An innovative system for monitoring poultry health and behaviour

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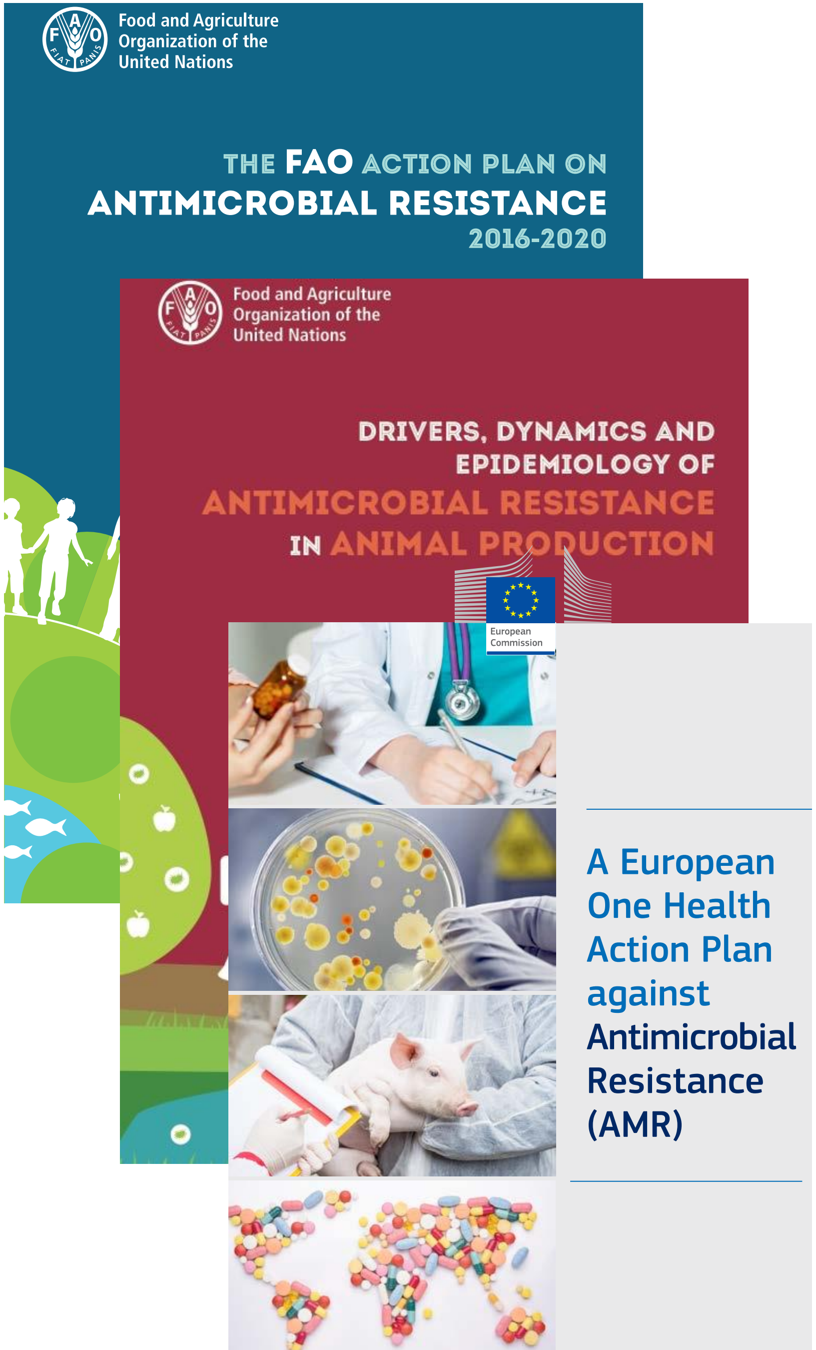
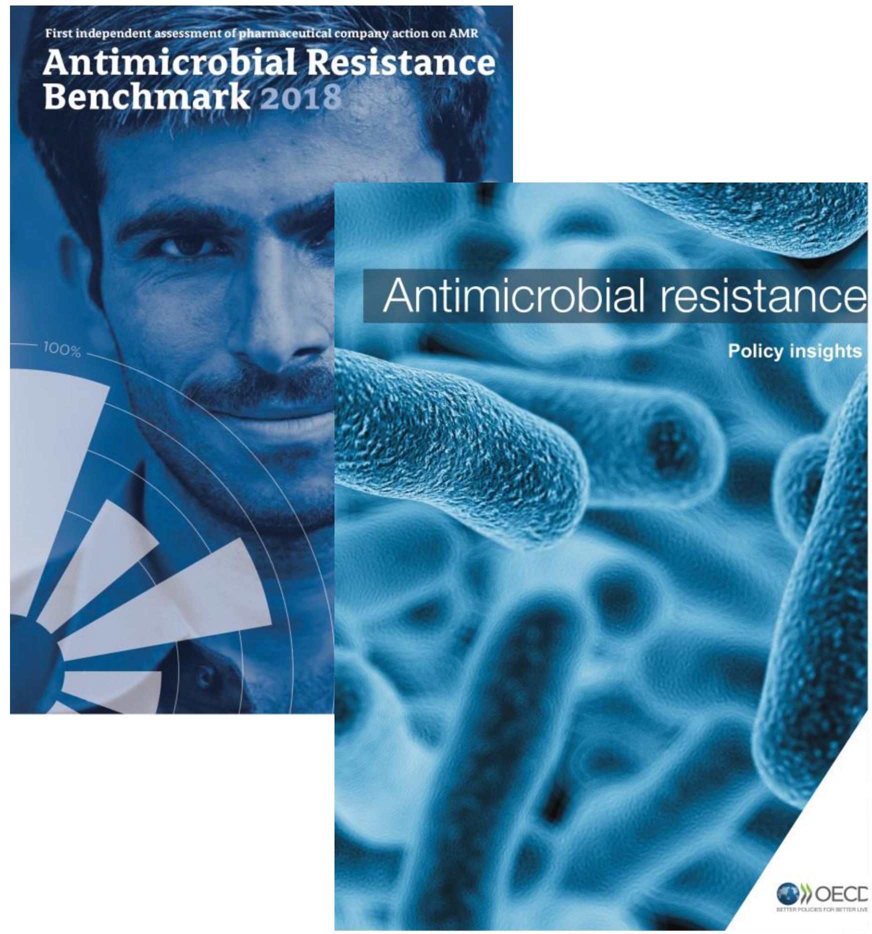

