'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
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 for the individual animals.
What is PLF?

(not "wearables for cows")

A management concept.

In a farm: a real time monitoring (sensors) aiming to handle of the smallest manageable production unit

Diagram adapted from Daniel Berckmans

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

What is PLF?

Technology

What should we monitor?

- Rumination/pH
- Temperature
- Methane emissions
- BCS Fatness or thinness
- Animal position/location
- Chewing activity
- Feed intake
- Respiration
- Heart rate
- Milk content
- Heart rate
- Lying/standing behavior
- Mobility
- Hoof health
- Bolus

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Automatic lameness detection

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

Case study 1
3rd Setup: 3D-camera

Automatic lameness detection
Automatic lameness detection; EU-FP7

Tom van Hertem’s Ph.D. Case study 1

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

R² = 0.98 std 0.15kg

Low cost camera

Medium cost camera
Evaluation of cow individual feed efficiency by camera

 Victor Bloch; Harel Levit; Ilan Halachmi

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

*Case study 2*
Cow individual feed efficiency
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

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

Individual meals

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<td>7:32:43</td>
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<td>8:28:28</td>
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<td>3</td>
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Feed Efficiency rank

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<tr>
<th>Cows</th>
<th>original</th>
<th>Model Volcani</th>
<th>Model SCR</th>
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<tbody>
<tr>
<td>3503</td>
<td>1</td>
<td>1</td>
<td>1</td>
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Case study 2

- Individual meals
- Cow individual feed efficiency - results
- Working under commercial condition
- List of the most efficient cows vs. the inefficient cows
- Economic evaluation in other countries
- Ready for cooperation

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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

Cameras (RGB, 3D)

Model

- Image Processing and Signal Processing

Accuracy (1-5 Scale)

<table>
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<th>Range</th>
<th>0-1/4</th>
<th>0-1/2</th>
<th>0-3/4</th>
<th>0-1</th>
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<tbody>
<tr>
<td>Training set</td>
<td>53%</td>
<td>82%</td>
<td>98%</td>
<td>100%</td>
</tr>
<tr>
<td>Testing set</td>
<td>43%</td>
<td>72%</td>
<td>94%</td>
<td>100%</td>
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2013 Accepted by the JDS
On farm application

3D Camera

Introducing DeLaval body condition scoring BCS. Daily, automatic scoring of your cows.

The DeLaval BCS system:
- Delivers daily, consistent and accurate scoring
- Provides individual, group and herd overview
- Helps improve cow health and milk yield
- Facilitates optimized feeding
- Removes hassles of scoring cows in the barn

8000 euro/camera
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.
Sheep and goats

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

Individual growth

Date

Weight changes (kg)

Sheep and goats  Results (2)  Case study 4

eyearly detection of food quality changes by monitoring drinking behavior

Case study 4

Sheep and goats

Results (2)

Early detection of food quality changes by monitoring drinking behavior

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Results (3) - practical problem

Automatic labeling (paint) for individual care
Case study 5

Poultry

Well, why do you think you crossed the road?
Poultry

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.
Individuals vs. group monitoring

House Temperature

Case study 5

Poultry
Poultry

- 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
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.

A cooling is: 1 min. shower and 4 min. fan $\times$ 9 times $= 45$ min
Dairy - individuals vs. herd

Case study 6

Harel Levit
Further information

PLF Conferences:

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

EU Projects sites:

FP6 OPTISCORE: electronic sensors to create animal condition scoring protocols
Bio Business
EU - PLF
FreeWalk
DairyCare
COST 2006 SMART, 2016 DairyCare, and few more

Research papers

A PLF section (Editor)
Book: PLF Applications (editor, Wagennigen Press)

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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

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Embad video media 1

Embad video media 2

Volcani Institute
The PLF management concept

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

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