Agricultural Research Organization (ARO), The Volcani Centre, **Israel**

Institute of Agricultural Engineering

Institute of Animal Sciences
Agricultural Research Organization

רמת הנדיב
Ramat Hanadiv رمات هنديف

Precision Livestock Farming (PLF) Lab

EAAP Study Commission on PLF

'Physiological diversity between individuals: when do we need 'personalized livestock farming (PLF)'?'

Ilan Halachmi

N. Barchilon, V. Bloch,, A. Godo, Y. Lepar, H. Levit, J. Grinshpun, L. Rosenfeld,, E. Vilenski, M. Kaganovich, S. Hayun, R. Bezen,, O. Geffen, E. Maltz, E. Metuki, E. Ram,

T. Glasser, S. Druyan

EAAP Annual Meeting 2018, Dubrovnik, Croatia

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PLF related sessions at the EAAP 2018

22. Physiological diversity between individuals: do we need 'personalized farming'? (PLF)

40. Interactive workshop on behavioural measurements

24. Novel traits (health/quality related traits) based on images or sensors

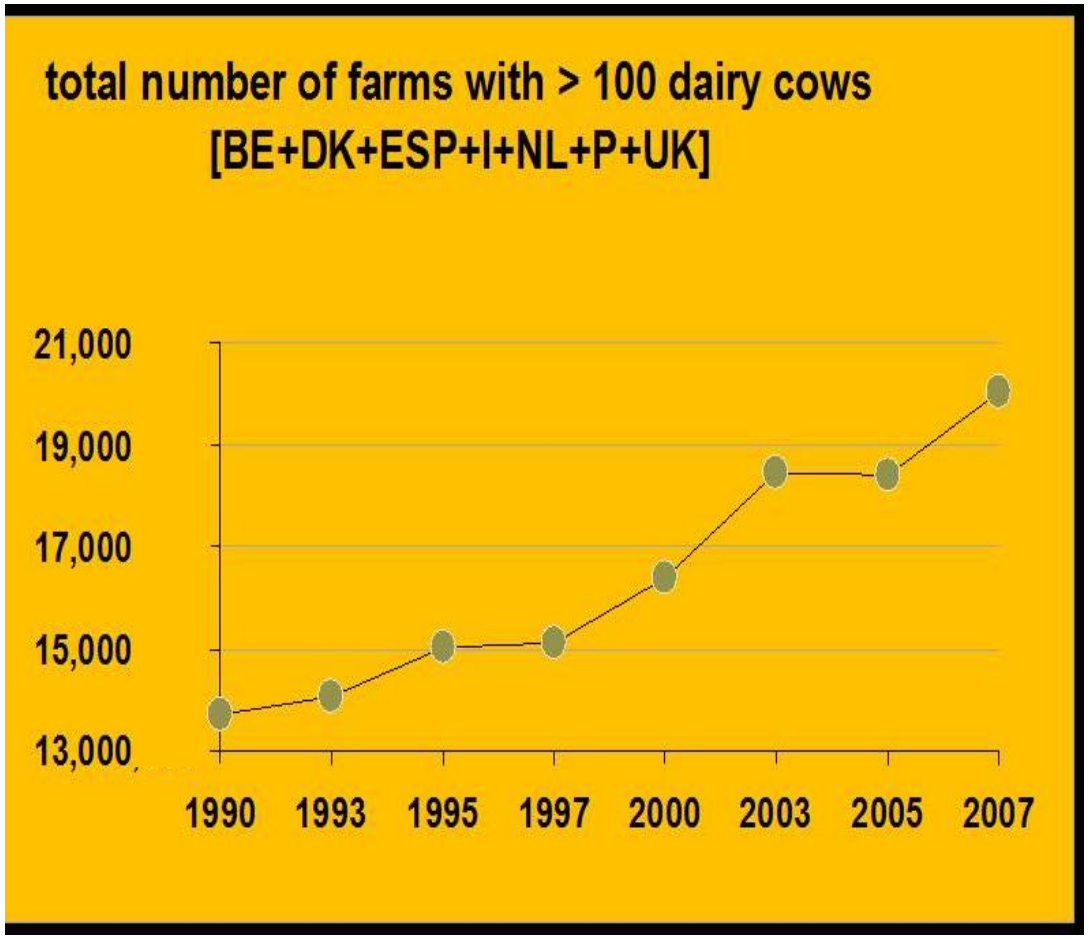
32. PLF in nutrition, genetics, and in physiology

43. Pig behaviour and/or machine learning

64. PLF in poultry, pigs, red-deer and rabbits

54. From (PLF/farm/lengthwise the chain/big) **data to a solution or decision**

Trends in animal husbandry



Smart sensing (PLF) allows caring the individual animals

What is PLF ?

(not “wearables for cows”)

Inputs:
nutrition, ventilation, handling, light, heating

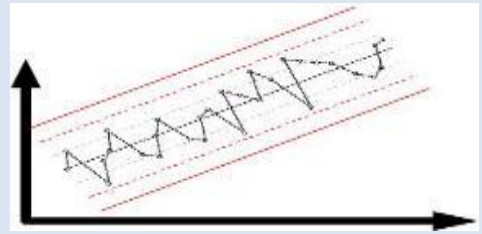
Biological Process:
Cow, Chicken, Pig

Outputs:
Behavior, Physiology, Growth, Fertility ,Production

Sensor:
Activity, Temperature, Rumination, Heart rate, Respiration, Body weight changes, Milk

Model predictive controller

Targets:
Normal behavior, production, efficiency, animal welfare



A management concept.

Alone the production chain.

In a farm: a real time monitoring (sensors) aiming to handle of the smallest **<u>manageable</u>** production unit

Diagram adapted from Daniel Berckmans

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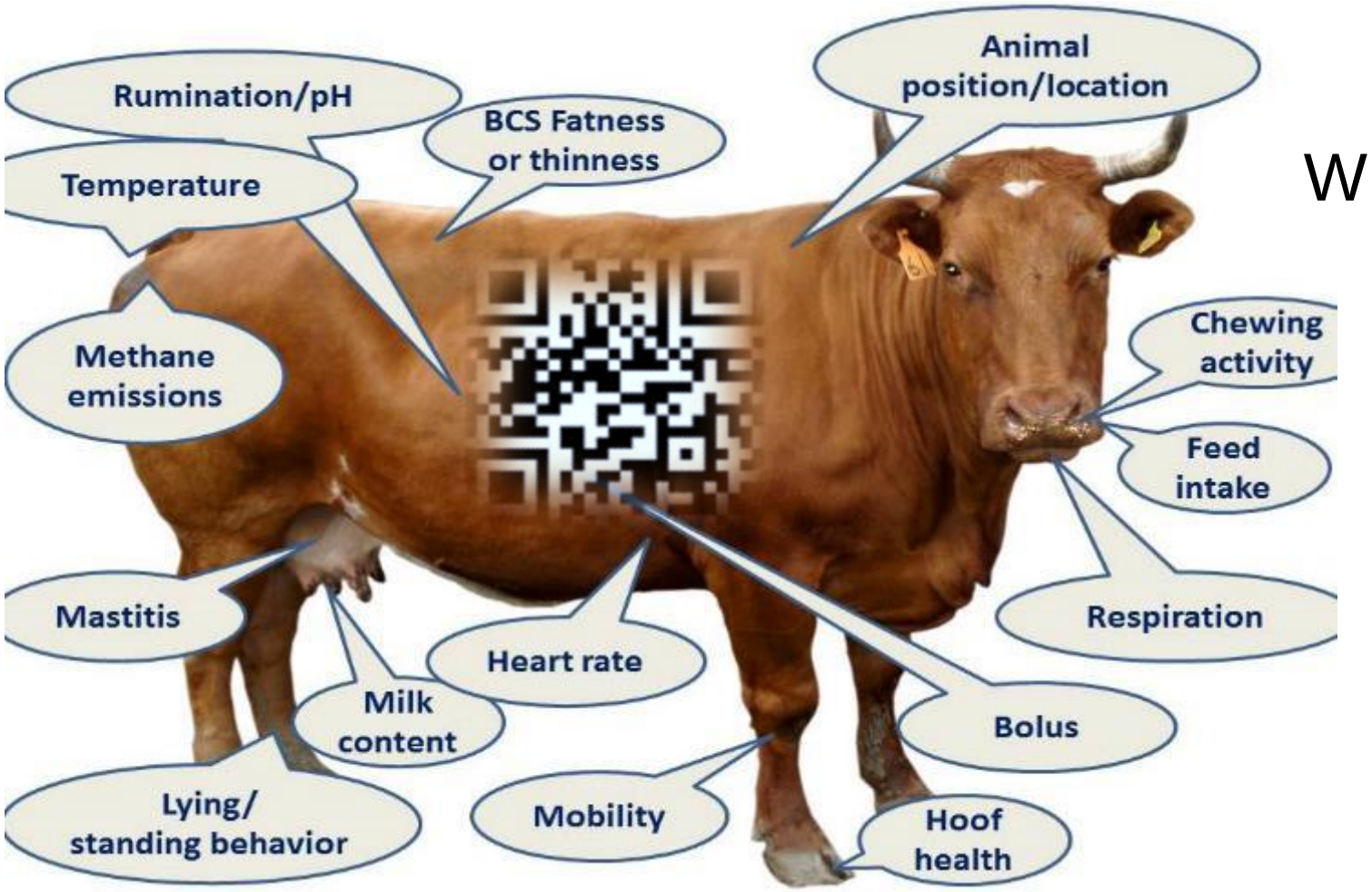
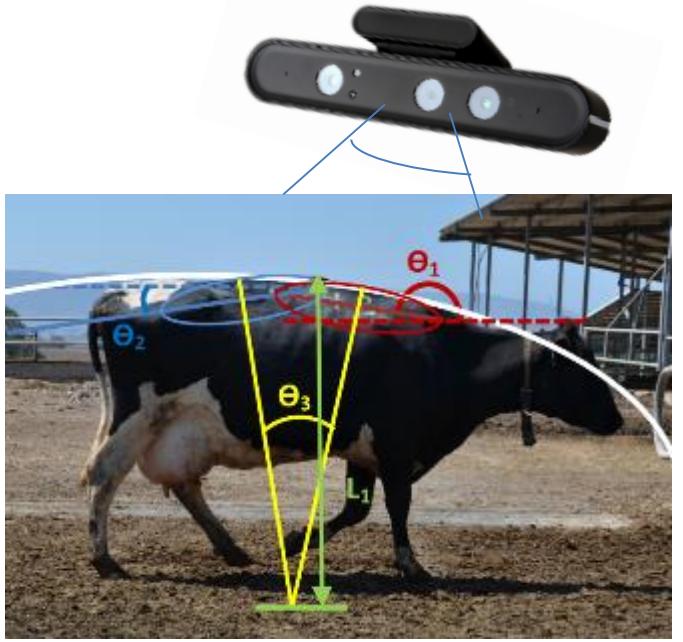
What is PLF ?

