# Monitoring welfare in dairy farms: analysis of census-level welfare assessment protocols reveals farm characteristics associated with reduced or improved welfare levels

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**Summary**
In 2016, the Dutch dairy industry introduced the Welfare Monitor, a welfare assessment protocol to give dairy farmers insight into the welfare of their animals and identify any areas for improvement (1). The Welfare Monitor (WM) is a practical and pragmatic implementation of the WelfareQuality® protocol, annually filled by the veterinary practitioner of dairy farms. In the WM, all observations of the practitioner are translated into 12 (numerical) criteria via a set of calculation rules, which in turn result in a 0-100 score for each of four welfare *principles:* Nutrition, Housing, Health, and Behaviour. Since 2020, the WM has a 95% participation rate among dairy farmers. The aim of this study was to analyse variance components of WM scores within- and between herds and to assess associations with farm characteristics. Results showed significant differences in the variation in scores between farms, and within farms over the analysed period. Highest variation between farms was observed in the principles Nutrition and Behaviour. Apparently, some farmers succeed in performing well within these principles, while a substantial number of farms score low. Multivariable analysis of WM scores in relation herd characteristics provided insight in the profile of dairy farms that either scored high or low in the WM. For instance, having a favourable certified health status (IBR, paratuberculosis, salmonella) was associated with higher WM scores. Also, there are indications that farmers striving for higher longevity of their herd achieve higher WM scores. Why some farmers succeed well in maintaining a high level of welfare in their herds, where others do not, is complex and needs further research. It is also recommended to investigate whether the presentation of the Welfare Monitor to farmers can be optimized, e.g. with national benchmark values and graphics providing insight in farm-level trends over time.

**Methods**
Yearly WM scores from all dairy herds in the period 2020 to 2023 were provided by ZuivelNL, the organisation of the Dutch dairy supply chain. The measurements per welfare criteria are summarized below. Details on the measurements and criteria that define the WM protocol are described in detail by (1).

Measurements per welfare principle in the Dutch Welfare Monitor for dairy herds:
Nutrition
-Extreme body condition scores (BCS 1 or 5)
-Water supply (quality, quantity, accessibility)
Housing
-Comfort (freestall dimensions, bedding, softness)
-Cow hygiene
-Freedom of movement (access to pasture)
-Barn conditions (daylight, ventilation, cow brushes
Health
-Lameness (locomotion score)
-Wounds, swelling, hock and knee injuries
-Mastitis incidence and other diseases (respiratory/metabolic/fertility)
-Dehorning (with/without pain mitigation)
Behaviour
-Ability to express natural behaviour (access to pasture)
-Avoidance distance at the feeding fence

Farm characteristics describing herd size, replacement rates, open/closed farming system and geographical location (postal code area) were provided by the Netherlands Enterprise Agency (Assen, the Netherlands). Herd health certification statuses (BVD, BoHV-1, MAP, salmonellosis and leptospirosis, see (2) for a program details) were available at Royal GD (Deventer, the Netherlands). Farm identification numbers were anonymized in all datasets prior to data transfer to Royal GD.

*Analysis*
All analyses were performed using Stata software (StataSE, version 18). Descriptive analyses involved the quantification of within-herd (year-to-year) and between-herd variation in scores for each welfare principle between 2020-2023. For this purpose, the 'within-subject' and 'between-subject' variance was estimated for each welfare principle via linear regression models including a random herd effect. By dividing these by the long-term average of the welfare principle, a coefficient of variation (CV) was calculated, which allows for the comparison of variation amongst welfare principles. In-depth analyses involved multilevel multivariable logistic regression analyses per welfare principle, to assess the association between farm characteristics and the probability of an either high score (>75$^{th}$ percentile of the population) or low score (<25$^{th}$ percentile of the population) for each of the four principles.

**Results**
The dataset contained 54,208 annual entries from 14,624 different dairy farms over the period 2020-2023. WM scores for all four years were available for 12,135 farms (83% of all dairy farms). Most farms were assessed by their practitioner in the period October to December (~60% of the farms).