Food and Agriculture Organization of the United Nations
THE FAO ACTION PLAN ON ANTIMICROBIAL RESISTANCE 2016-2020
Food and Agriculture Organization of the United Nations
DRIVERS, DYNAMICS AND EPIDEMIOLOGY OF ANTIMICROBIAL RESISTANCE IN ANIMAL PRODUCTION
European Commission
A European One Health Action Plan against Antimicrobial Resistance (AMR)


First independent assessment of pharmaceutical company action on AMR
Antimicrobial Resistance Benchmark 2018
100%
Antimicrobial resistance
Policy insights
OECD

Pressures on poultry production

- To reduce anti-microbial use
- AND to produce more food more efficiently (less space, less food, less water and with less waste)
- AND to improve food safety
- AND to improve standards of animal health and welfare
- AND to be economically viable

Can technology help?

Technology in poultry production

- Technology available for monitoring temperature, humidity, water use etc. but not health and welfare
- Need technology suitable for large groups
  - Individual tagging inconvenient/impossible
  - Visual tracking of individuals computationally difficult
  - Flock level measures

Automated analysis of flock behaviour

- Help producers to manage their flocks for greater health, welfare *and* efficiency
- Provide continuous, real-time welfare and disease measures
- Give early warning of health and welfare problem, enabling targeted interventions and reduced use of anti-microbials

The team….

Stephen Roberts (Engineer. Machine learning)

Martin Maiden (Microbiologist)

Adrian Smith (Immunologist)

Frances Colles (Microbiologist)