Technology



What should we monitor ?



In reality – we are drowning in data but starved for actionable list

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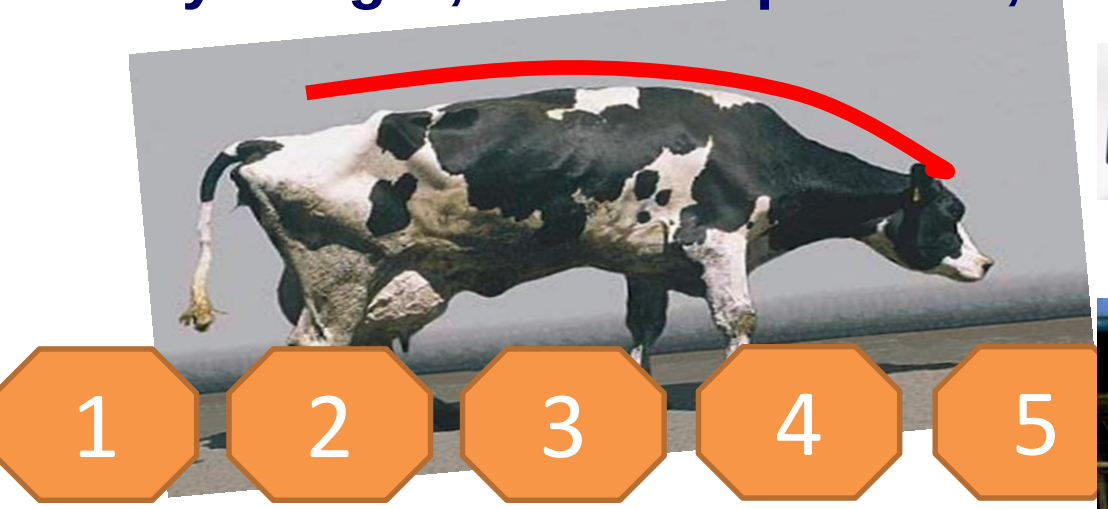
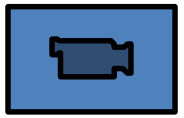
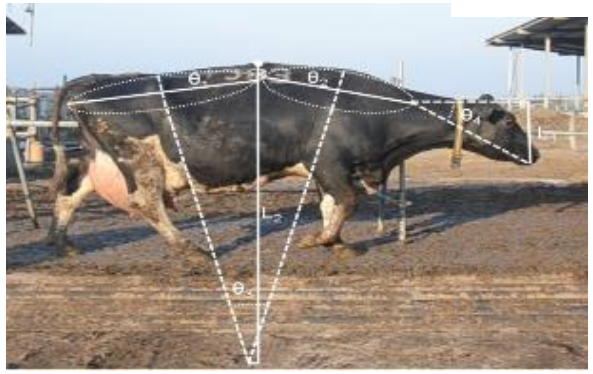
Automatic lameness detection

Case study 1

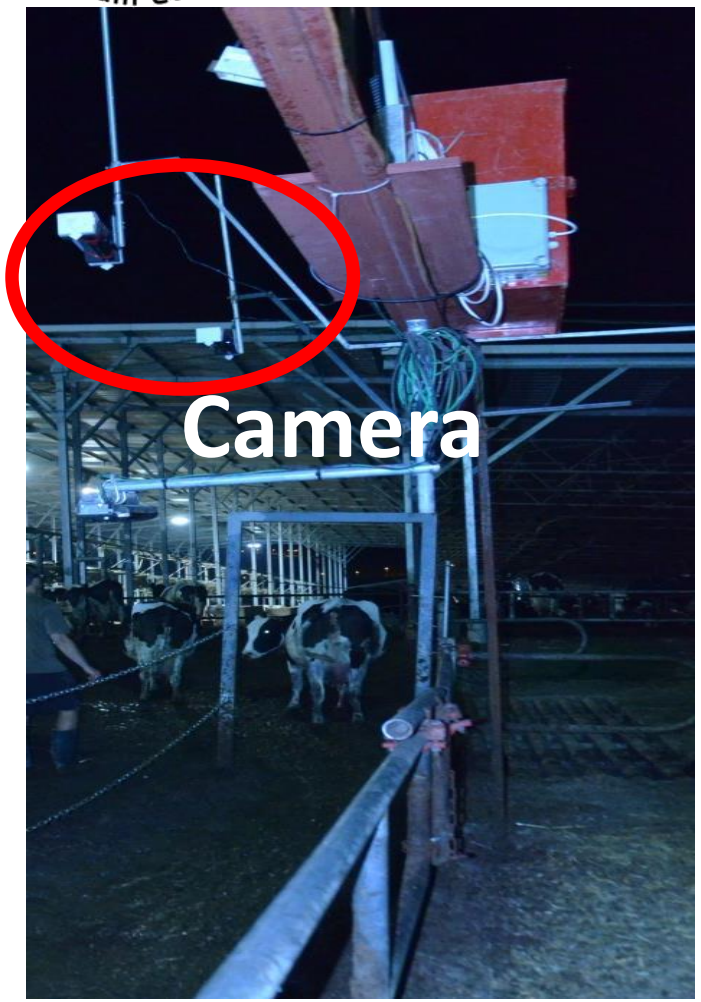
Combining: Lying behavior, Rumination, Neck Activity, Body Weight, Milk components, Camera

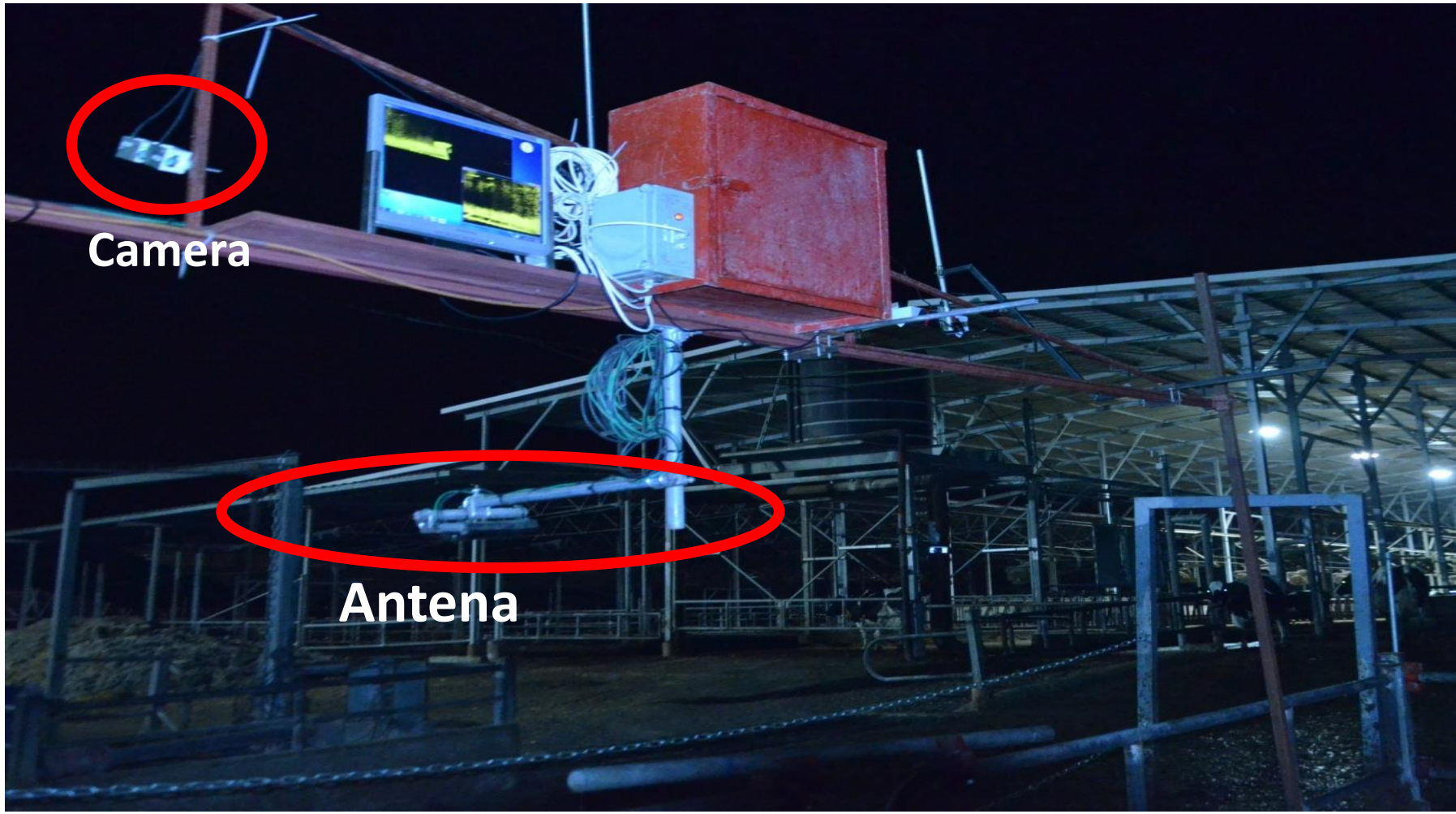






3rd Setup: 3D-camera





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Automatic lameness detection; EU-FP7

