Impact perspectives of smart farming research

First International Conference on Sustainable and Regenerative Farming

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universidade de aveiro

instituto de telecomunicações

Me

- PhD in Informatics Engineering
  - MSc in Telecommunications
- Professor at Aveiro University
  - Computer Networks and System Administration
- Researcher at Instituto de Telecomunicações

instituto de telecomunicações

universidade de aveiro

My previous background

- MSc dissertation (2002-2004):
  - QoS manager for a B3G network
- PhD thesis (2005-2010):
  - Policy-based network management PCRF
- Portugal Telecom 4G (2009/2010):
  - Ericsson integrated solution for 4G
- Mobydick project - IST-2000-25304
  - 2001-2004
- Daidalos - IST-2003- 506997
  - 2003-2006
- MUSE – ist-muse
  - 2004-2007
- Daidalos II – FP6 -506997
  - 2006-2008

My research unit and my (some of) colleague's research

- Instituto de Telecomunicações:

- 5 research areas:
  - WIRELESS TECHNOLOGIES
  - OPTICS & PHOTONICS
  - INFORMATION & DATA SCIENCES
  - NETWORKS & SERVICES
  - BASIC SCIENCES & ENABLING TECHNOLOGIES

- Just some examples:
  - Vehicular communications
  - Autonomic driving vehicles
  - Space Technologies
    - Satellite communications
  - Optics
    - Fiber based sensors, Quantum Cybersecurity
  - Energy communities
    - Energy consumption/production forecast

- I grew up in a small village
- I sympathize with the concept of circular economy and rural development
- I started to pay attention to precision farming issues

Animal based weeding

Vineyard manager contact

- Need for weed the herbs
  - Herbs compete for nutrients
  - facilitate the appearance of mildew
- Ramos pinto abandoned chemical weeding procedures
  - mechanical weeding is a highly costly process

Vineyard manager meeting

- Weeding has to be performed 2/ 3 times a year
- Douro vineyards have terrible slopes
- They already had tried dwarf goats
  - but they can rise up and eat the leaves

- “How about a collar, something like anti-bark collar?”

SheepIT

- R&TD funded by compete 2023
- 24 months project

- Collar monitors animal behavior
  - Detects prohibited posture
    - Eating at an elevated neck angle
- Emits a warning sound
  - and an electrostatics simulae if not reverted

SheepIT weeding

- Animals freely graze
- Herbs keep being weed
- Animals fertilize vineyard

Lessons learned from SheepIT

- Solution cost (100€) considered too high:
  - “Collars are too expensive”
  - “Collars cost the same as the sheep”
  - “If sheep are stolen we would loose the collars too”

- Winemaking activity is very specialized:
  - employees do not know how to handle animals
  - vineyards do not have animal shelters
  - animals are considered as burden
  - “How much does it cost to maintain a sheep?”