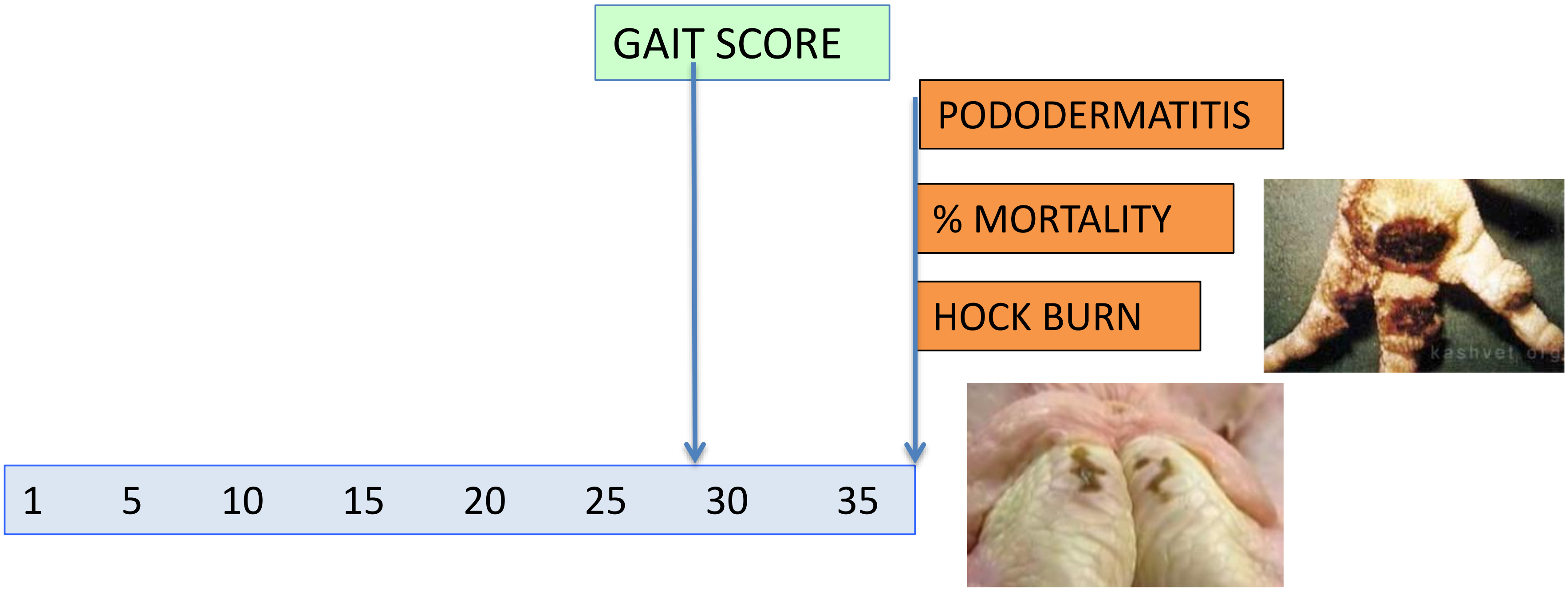
Stephen Ellwood (Biologist, hardware)

Max Whitby (Software)

Christl Donnelly (Statistician)

Marian Dawkins (Animal welfare)

Current methods of assessing broiler health and welfare are mainly post-mortem

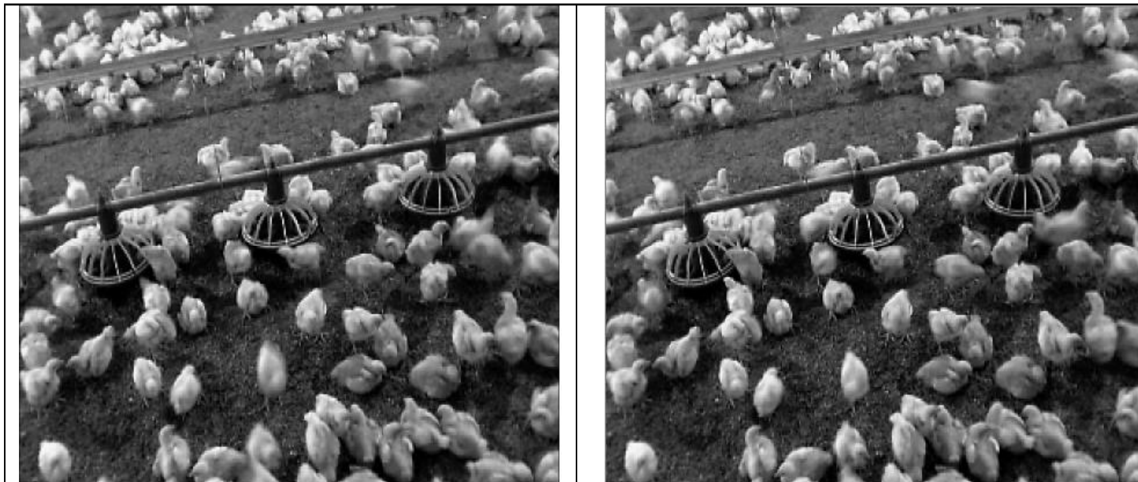


Gait scoring (to assess walking ability) is labour-intensive, subjective and only gives a ‘snapshot’ on one day

We use ‘optical flow’ to measure flock behaviour throughout life

- Most automated analyses of video track individual animals
- Optical flow is much simpler
- Measures overall flock movement
- Non-invasive and continuous
- Analysis done immediately
- Doesn’t store images (no invasion of privacy)
- Runs for months at a time

Optical flow compares the patterns of light and dark in successive images

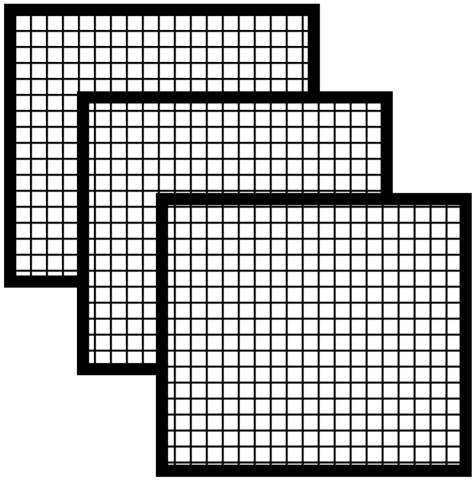


(a) Image frame at time t | (b) Image frame at time $t+1$

Individual animals are not tracked, but the changing patterns over time ("flow") give an indication of behaviour at flock level.