Case study 1

Bio Business

Sweden

Netherlands

Belgium

Israel

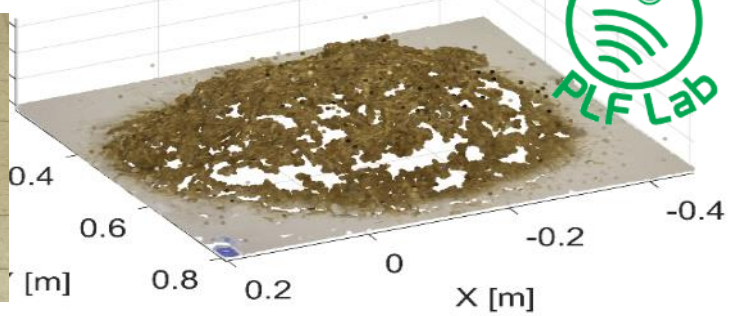
Van Hertem et al., 2013 Lameness detection, JDS *96*(7), 4286-4298
Computers and Electronics in Agriculture
Journal of Dairy Science;

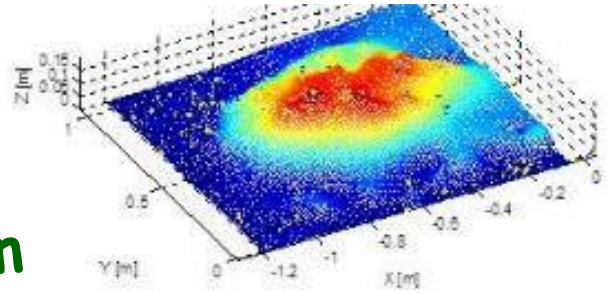
2.5 M€ 11 PhD Students

Case study 2

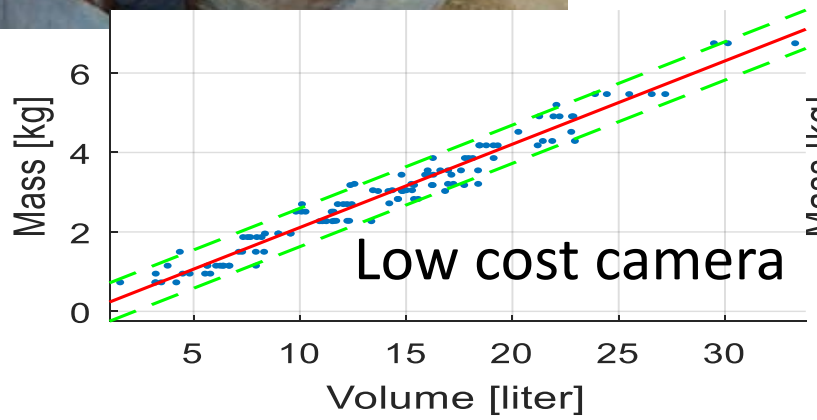
Evaluation of cow individual feed efficiency by camera

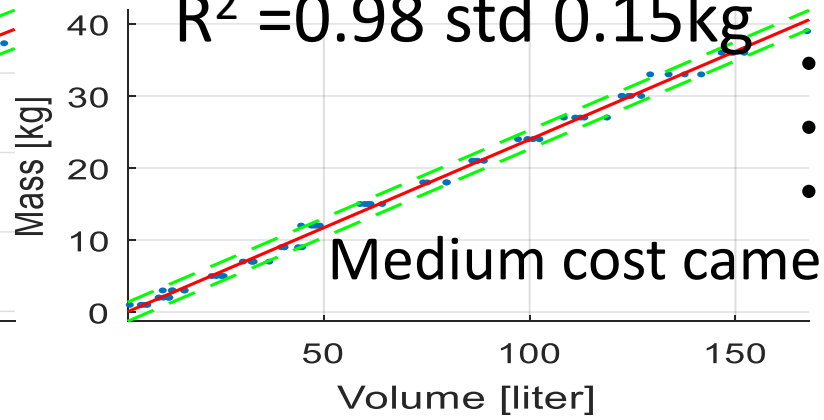
Victor Bloch <victorc@volcani.agri.gov.il>*; Harel Levit; Ilan Halachmi*





Reliable and affordable system for a commercial farms



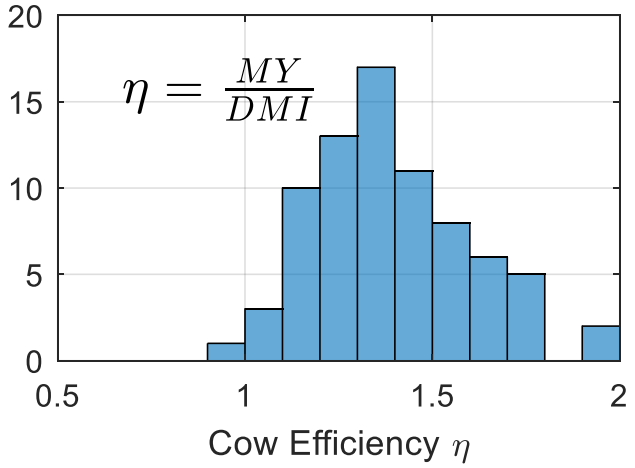


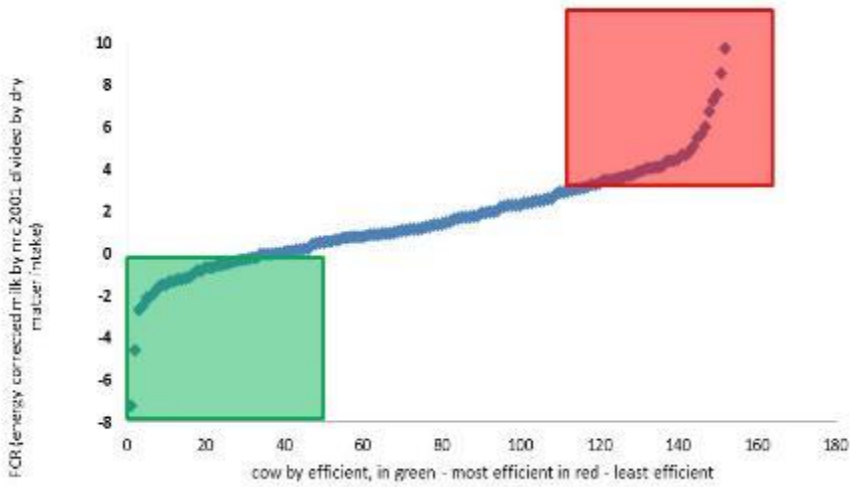
- Estimation with precision ~300 gr.
- Low-cost sensors (RGB cameras).
- No need additional infrastructure.

Case study 2

Evaluation of cow individual feed efficiency by camera

Victor Bloch; Harel Levit; Ilan Halachmi





20-24% difference among individual cows

Feeding behaviour improves prediction of dairy cow voluntary feed intake but cannot serve as the sole indicator. Halachmi et al. (2015). *Animal* 10 (09)

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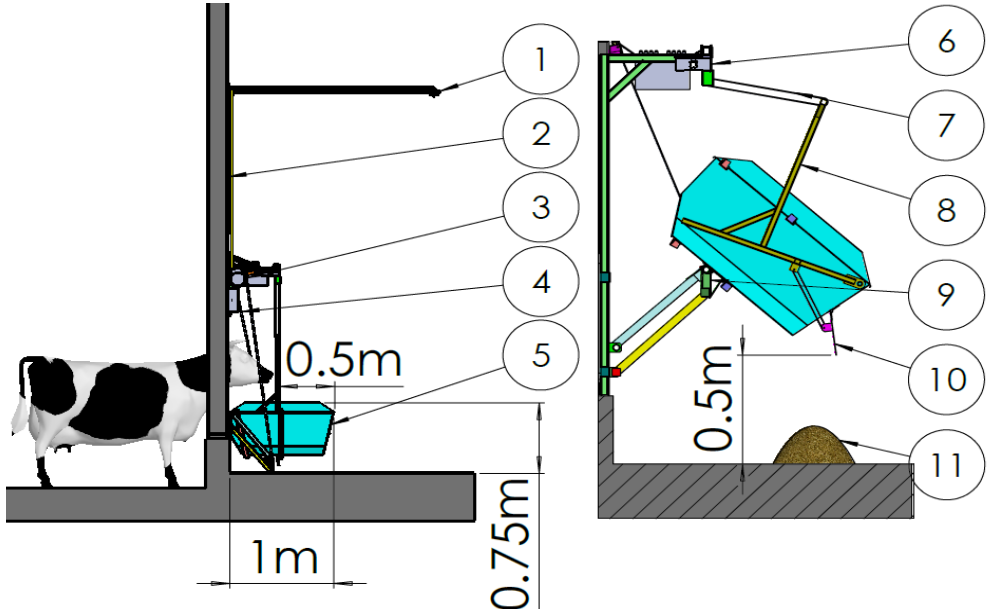
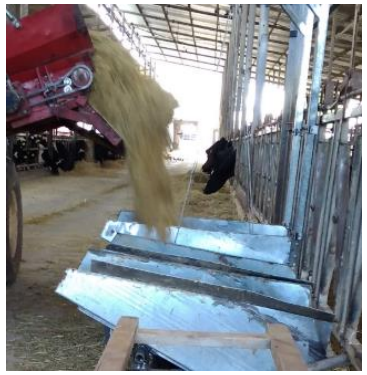
Cow individual feed efficiency

Case study 2

Design a low-cost mechanical system, fitted to commercial farms





- Fitted for distribution and cleaning by existing farm methods.
- Price ~10,000$ for 16 feeding stations.
- Enough to measure 150 cows during 1 month during the lactation.

