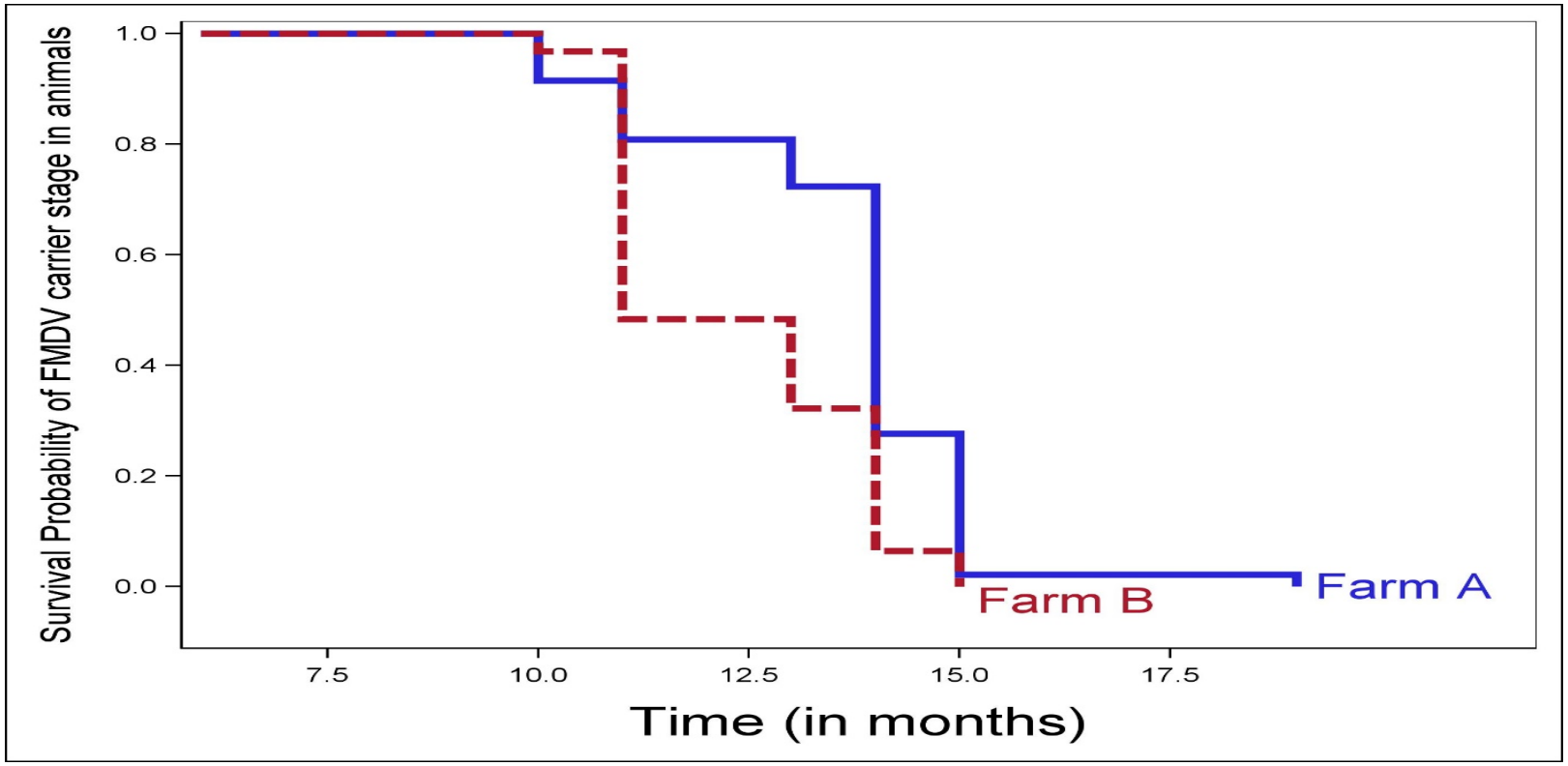
Background

- Carriers (n=78) were sampled monthly from 6 to 23 month post outbreak for:
  - Presence of viral particles in oropharyngeal fluids by multiplex PCR and rRT-PCR.
  - Antibodies against non-structural proteins
  - Carrier state extinction: 4 consecutive negative tests