Dawkins et al. (2009) *Applied Animal Behaviour Science* 119: 203-209

Optical flow is the rate of change in image brightness over time



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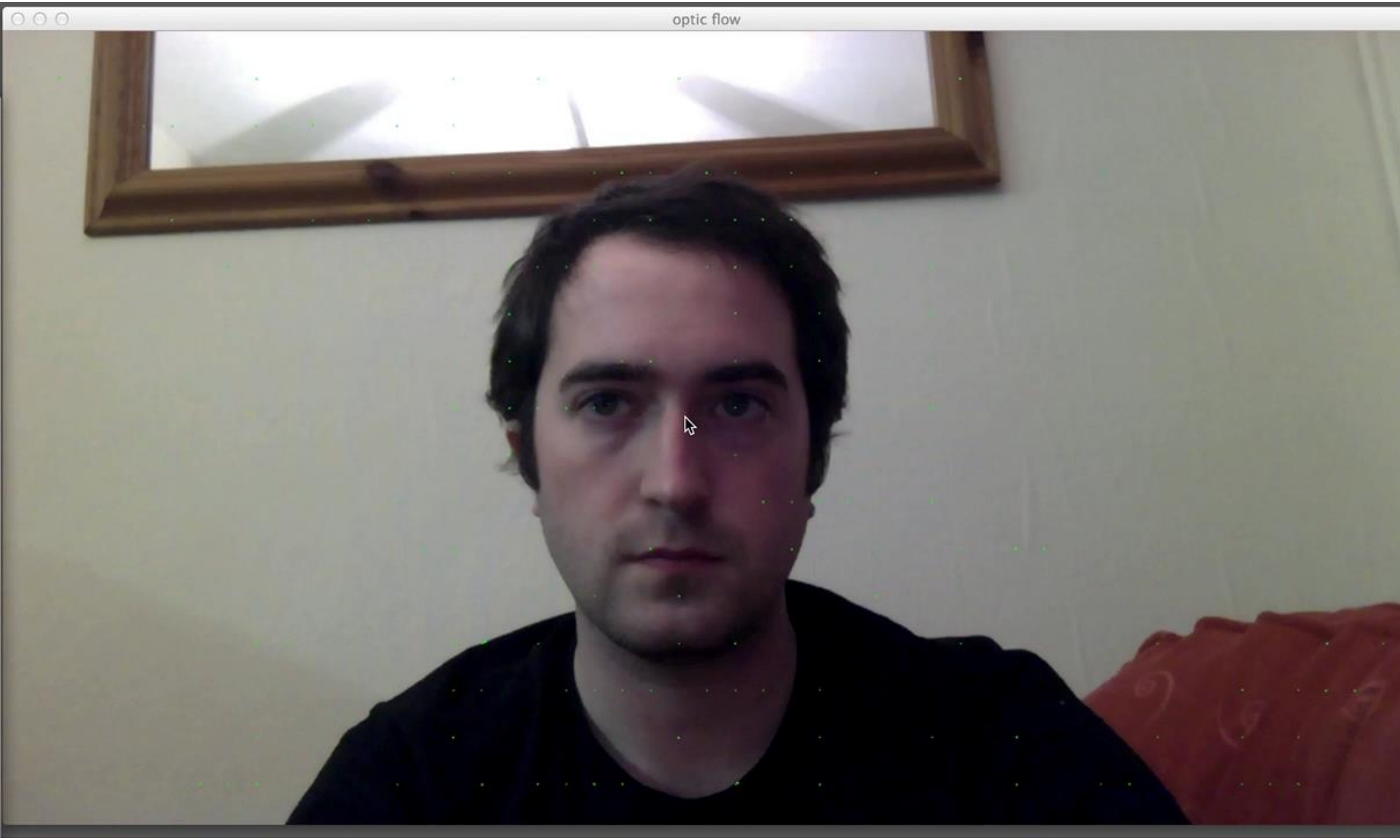
Each (320 x 240) video frame is divided into (8X8) pixel squares.