Cow individual feed efficiency - **results**

Case study 2

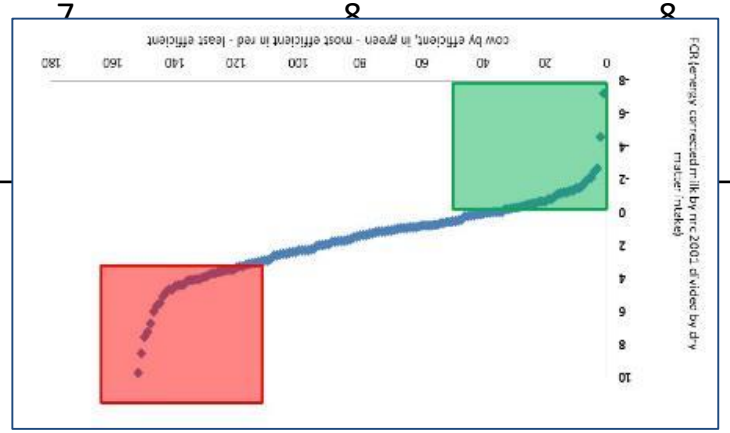
- ✓ working under commercial condition
- ✓ List of the most efficient cows vs. the inefficient cows
- Economic evaluation in other countries .
- Ready for cooperation

Individual meals

Start [h:m:s]	End [h:m:s]	Mass, [kg]	Cow No.
7:32:43	7:33:23	0.30	7
7:40:13	7:40:48	0.06	3
7:53:53	7:57:58	0.42	11
8:08:58	8:15:03	1.14	6
8:16:33	8:16:53	0.30	8
8:17:08	8:23:08	1.04	3
8:24:48	8:28:18	1.42	4
8:28:28	8:32:03	0	3

Feed Efficiency rank

Cows	original	Model Volcani	Model SCR
R^2		0.848	0.835
3503	1	1	1
3640	2	2	2
3631	3	3	3
3488	4	4	4
3663	5	5	5
3637	6	6	6
3536	7	8	8
3588			
3584			
3463			
3203			
3603			
3626			
3643			
2989			
3386	72	70	70
3518	73	74	74
3388	74	68	68
3600	75	75	75
3665	76	76	76



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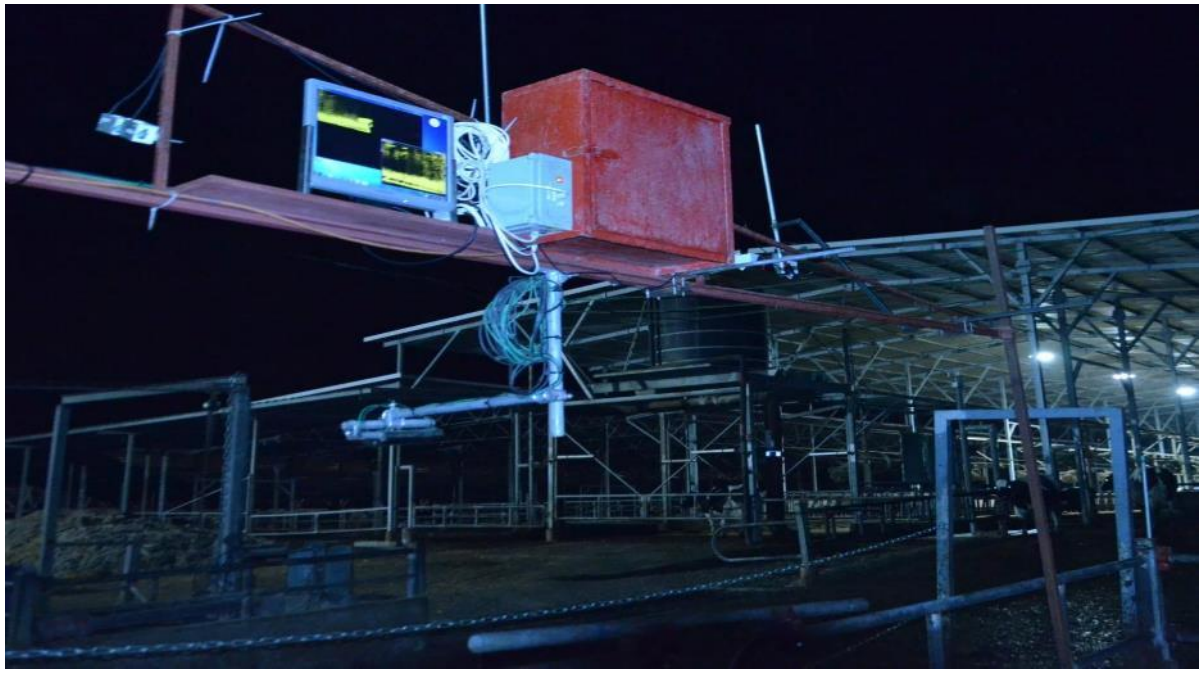
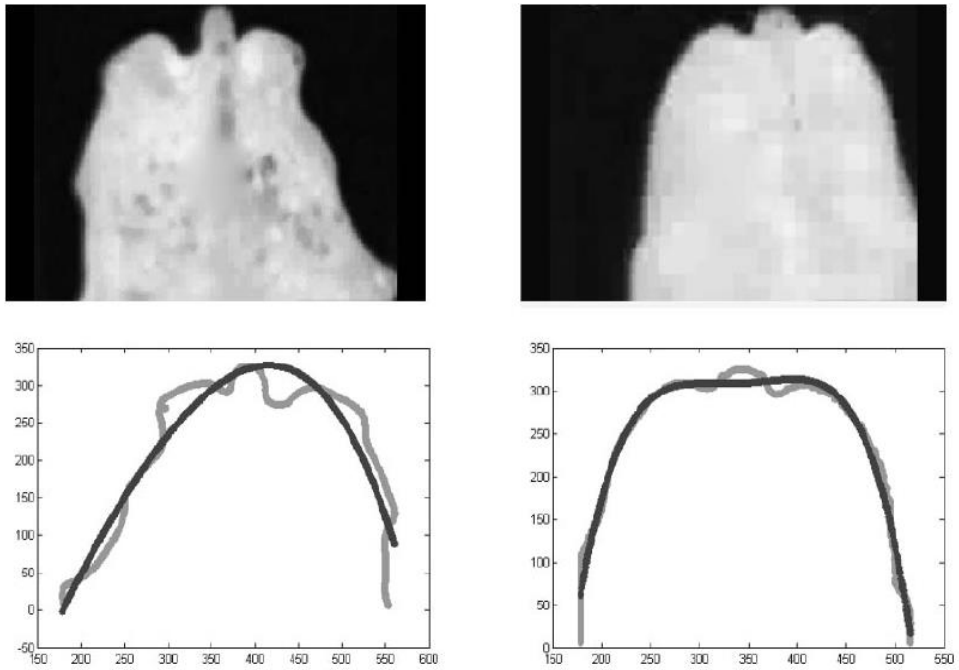
Case study 3

Automatic body condition scoring

- Polynomial fitting to cow contour
- Thermal camera: Halachmi, Klopcic et al., JDS 2008
- Regular camera
- sophisticated algorithm: Halachmi, Klopcic et al., COMPAG 2010





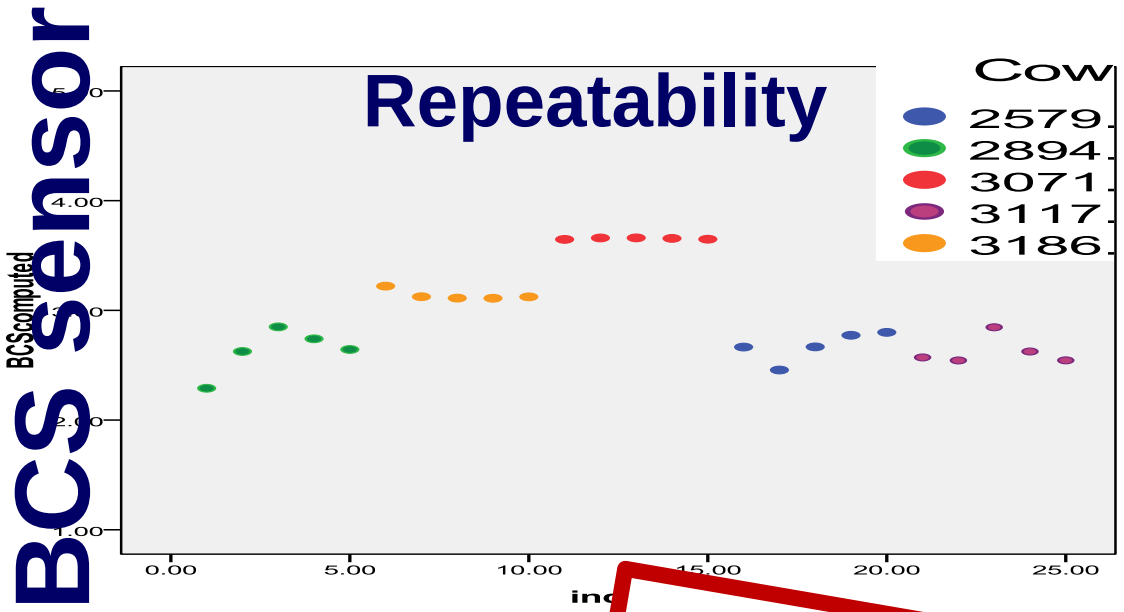
Results

BCS Sensor

- Camera (RGB, 3D)