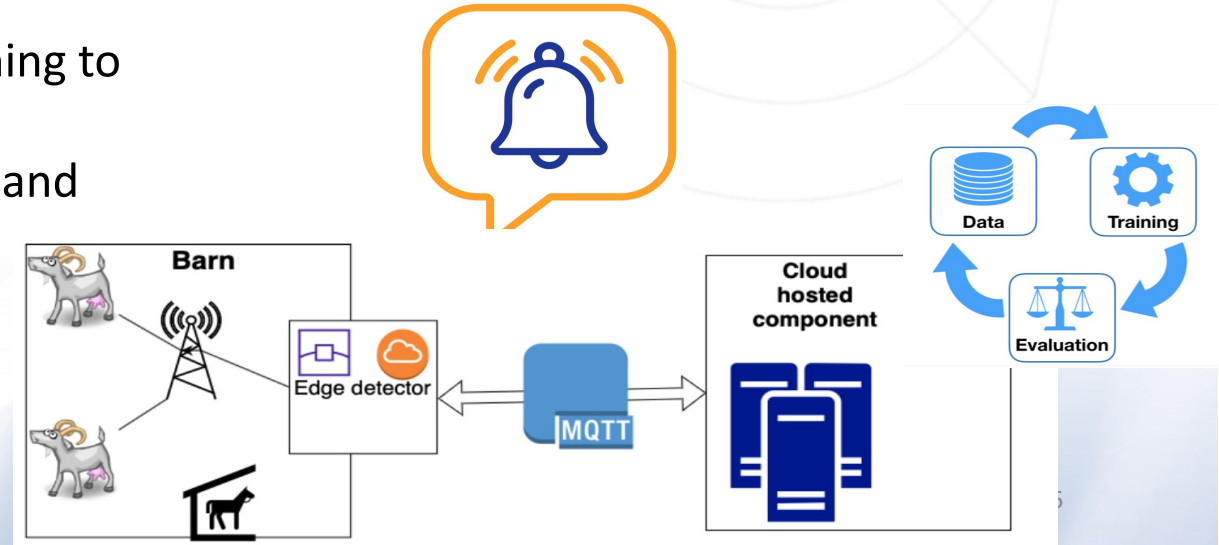
Lambing detection

Animal parture

- Animal birth is a very impactful event
- 5-10% of partures present some kind of complication
  - Because of wrong placement of the offspring
  - with a higher incidence in births with multiple offprints
  - more frequent in the first birth
- Terrible impact on offspring
  - Dead's, diseases due to the delay in the process
- Tremendous impact on mothers
  - Dead, vaginal prolapses
- Solutions exist for bovines
  - Delaval, Lelly
- Ontime detection allows nursing assistance
  - But process takes to long and human supervision is costly

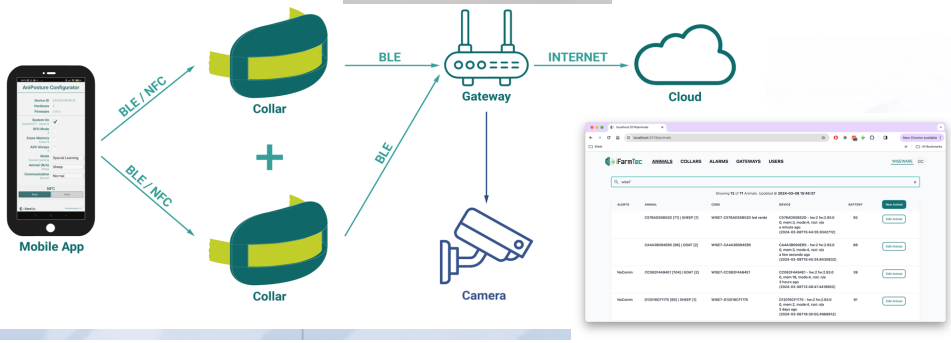
On the development of an automatic lambing solution

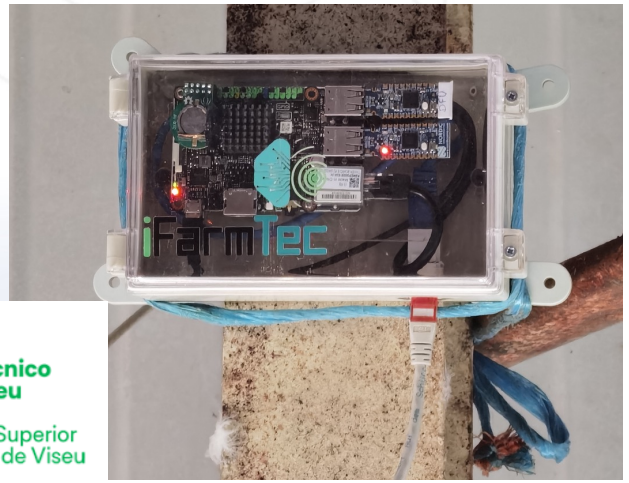
- The plan
  - Use collar accelerometry to monitor activity
  - Use video recording to annotate accelerometry data
  - Use Machine / Deep Learning to create a learning model
  - Use edge device to detect and trigger nursing assistance



Viseu essay

- Flock of 120 sheep
- 6 Sheep in the barn
  - Lambed sheep replaced the day after
- Video recording over the animals





