# At-market sensor technologies to develop proxies for resilience and efficiency in dairy cows

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## Introduction

Currently, on-farm sensor technologies provide high-frequency repeated measures of, e.g., activity of individual animals. With these high-frequency sensor measurements, we moved forward from occasional snapshots of an animal's status, to a situation where we have continuous time-series of measurements. Until now, these measurements have largely been deployed for the detection of, e.g., a heat or mastitis event. However, little attention has been paid to their possible use for phenotyping complex traits, like resilience and efficiency (R&E). We hypothesize that these at-market sensor technologies can be used to develop proxies for R&E. As a first step, we compared curve-parameters of the 10% most and least resilient or efficient animals.

## Materials And Methods

Data originated from the Dairy Campus, a Wageningen Research farm, and included data from 487 cows, or 487 lactations, between 2014 and 2015. Data included, albeit not continuously for all sensor technologies, sensor data on feed intake (through Roughage intake control bins), milk yield, activity, rumination activity, and live-weight.

For both R&E pragmatic definitions were used, where efficiency was expressed as feed efficiency, and computed for at lactation level as total input (DMI, in kg) over total output (milk yield, in kg). To be eligible for this feed efficiency computations, cows were required to have at least one RIC recording per week, for a minimum of 36 subsequent weeks. Resilience was defined to reflect a cow's ability to re-calve. To do so, lactations were divided into lactations where a cow was able to get in-calf again ("recalvers"), and those that were not ("non-recalvers"). Scoring for non-recalvers was done by counting the number of diseased days in the first 100 DIM, the more diseased days, the lower the ranking of the cow's lactation. For the recalvers, ranking was done based on inseminations and diseased days; those with just one insemination and no diseased days were ranked highest. Lactations were ranked according to their resilience or efficiency score.

The sensor measurements were aggregated to daily values. These daily values were made relative to the herd mean, and subsequently summarized these relative values into "curve-parameters" at lactation level. These curve-parameters involved the mean, and autocorrelation (lag1) of the relative curve of each lactation, the slope of the linear regression line through this relative curve, and the skewness and standard deviation of the residuals. These curve parameters were computed for all lactations (for both R&E). Subsequently, the 10% most and least resilient or efficient lactations were selected, and curve-parameters of these selected lactations were compared. Mean differences in these variables between groups were compared.

## Results And Discussion

There were 98 lactations that had enough RIC recordings to compute efficiency at lactation level. These efficiency scores ranged from 0.48 (most efficient cows) to 1.19 (least efficient cows) kg DMI/kg milk. For ranking lactations for resilience, there were 128 lactations of non-recalvers and 359 lactations of recalvers. All lactations where cows were not in-calf received a lower resilience score than those lactations were cows were in-calf. Table 1 summarizes the mean values of curve- parameters for activity measurements of the 10% most and least resilient or efficient lactations. For activity, the mean values appear to be different between groups, although the ranges do overlap. Similar results were seen for the other sensors. These results imply that using a single sensor will be insufficient for a proxy for resilience or efficiency, and that combining sensors for this purpose is likely to be required. The lack of differences in mean values, and the overlap in the ranges, may also occur partly due to the very pragmatic definitions we used. Our current method to rank cows for resilience was based on the last lactation only, which has the consequence that cows in higher parities are likely to be underestimated for their resilience score compared to, e.g., heifers. This method could be improved by a scoring approach where cows with multiple lactations, that thus have shown the ability to re-calve several times, will receive more points than those that only make  a first lactation. Concepts for such a method are under construction, and will be implemented in the future.

## Conclusion

Comparing the curve-parameters of the 10% most and least efficient and resilient cows did demonstrate differences in means, although the ranges did overlap largely between the two groups. This implies there is little value in the use of individual sensors to develop proxies for resilience and efficiency so that combining sensors will required to obtain good proxies.


## Acknowledgement

The research leading to these results has received from funding from European Community's H2020 Framework Programme – GenTORE, under grand agreement n° 727213.


**Table 1:** Mean values (range between brackets) for activity measures, for the 10% most and least resilient or efficient lactations

| | Resilience | | Efficiency | |
|---|---|---|---|---|
| **Curve-parameters** | **Top 10%** | **Lowest 10%** | **Top 10%** | **Lowest 10%** |
| Mean | 100.7 (57.2-159.3) | 91.1 (37.6-207.3) | 116 (75.1-177.9) | 110.8 (79.4-154.4) |
| Autocorrelation 1 | 0.6 (-0.1-0.9) | 0.4 (-0.7-1.0) | 0.6 (0.2-1.0) | 0.7 (0.3-0.9) |
| Slope | -0.4 (-18.4-1.5) | -0.4(-10.8-3.1) | 0 (-0.2-0.3) | 0 (-0.1-0.2) |
| Skewness | 0.6 (-1.7-4.0) | 0.3 (-1.6-3.7) | 0.7 (-2.2-4.2) | 0.6 (-1.5-2.9) |
| Standard Deviation | 12.1 (0-39.2) | 12.0 (0-32.5) | 18.5 (8.9-39.3) | 17.0 (10.1-33.3) |