Model

- Image Processing and Signal Processing



Fuzzy Logic,
Adaptive methods
Applied,

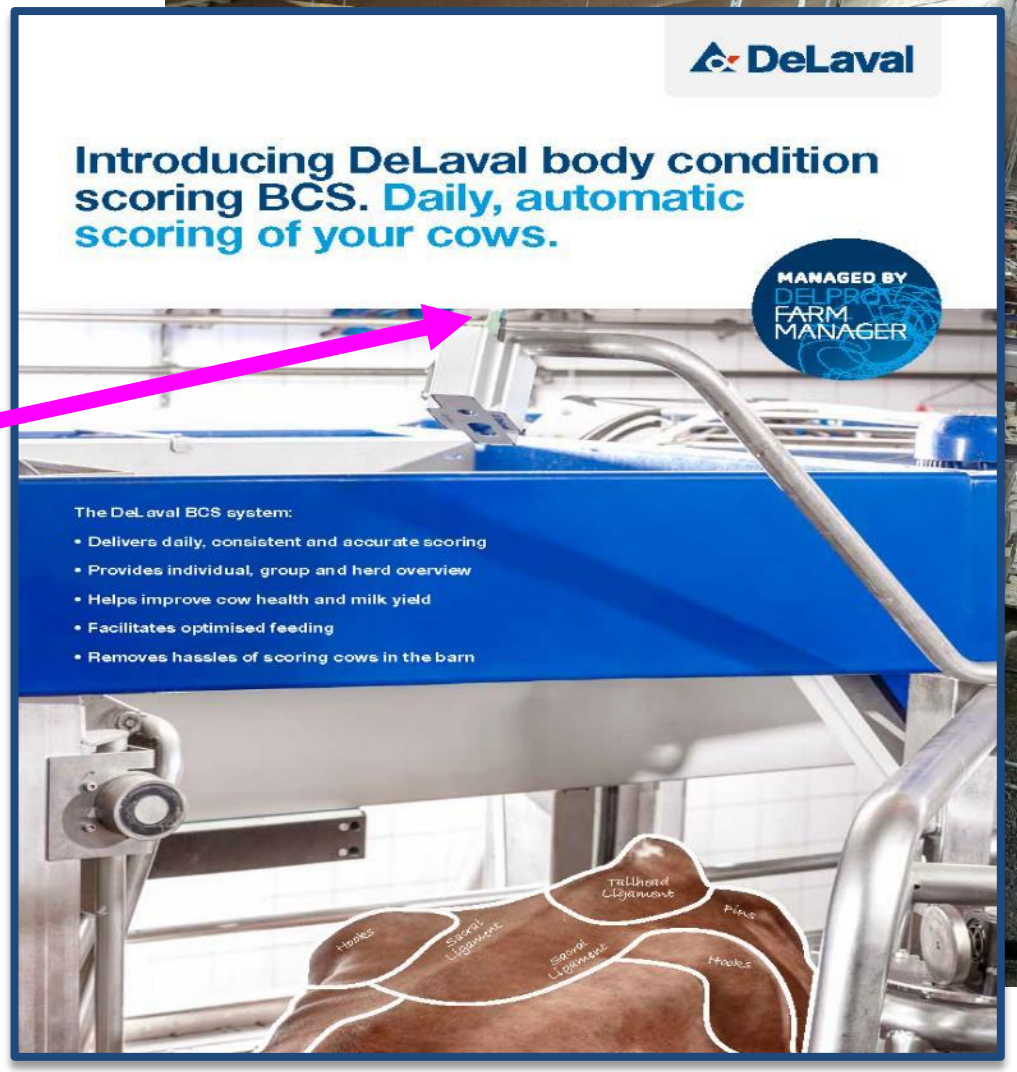
Accuracy (1-5 Scale)

Range	0-1/4	0-1/2	0-3/4	0-1
Training set	53%	82 %	98%	100%
Testing set	43%	72 %	94%	100%

2013 Accepted by the JDS

On farm application

3D Camera



8000 euro/camera

Sheep and goats

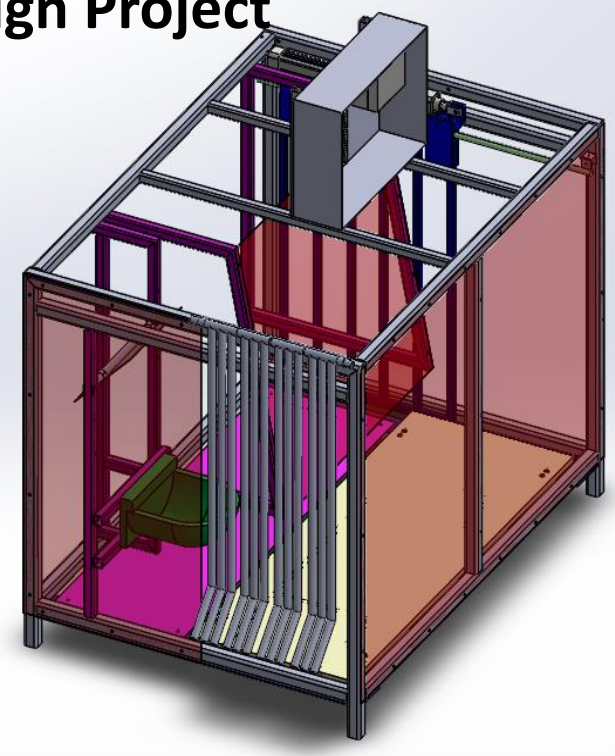
Case study 4

Assaf Godo, Yossi Lapper, Tzach Glassar, Ilan Halachmi

To develop one single device that will care individuals while kept a large herd.

The device is installed in a yard, free access. It monitors growth rate (**body weight)** and the **water consumption** of the each individual animal.

Design Project



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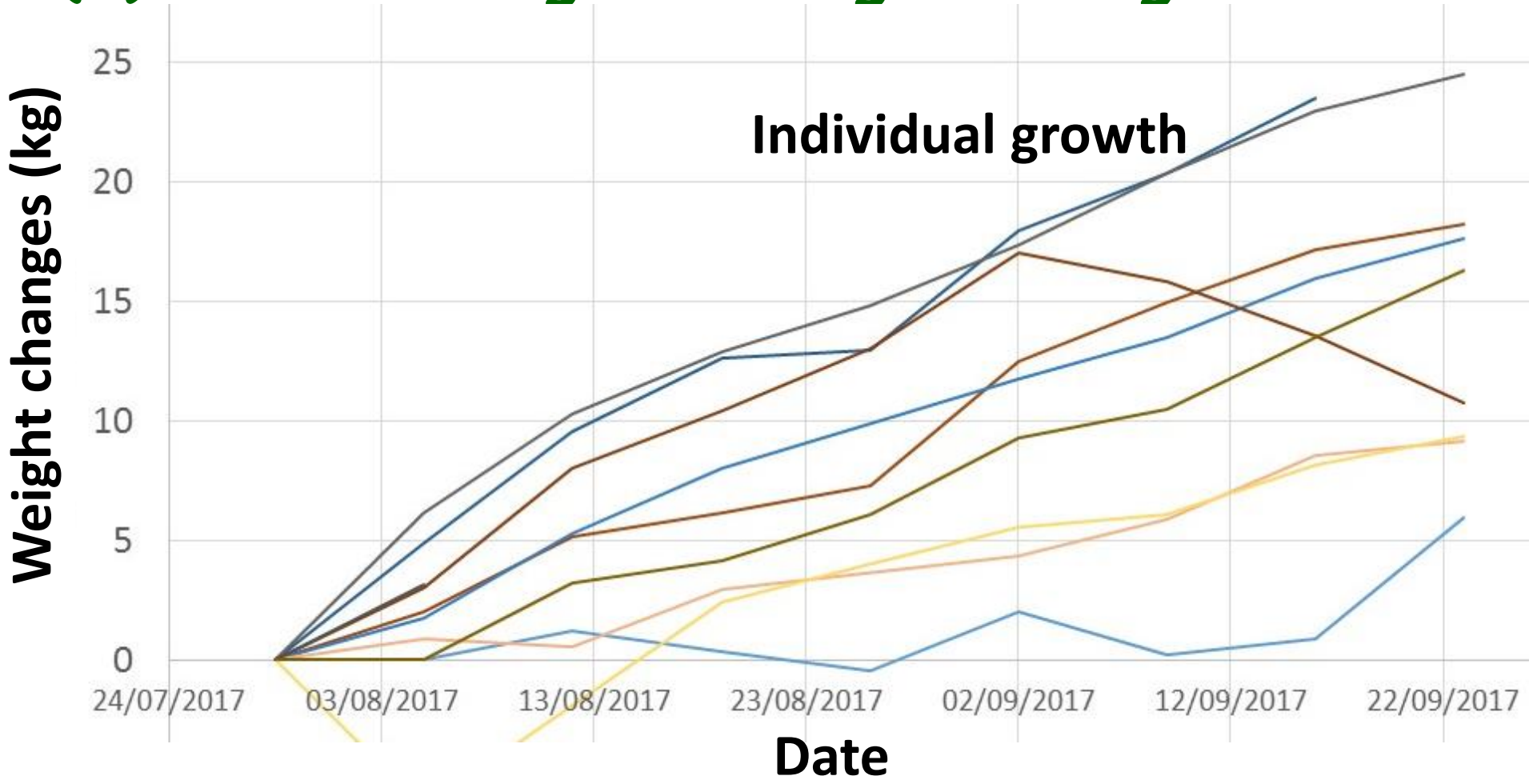
Sheep and goats