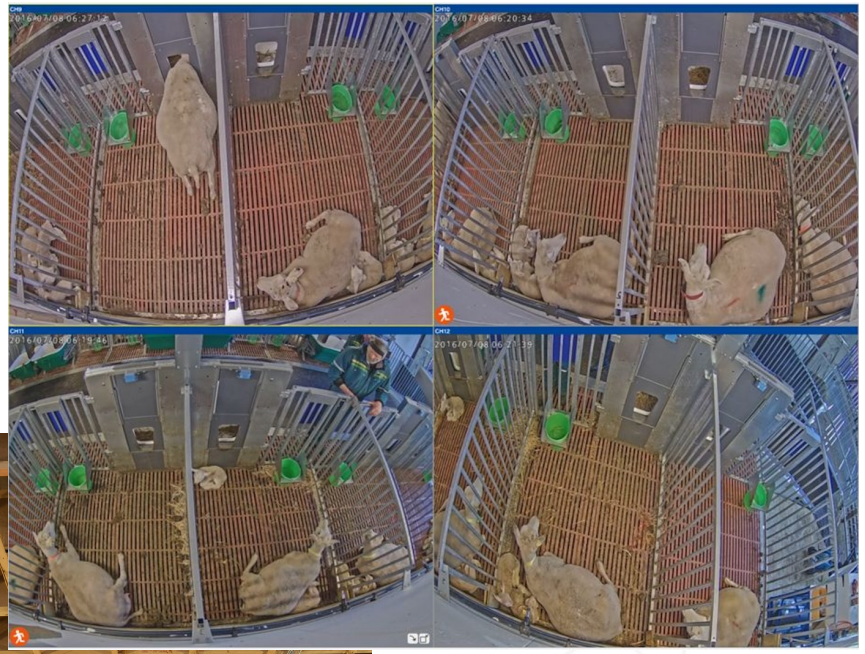
Politécnico de Viseu
Escola Superior Agrária de Viseu

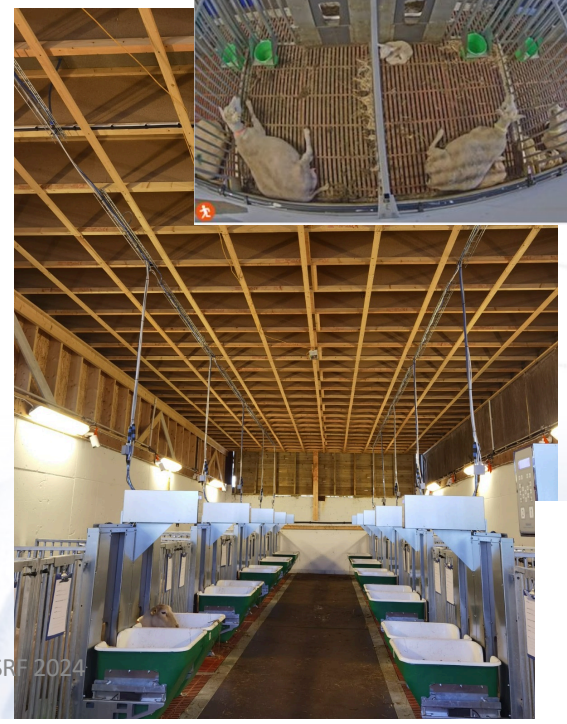
ESAV dataset

- 27 monitored lambing's
- 7 video recorded lambing's
  - Lambing's occurred in meadow not video recorded

Tjøtta essay

- 480 lambing sheep
- 10 collaborators handling process
  - 24/7 during 4 weeks
- 24 pens under video coverage
  - 1 collar per sheep
  - Video recording 24/7
  - Lambed sheep replaced after 1/2 days
  - 1 gateway gathering accelerometer data
- Production barn not monitored