If there is no movement between frames, the brightness of all squares remains the same. If there is movement, then some black squares become white and vice versa


optic flow

Optical flow detects

1-100%	%Mortality		✓
	% Hockburn		✓
	% Foot pad dermatitis		✓
Gait score	% Lame birds		✓

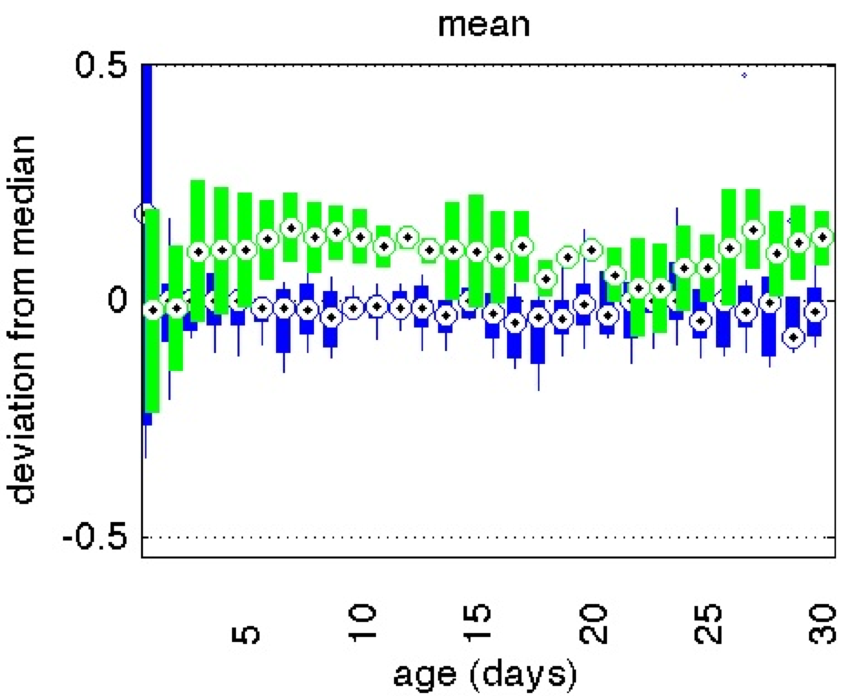
The statistics of health & welfare

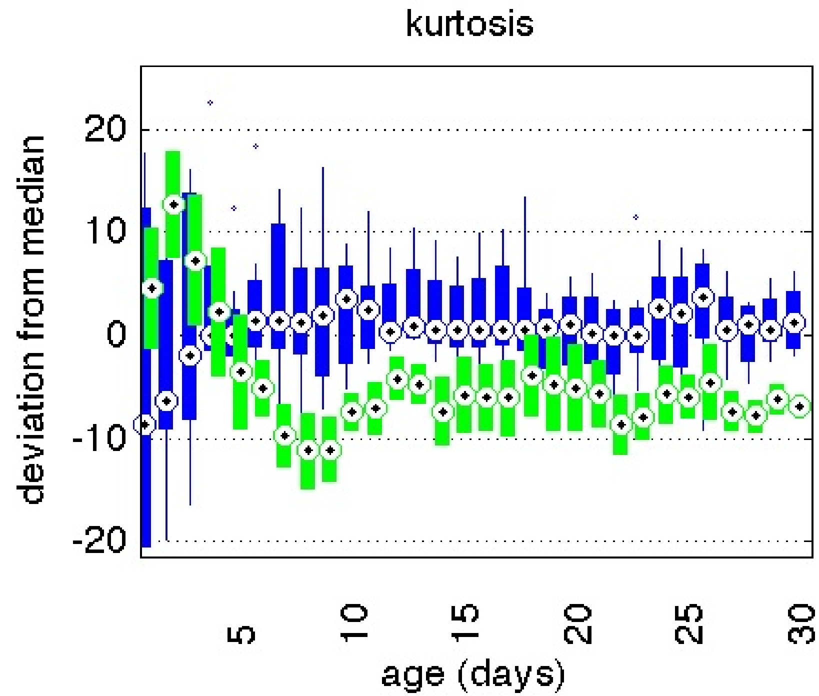
- Poor welfare flocks: slower and more variable (lower mean and higher kurtosis)
- High welfare flocks: faster and more uniform (higher mean and lower kurtosis)
- Kurtosis is a statistical measure of variation

Can optical flow detect disease?

- *Campylobacter* - important issue for the European poultry industry
- Optical flow with cameras
- Faecal sampling with bootsocks at 21 days, 28 days and 35 days and whole faeces at 28 days