Case study 4

Results: (1) – Monitoring the weight change of lambs (ADG)



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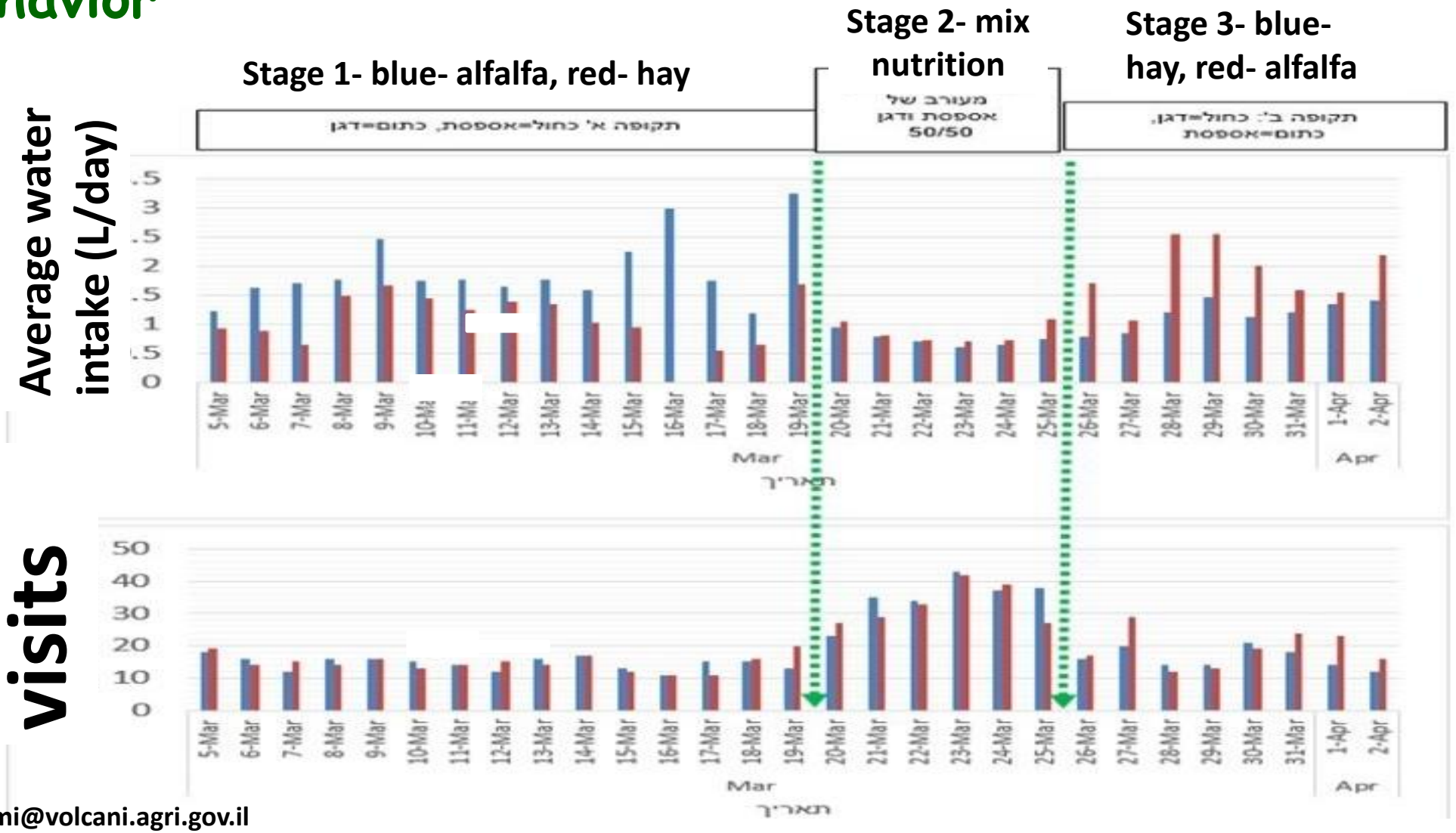
Sheep and goats Results (2) Case study 4

early detection of food quality changes by monitoring drinking behavior



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Results (3) - practical problem