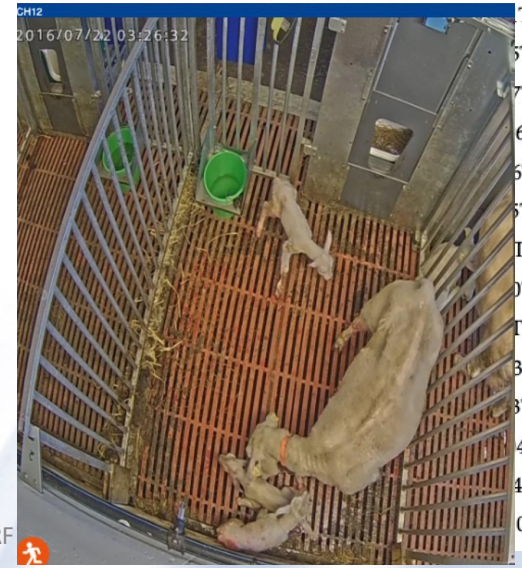


NIBIO
NORWEGIAN INSTITUTE OF BIOECONOMY RESEARCH

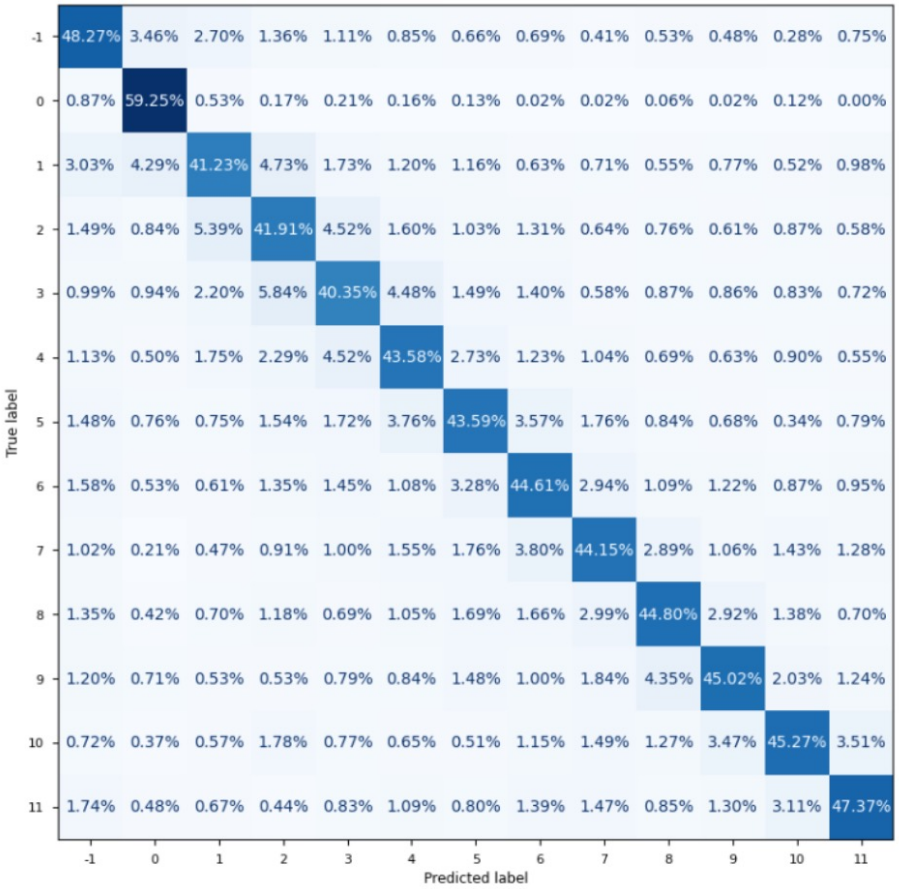
Tjøtta dataset

- 61 lambed sheep
  - 16 Single
  - 38 Double
  - 7 Triple
- 113 lambs monitored
- During the first week were born in production barn more than 400 lambs

Number	Datafile	Number of rows
1	POS_08_F199295AE047_2024-05-10T04.34.00+02.00_2.csv	866707
2	POS_10_E529A33F92FC_2024-05-02T00.52.00+02.00_2.csv	816211
3	POS_08_F199295AE047_2024-05-03T19.16.00+02.00_2.csv	864981
4	POS_23_DB311ED1553E_2024-05-09T11.05.00+02.00_2.csv	867008
5	POS_02_EFFB68709EC6_2024-05-04T21.55.00+02.00_2.csv	866532
6	POS_09_FF6C81A617AF_2024-05-12T21.43.00+02.00_3.csv	696977
	T07.34.00+02.00_2.csv	841896
	5T13.08.00+02.00_2.csv	867453
	7T09.38.00+02.00_1.csv	810691
	6T16.06.00+02.00_2.csv	866294
	5T14.10.00+02.00_3.csv	862014
	5T17.25.00+02.00_2.csv	867018
	T11.56.00+02.00_1.csv	867243
	0T06.31.00+02.00_2.csv	866921
	T11.51.00+02.00_2.csv	867438
	3T16.08.00+02.00_3.csv	862572
	3T19.00.00+02.00_2.csv	522358
	4T07.53.00+02.00_2.csv	867630
	4T09.37.00+02.00_1.csv	867218
	0T16.26.00+02.00_3.csv	867241