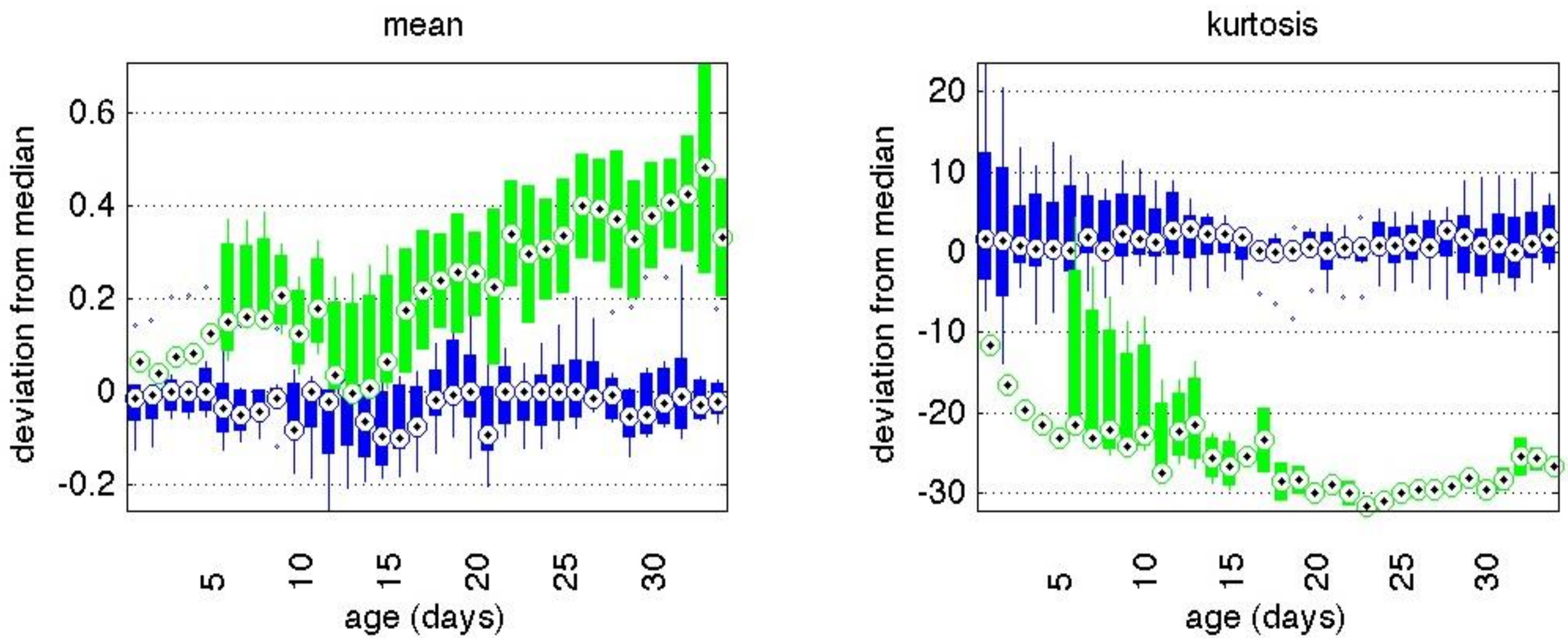
Campylobacter-free flocks have higher mean and lower kurtosis optical flow than infected flocks





The data show deviations from farm medians for each day for *Campylobacter*-negative and *Campylobacter*- positive flocks on one farm. (24 flocks). From Colles *et al*.(2016) *Proc. R. Soc*.

The result was even clearer from 3 more farms



The data show deviations from farm medians for each day for *Campylobacter*-negative and *Campylobacter*- positive flocks on three farms

These optical flow measurements have implications for *Campylobacter* control

1. Flocks that subsequently test positive for *Campylobacter* (at 21 days) are distinguished by their optical flow patterns by 7 days.