Automatic labeling (paint) **for individual care**

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Poultry

Case study 5

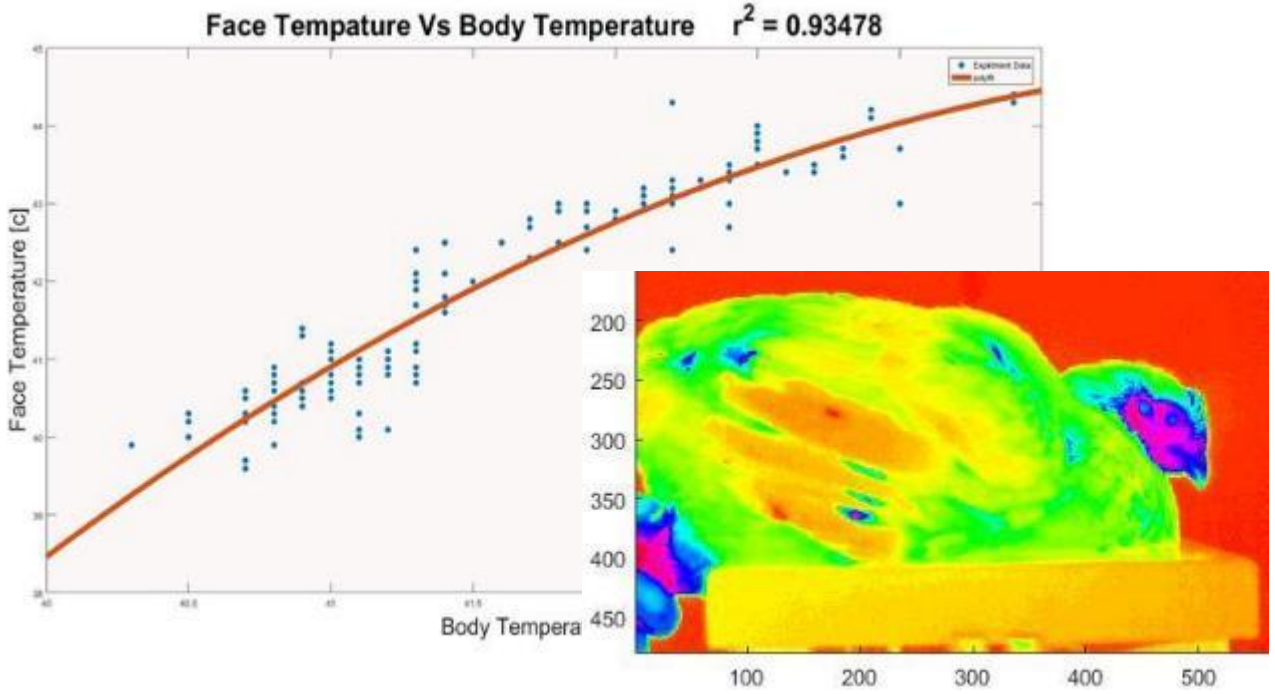
Poultry

Case study 5

Broilers thermal regulation

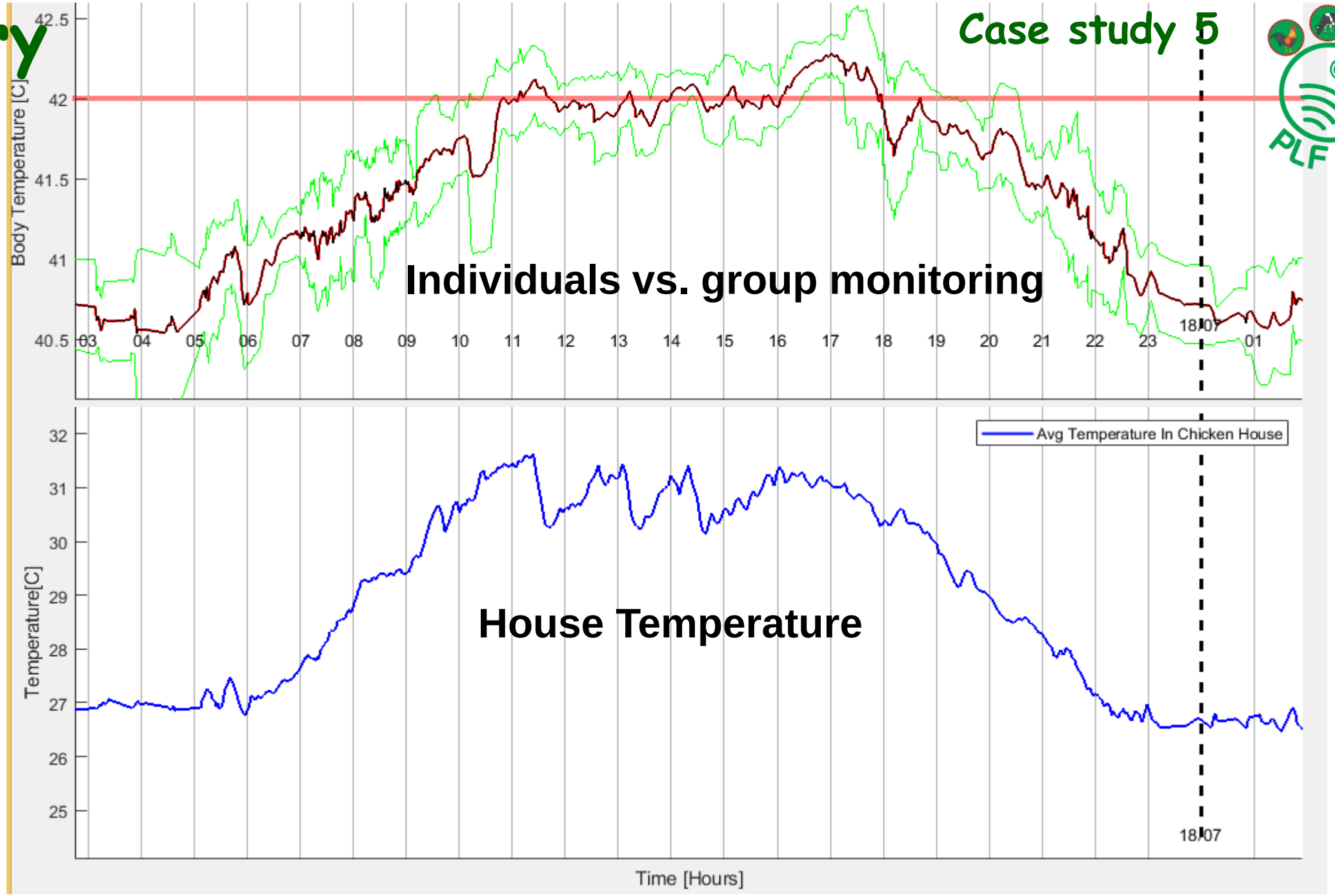
Nathan Barchilon, Odded Geffen, ***Shelly Druyan***

To develop an affordable real-time thermal system to evaluate broiler's body temperature and thus to improve climate control in the poultry house



Poultry

Case study 5



Poultry

Case study 5

- Correlations between thermal camera's prediction and body temperature was found to be sufficient.
- The findings encourage us to apply thermal camera's into the housing climate control system.
- Dr Shelly Druyan – 'PLF in poultry' session 64

Agricultural Research Organization Volcani Center

Institute of Agricultural Engineering

PLF Lab

OptiBarn

THE HEBREW UNIVERSITY OF JERUSALEM

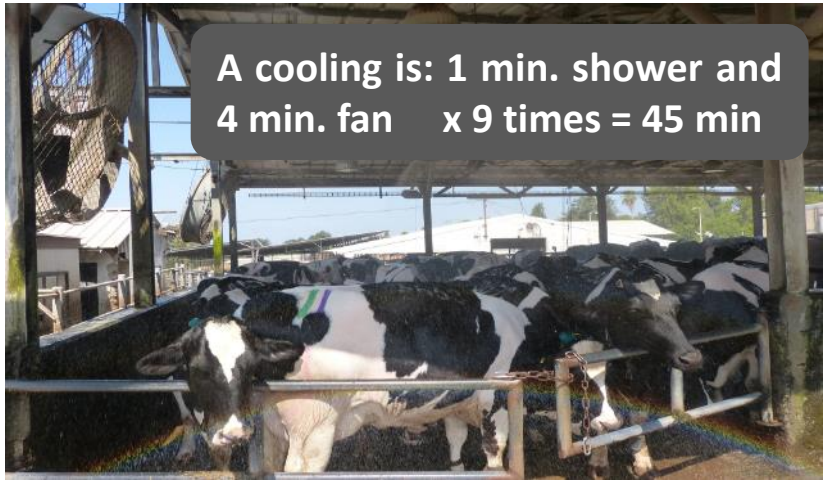
Harel Levit

Attenuating heat stress in dairy; bolus temperature, real-time animal response

Sensor-based cooling vs. **pre-defined, fixed timing** cooling

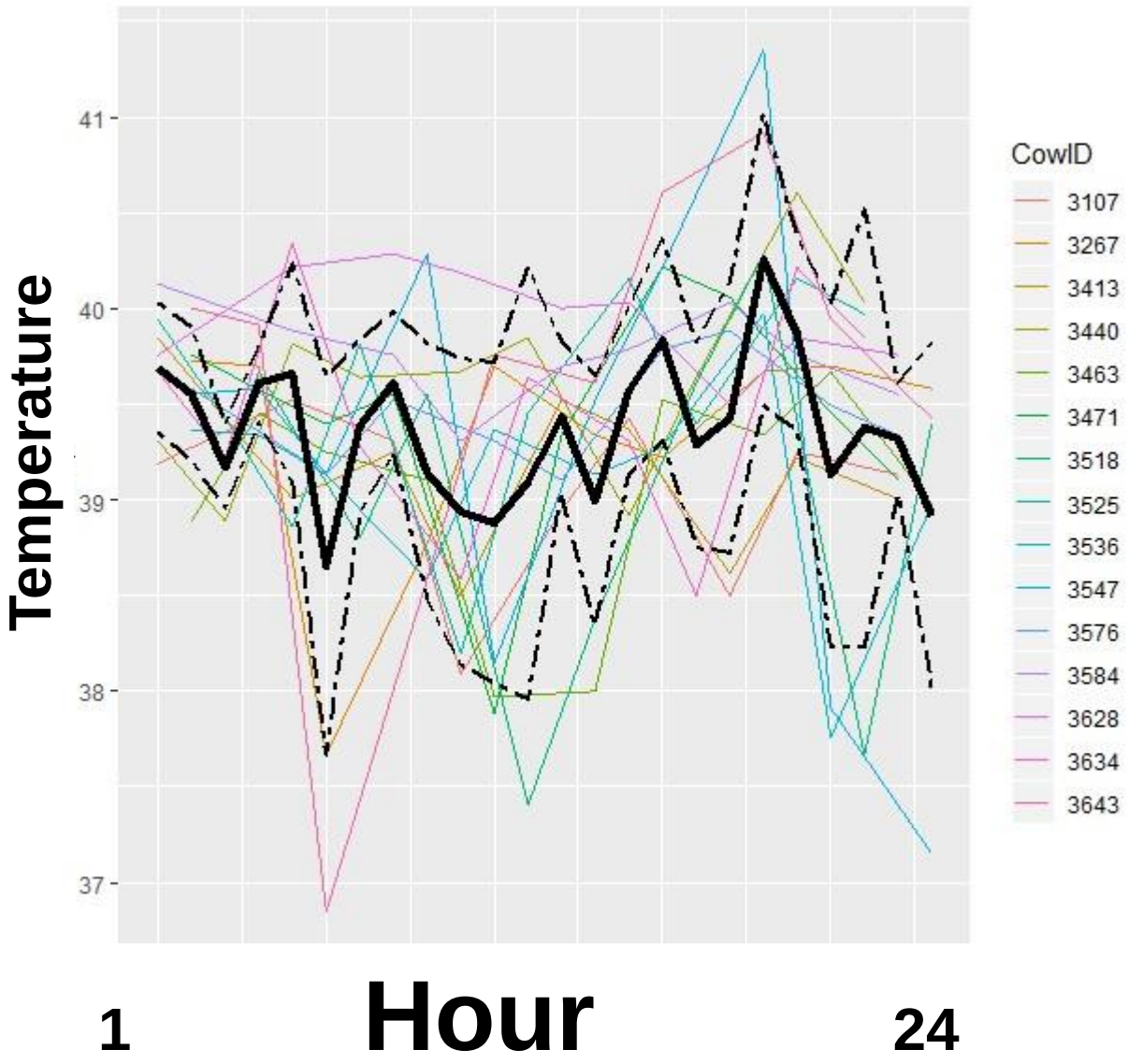
Rumen temperature (Reticulum bolus), Vaginal temperature (i-button logger, cider)