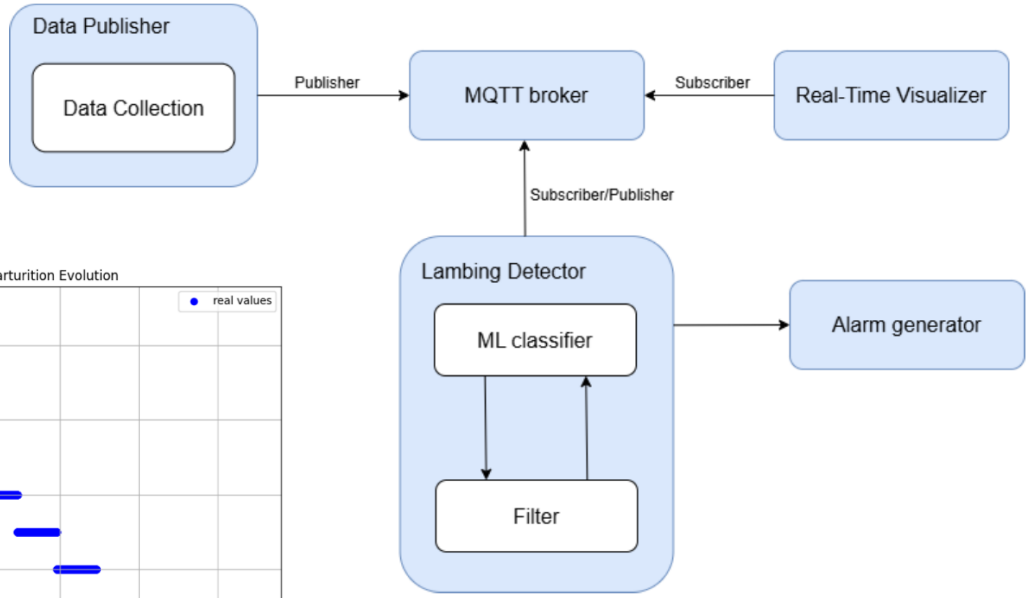


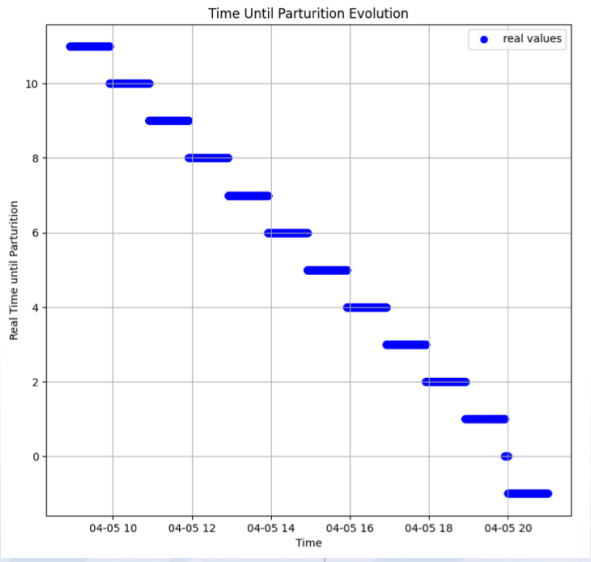
Detection results

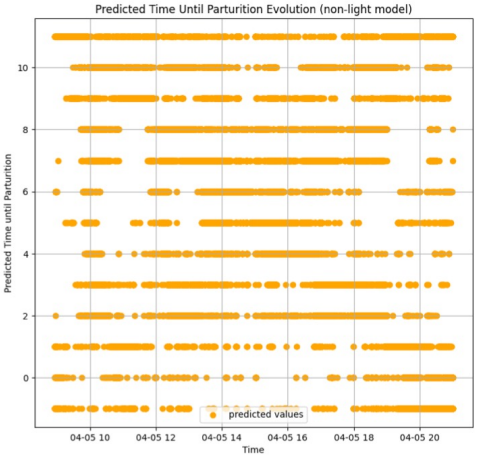


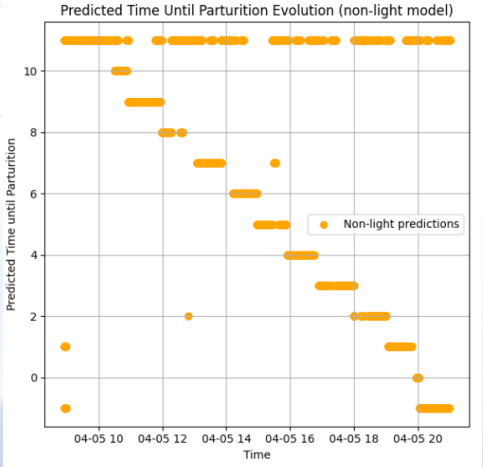
Model	Accuracy	Precision	Recall	F1 Score	MCC
DecisionTreeClassifier	0.51	0.51	0.51	0.51	0.47
RandomForestClassifier	0.77	0.77	0.77	0.77	0.75
ExtraTreesClassifier	0.81	0.81	0.81	0.81	0.79
Bagging	0.65	0.65	0.65	0.65	0.62
MLP (Keras)	0.13	0.16	0.13	0.13	0.00