*Within- and between-herd variation in scores*
The average score per principle varied over the analysed period from 51.5 points for Health to 78.5 points for Nutrition (Table 1). The principles Nutrition and Behaviour showed most variation between farms; the CV varied between 25.8% and 31.8% of the population average, respectively (Table 1). The scores for the principle Health varied the most from year to year within the same farm, with a CV of 17.7%.

*Associations with farm characteristics*
This in-depth analysis provided insights into the profile of a dairy farm with a low or high score for each of the four welfare principles within the WM. Significant associations (*p*-value <0.05) are summarized below per farm characteristic.

*IBR status:* Herds with a IBR-free certificate have higher Nutrition, Health and Behaviour scores;
*Salmonella status:* Herds with a favourable Salmonella certificate have a higher Nutrition score;
*MAP status:* Herds with a favourable MAP certificate have a higher Nutrition score;
*Leptospirosis status:* No associations found;
*BVD status:* No associations found;
*Grazing:* Herds that apply grazing have higher Health scores;
*Herd size:* Larger herd sizes (99-191 cows and >191 cows) are associated with higher Housing scores. Smaller herd sizes (<49 cows and 49-98 cows) are associated with higher Behaviour scores
*Replacement rate:* Low replacement rates (<16% of cows per year) are associated with higher Behaviour and Health
scores;
*Mean cow age:* Herds with a high mean age (>52 months) in their herd have higher Health scores yet lower Housing
scores. Herds with a very low mean age (<35 months) in their herd have higher Health scores;
*Month of assessment:* Herds that were assessed early in the year (January/February) have higher Health scores, yet lower
Nutrition and Housing scores.

**Discussion**
Results of this study showed significant differences in the level of each welfare principle with the WM (Health, Nutrition, Housing, and Behaviour) and the variation between farms and within farms over the analysed period. Most differences between farms were observed in the principles Nutrition and Behaviour. Apparently, some farmers succeed in performing well within these principles, while a substantial number of farms score low on these principles. A note here is that these two principles are each based on only three criteria, so not having one of the measurements in order has a greater impact on the principle score than in a principle composed of five criteria. The in-depth analysis provided some insight into the profile of dairy farms that score high or low in the WM. For instance, favourable herd health statuses were associated with a high Nutrition score. Additionally, there are indications that farmers striving for longevity of their herd, in the form of a low replacement rate and/or high average age of the herd, achieve higher scores in Behaviour and Health. In a few cases, conflicting results were found between farm characteristics and the different principle scores. For example, larger dairy farms scored higher on the principle of Housing, but lower on Behaviour. It is also noteworthy that the month of the year in which herds were assessed influenced some principle scores, which could be due to factors associated with winter housing period versus grazing period (such as cow hygiene). Also, it is assumed that veterinarians conduct assessments consistently throughout the year, yet variation between veterinarians (or veterinary practices) cannot be ruled out.

**Conclusion**

This study provided a first overview of the national animal-based WM scores in dairy herds in the Netherlands and revealed where most variation between farms exist and thus, where potential for improvement can be found. Why some farmers succeed well in maintaining a high level of welfare in their herds, where others do not, is complex and needs further research. It is also recommended to investigate whether the presentation of the WM to farmers can be optimized, for example by including national benchmark values and graphics that provide insight in farm-level trends over time.

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| Statistic | Nutrition | Housing | Health | Behaviour |
|---|---|---|---|---|
| Mean | 78.5 | 64.9 | 51.5 | 71.1 |
| Median | 89.0 | 65.0 | 50.0 | 78.0 |
| Standard deviation | 23.3 | 9.5 | 13.4 | 24.2 |
| Range | 0-100 | 34-98 | 0-100 | 19-97 |
| Between herds CV | 25.8% | 13.9% | 19.1% | 31.8% |
| Within herds CV | 14.9% | 4.71% | 17.7% | 12.6% |

Table 1. Descriptive statistics per welfare principle within the Welfare Monitor over the period 2020-2023, with between- and within-herd variation expressed as coefficient of variation (CV).

**Keywords:** Welfare, Dairy farms, Monitoring.

**References:**

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