Post-outbreak Dynamics

Results

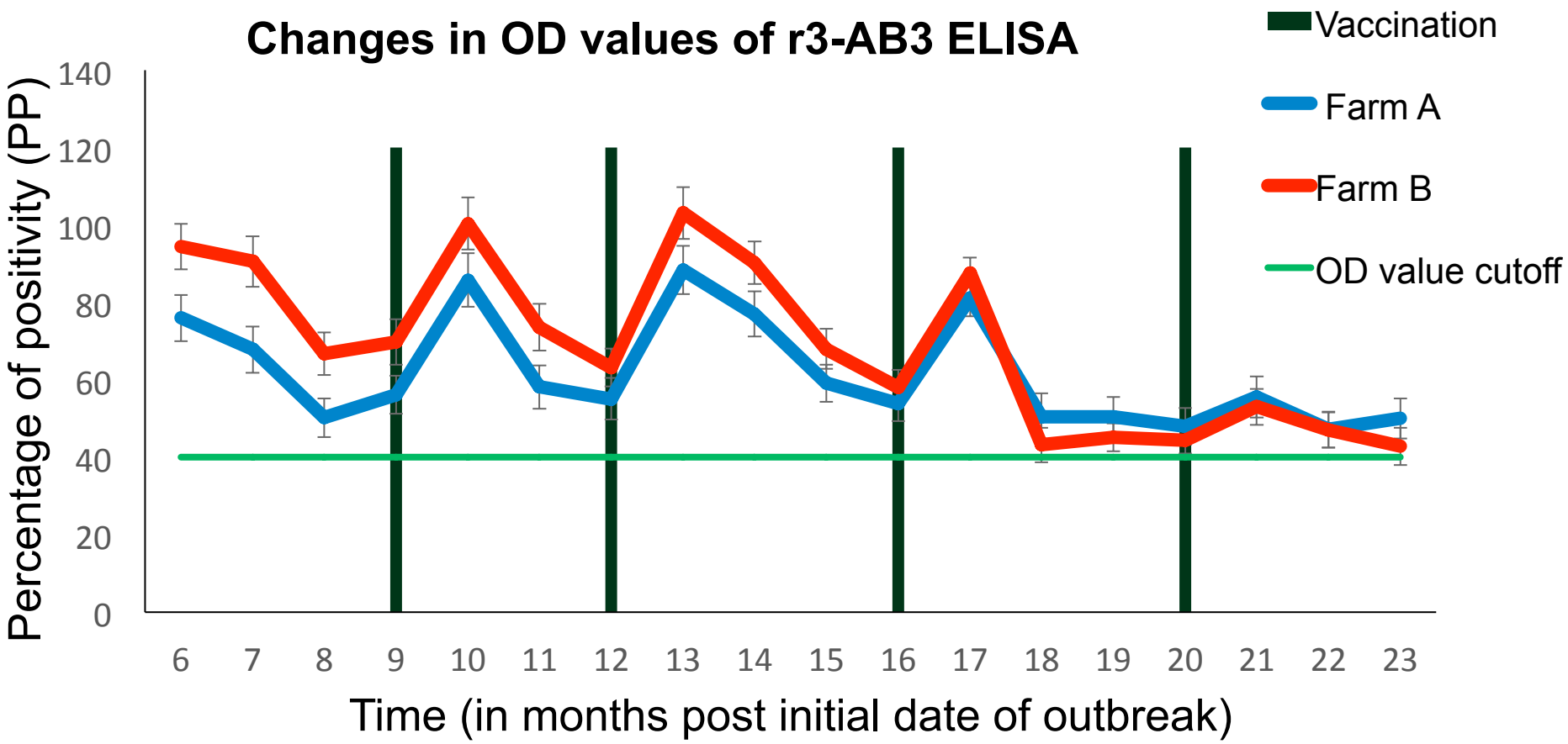
- Average length of carrier stage was ~13 months at both farms