Automatic detector

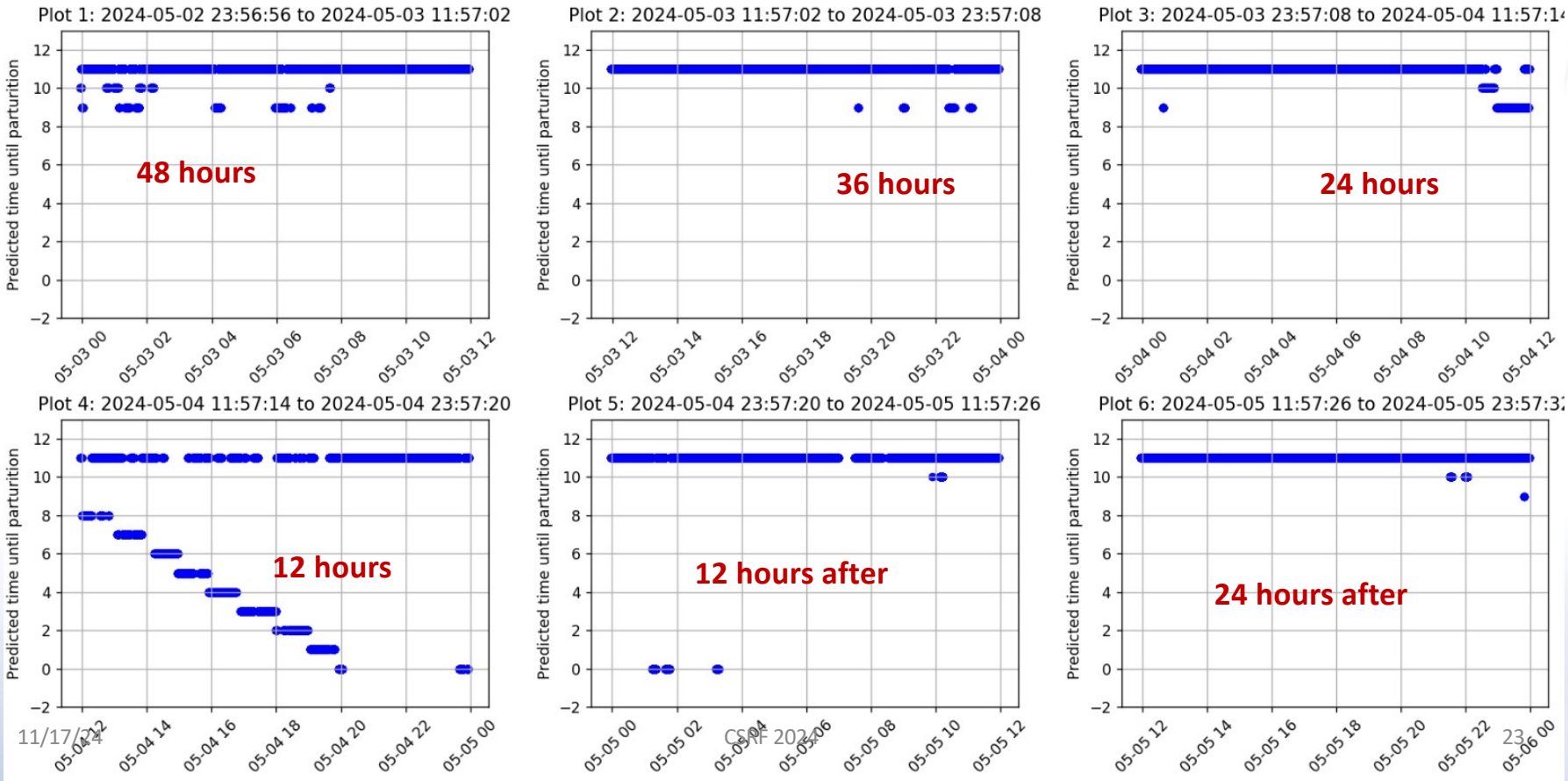








3 days test


Plot 1: 2024-05-02 23:56:56 to 2024-05-03 11:57:02
48 hours
Plot 2: 2024-05-03 11:57:02 to 2024-05-03 23:57:08
36 hours
Plot 3: 2024-05-03 23:57:08 to 2024-05-04 11:57:14
24 hours
Plot 4: 2024-05-04 11:57:14 to 2024-05-04 23:57:20
12 hours
Plot 5: 2024-05-04 23:57:20 to 2024-05-05 11:57:26
12 hours after
Plot 6: 2024-05-05 11:57:26 to 2024-05-05 23:57:32
24 hours after
Predicted time until parturition

But...

Learned lessons from lambing detector

- Intensive producers do not need detector
  - Sheep get inseminated synchronously
  - Use ultrasound to forecast events
  - Keep a handling team 27/7 for the process
- Non intensive producers don’t care:
  - they see 5% of losses as normal
  - consider technology as a huge cost

Lambing supervision - zoomed

So what?

What's left to do?

Scopus query on 15/11/2024

((smart OR iot OR precision) AND (subquery)) 15/11/2024

area	subquery	records
Smart cities	(city OR cities))	72670
Smart Homes	(home OR house)	54575
Smart vehicles	(vehicle OR road OR mobility) (vehicle OR road)	100919 84537
Smart industry	(industries OR industry) (industries OR industry) OR "industry 4.0" OR "industrie 4.0"	89021 113868
Smart heath	health (health OR fit OR excercise)	102738 130813
Smart farm	(greenhouse OR farm OR agro OR agriculture OR farming OR livestock OR pasture) (farm OR farming OR livestock OR pasture) (greenhouse OR farm OR agro OR agriculture OR farming OR livestock OR pasture)	57838 25774 56925

Reasons for the difficulty of transferring technology to the agricultural sector

- Low-risk culture and dependence on subsidies
- Small size of companies
- Lack of employee training