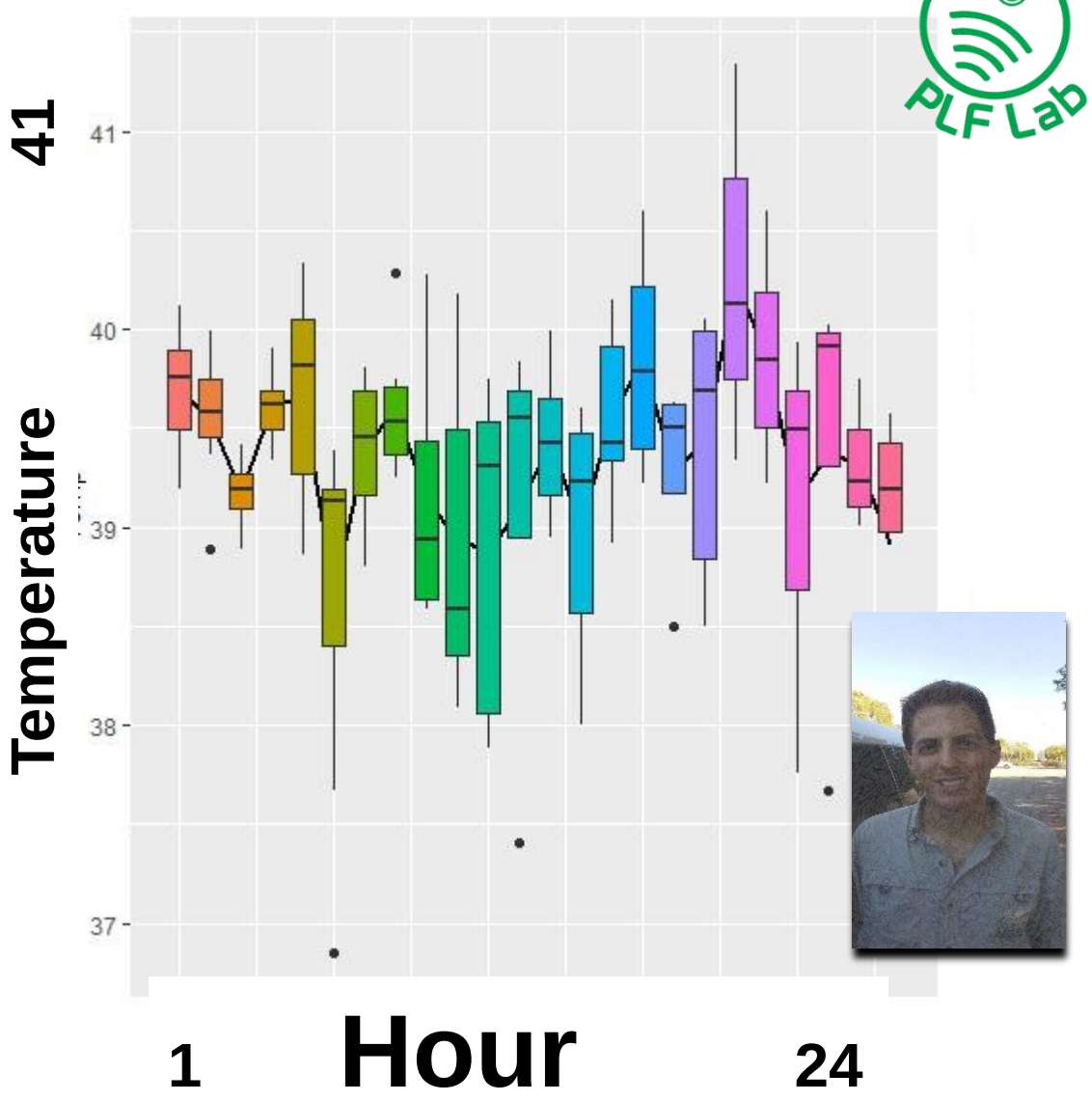
ARO, Volcani, research dairy barn. 2016. 24 Holstein cows, 2017. 30 Holstein cows, 3 months.



Dairy –individuals vs. herd

Case study 6





Harel Levit

Further information

PLF Conferences:

EAAP Study Commission on PLF (President)
EC-PLF European Scientific Committee

Research papers

A PLF section (Editor)

Book: PLF Applications (editor, Wagennigen Press)

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EU Projects sites:

Young Scientists for Food Quality & Safety

FP6 OPTISCORE: electronic sensors to create animal condition scoring protocols

Bio Business

EU - PLF

OptiBarn

FreeWalk

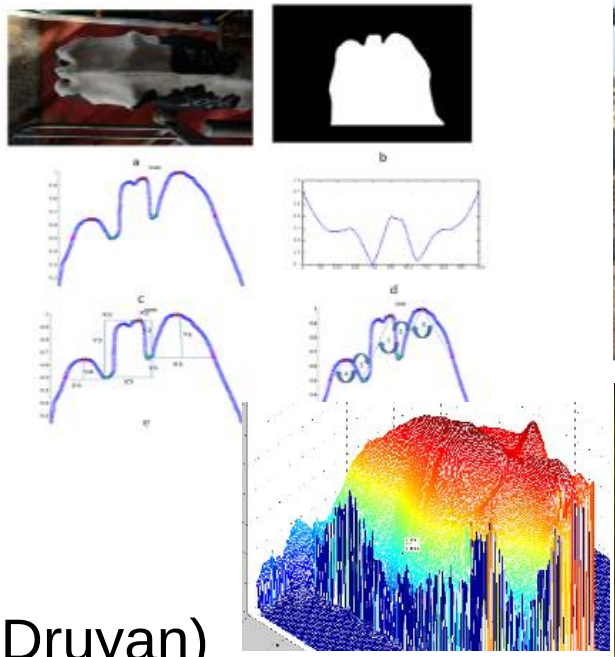
DairyCare

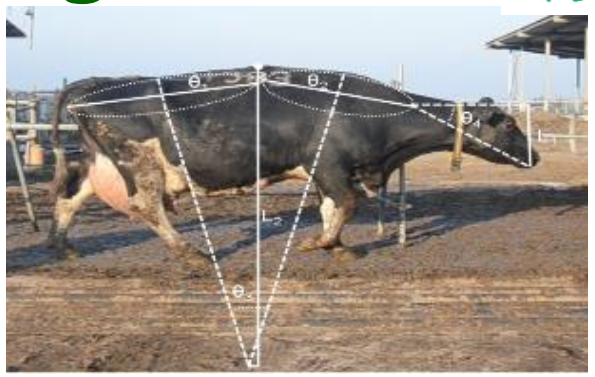
COST 2006 SMART, 2016 DairyCare, and few more

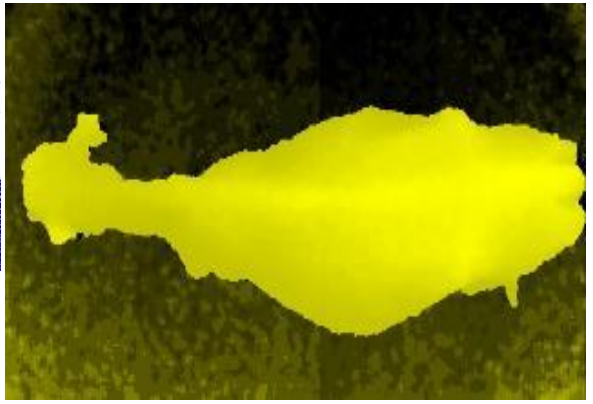
Do we need 'personalized livestock farming (PLF) ?

Case studies at the ARO's PLF Lab.

1. Automatic lameness detection
2. Automatic body condition scoring
3. Auto. detection of early lactation diseases
4. Identifying the cow individual feed efficiency
5. Caring the individuals in small ruminants
6. Heifer height and weight (Dr G Adin)
7. Sensing and mitigation heat stress of broiler (Druyan)
8. Sensing and mitigation heat stress of dairy cows (bolus, Harel Levit)







Potential joint research and business development

Embad video media 1

Embad video media 2

Volcani Institute

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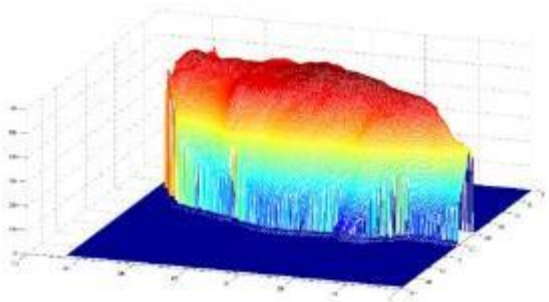
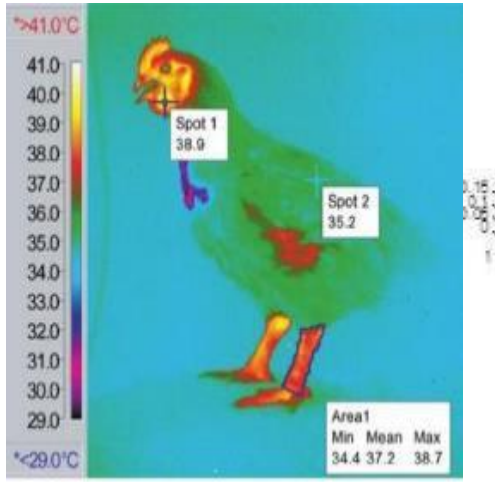
The PLF management concept

A real time monitoring (sensors) aiming at caring the smallest manageable production unit

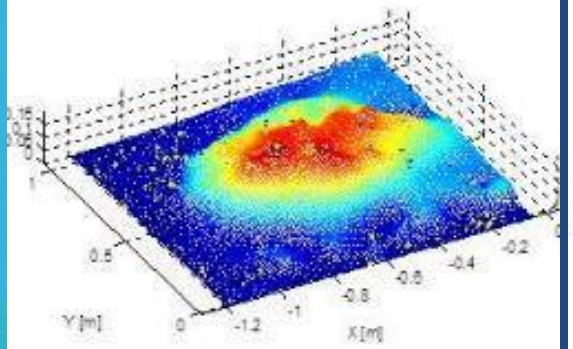
Automatic lameness detection (3D camera)





Climate control based on animal response, thermal imaging (new project)

Small ruminants (new project)
Automatic BCS, Heifer height, Attenuating Heat stress



Monitoring cow individual feed efficiency

Technology

- Thermal imaging
- 3D camera
- Vary sensors
- Realtime analysis
- Machine learning
- Big data

The Israeli PLF Lab.

Business development: Eitan Metuki <eitan@spark.co.il>

Prof. Ilan Halachmi : **halachmi@volcani.agri.gov.il**

Here around until Friday

PLF=precision livestock farming