2. We do not know whether birds are infected early or can just be recognized as susceptible in the first week

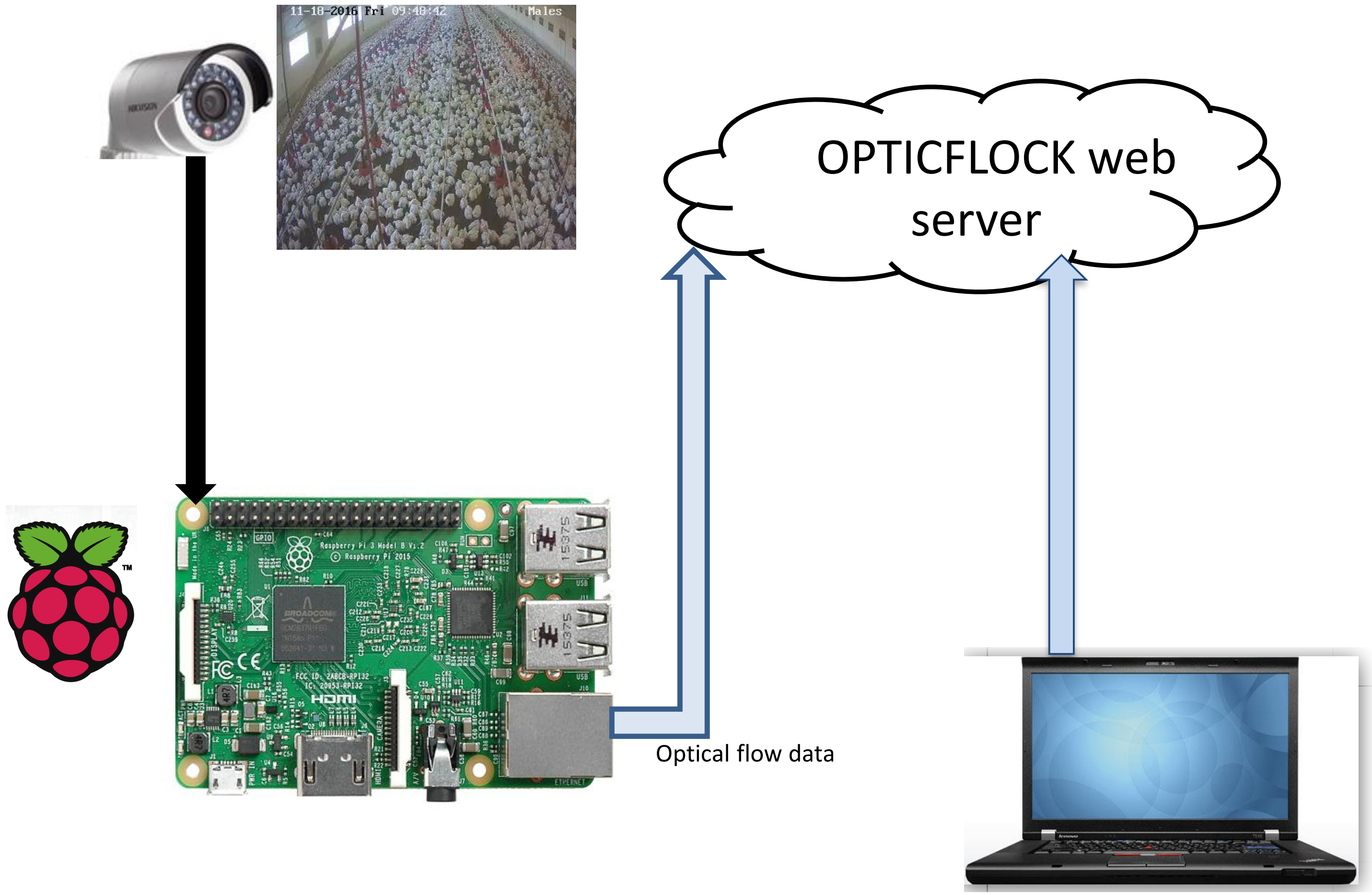
3. Not specific to *Campylobacter*

4. Potential for detecting and predicting other diseases

5. Early detection of flocks at risk of health problems enables targeted use of medication

How can this be used on farms?

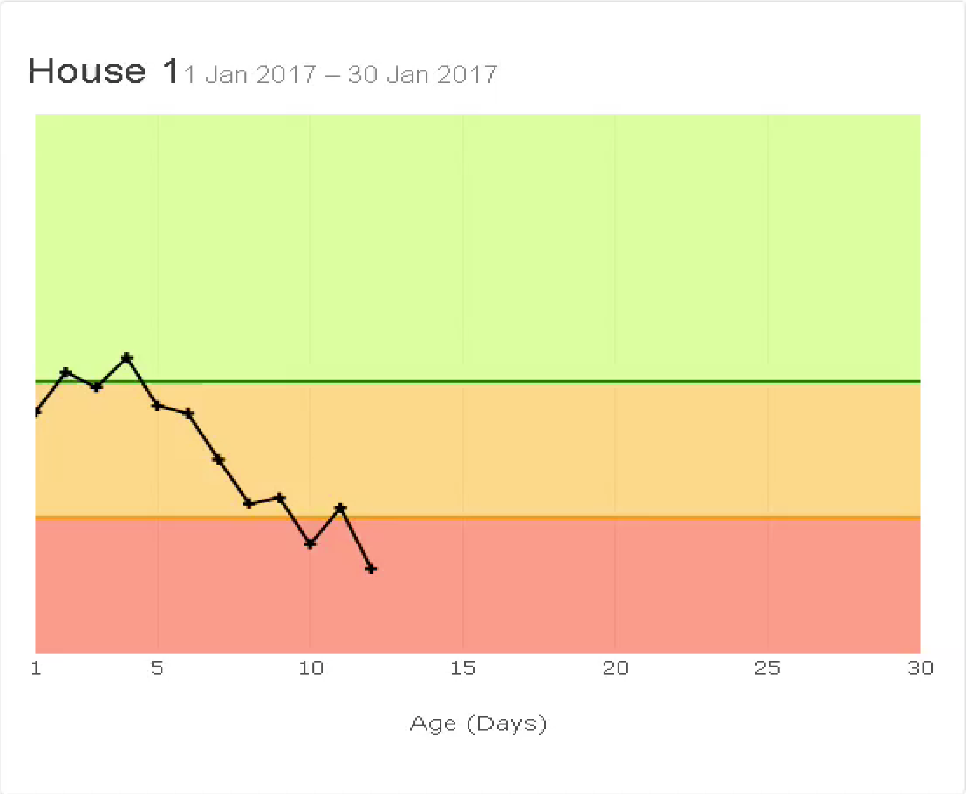
- Currently tested on over 150 flocks in UK, Switzerland and France
- Uses ordinary cctv cameras and small computer (Raspberry Pi)
- Immediate, automated processing of data
- Results computed every 15 minutes