Barriers to the adoption and diffusion of technological innovations for climate-smart agriculture in Europe: evidence from the Netherlands, France, Switzerland and Italy

Thomas B. Long [a,*], Vincent Blok [a], Ingrid Coninx [b]

Barrier	
Economic	High initial investments
	Poor access to capital
	Hidden costs
	Competing financial priorities
	Long pay-back periods (ROI)
	Switching costs/existence of installed base
	High implementation costs (actual and perceived)
	Uncertain returns and results
	Temporal asymmetry between costs and benefits
	Over discounting the future
Institutional/regulatory	Low institutional support
	Use of overly scientific language (Jargon)
	Farmer's knowledge not considered in R&D
	Lack of regulatory framework
	Prohibitively prescriptive standards
Behavioural/Psychological	Lack of management support/awareness
	Conflict with traditional methods
	Overly complex technologies
	Results/effects of technology difficult to observe
	Farmer's beliefs and opinions
	Low trust of advisers or consultants/lack of acceptance
	Irrational behaviour
	Negative presumed assumptions
Organisational	Lack required competencies/skills
	Poor readiness
	Poor information
	Inability to assess technologies
	Overly short-term/perverse rewards
	Organisational inertia/habitual routines
Consumers/Market	Poor information
	Lack market attractiveness/do not align to preferences
	Uncertainty
	Consumers/farmers level of motivation
	Market uncertainty
Social	Social/peer pressures

Conclusions

- Line of research with potentially huge societal impact
- Nice potential scientific impact
- But extremely difficult to transfer technology to agricultural operators

- And I plan to continue following this line.

Thank you

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