Post-outbreak Dynamics

Results

- NSP OD values increased post vaccination



Conclusions

- Transmission rate of serotype O in a vaccinated dairy was ~38, with 88% of animals protected from clinical infection through vaccination

- Persistence of carrier state was ~13 months
- Impure vaccines can transiently increase levels of non-structural proteins

Thank you

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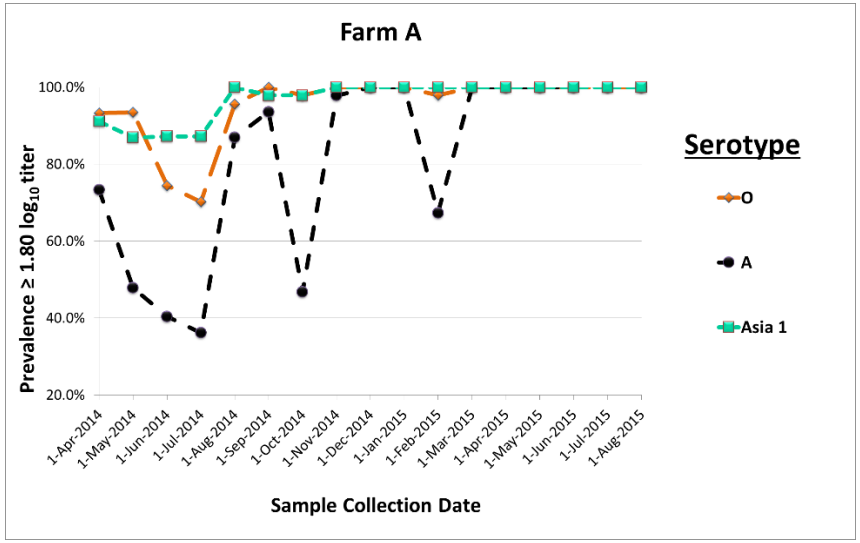
Farm A
100.0%
80.0%
60.0%
40.0%
20.0%
Prevalence ≥ 1.80 log10 titer
1-Apr-2014
1-May-2014
1-Jun-2014
1-Jul-2014
1-Aug-2014
1-Sep-2014
1-Oct-2014
1-Nov-2014
1-Dec-2014
1-Jan-2015
1-Feb-2015
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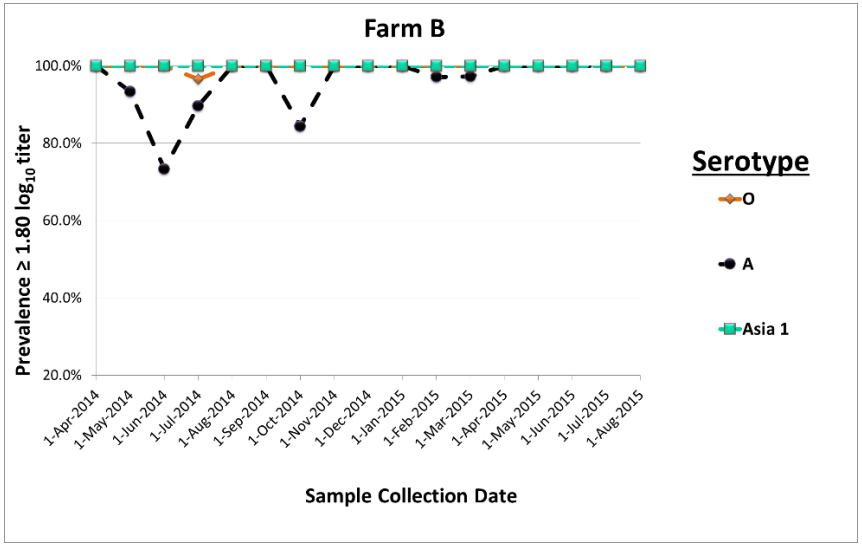
Sample Collection Date
Serotype
O
A
Asia 1


Farm B
100.0%
80.0%
60.0%
40.0%
20.0%
Prevalence ≥ 1.80 log10 titer
1-Apr-2014
1-May-2014
1-Jun-2014
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