Data are processed automatically on-farm

No images leave the farm so very secure

Aim to make technology available to producers



- Each flock is compared to reference flocks with high and low welfare.
- Here, green shows optical flow values for flocks with <10% hockburn and red shows values for flocks with >40%.
- Daily update

The reference flocks

- We have a set of ‘high welfare’ reference flocks (e.g. low hockburn, low pododermatitis, low mortality, good gaits sores etc).

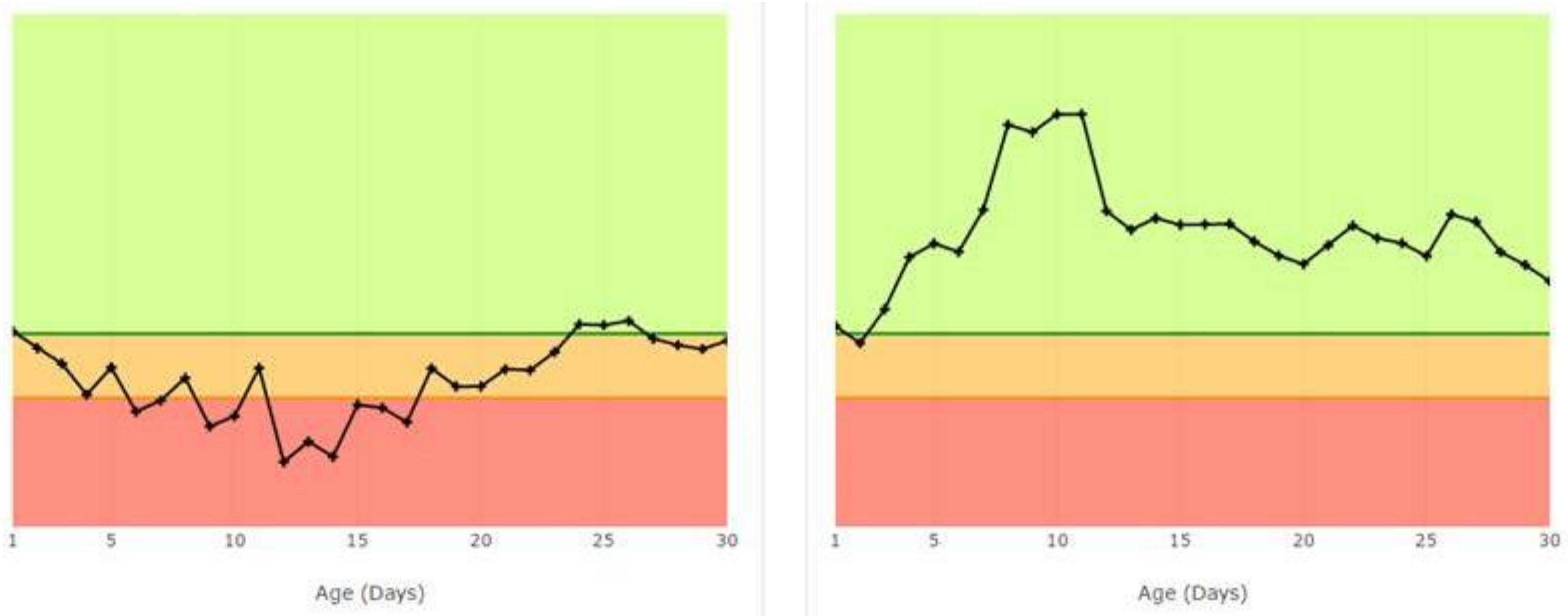
- And also a set of ‘low welfare’ reference flocks (e.g. high hockburn, high pododermatitis, etc)

- Does the optical flow pattern of a given flock look like that of a high welfare or low welfare flock?

We can see each flock in relation to ’high’ and ‘low’ welfare reference flocks

70% hockburn

0% hockburn



Green = Reference flocks with < 10% final hockburn

Red = Reference flocks with > 40% final hockburn

Technology has the potential to improve poultry health & to reduce anti-microbial use

- Important for good flock management
- Early detection of health and welfare problems
- Enables targeting of medication where really needed
- Targeting means reduction in total use