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LACTATION PERFORMANCE OF FIRST- AND SECOND-PARITY HOLSTEINS IN ROBOTIC MILKING SYSTEM

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Abstract

This experiment was conducted to evaluate performance parameters of first- and second-parity Holstein cows in the robotic milking system. Data from the first lactating cows (n = 124) and the second lactating cows (n = 57) were subjected to descriptive statistics and regression analysis. The mean DIM, milk yield, entrance to the robotic parlor, and compound feed consumption in the parlor were 222 days, 28.0 L, 2.89 times, and 2.97 kg for first-parity cows and 121 days, 36.7 L, 2.89 times, and 3.99 kg for second-parity cows, respectively. Entrance to robotic milking unit did not change as lactation advanced. Each entry was associated with increases in milk yield by 8.1 L and 1.00 kg compound feed consumption within the unit. In summary, the more entrance to the robotic milking unit, thereby the more feed consumption, increases milk yield in the robotic milking system, independent from the parity of cows.

Key words*: lactation, parity, robotic milking system.*

INTRODUCTION

Population in urban increases, whereas population in rural decreases. In relationship to this fact, the mean age of dairy farmers and workers is advanced, consequently farm sizes in rural decrease in global dairy operations. Thank to advancements in mechanization and electronics, robotic milking system (RMS), also known as automated milking system, is becoming common. Since the first RMS installation on a commercial farm in the Netherlands in 1992, switching to this system has dramatically increased to 35,000 units worldwide in 2022 (Geiger, 2022).

Robotic milking system technology allows voluntary milking, which is that each cow has ability to set its own milking schedule. Moreover, it provides data on volume, milking frequency, and milk quality that makes more accurate decisions on management, nutrition, and health (Urbanz & Cardaso, 2023; Marin et al., 2025). The advantages (Soffar, 2019) of this system include reducing number and cost of labor, obtaining more reliable data and experiencing less competition for feed banks, and holding area that create stress-free environment. It is reported that adoption of RMS caused reduction in labor cost by 86% and in number of employees by 69% and improvements in welfare by 77% and in herd performance by 73% (Malacco, 2022). The disadvantages (Soffar, 2019) of this system include high installation cost and initial adaptation.

Utilization of RMS changed feeding system. However, nutritional management in farms with RMS has not been fully elucidated yet. It is obvious that feeding management is key to eventual success. Not only content and physical form of concentrate offered in RMS, but also nutritive value and roughage: concentrate ratio in partial mixed ration (PMR) is important.

Cows were fed concentrate (averaging 3-5 kg) in RMS and given PMR at feed bunk (Tremblay et al., 2016). Data on palatability and amount of concentrate in RMS are not fully established. Bach et al. (2007) projected cows to consume either 3 or 8 kg concentrate in RMS and reported actual intakes were 2.6 and 6.9 kg. Similarly, Halachmi et al. (2005) projected either 1.2 kg per visit or 7 kg per day and reported an average actual intake of 3.85 kg. Menajovsky et al. (2018) set up groups in a

factorial arrangement of two levels of roughage : concentrate (54: 46 vs. 64: 36) in PMR at feed bunk and concentrate levels (2 vs. 6 kg/d) in RMR. They (Menajovsky et al., 2018) reported that feeding high level of concentrate increased milk yield while increasing day-to-day variability in concentrate consumption in RMS. Likewise feeding low roughage: concentrate ratio in PMR at feed bunk increased with yield without causing variation in concentrate consumption in RMS. However, low forage: concentrate in PMR at feed bunk induced ruminal acidosis as well increased time spent in holding area. Composition of PMR and responses to ruminal profiles may reciprocally influence performance in RMS. It is therefore inconclusive to claim that the more entry to consumption in RMS increases milk yield (Halachmi et al., 2005).

The objective of this study was to determine concentrate consumption in RMS and milk yield in the first and second lactating Holstein cows while *ad libitum* consumption of single type of PMR.

MATERIALS AND METHODS

Herd was generated from pregnant heifers purchased from Poland at different times, which caused parity difference.

Cows were housed in 2-row free stall farm equipped with 4 RMS units (VMS V300) and farm management software (DeLaval DelPro™) (DeLaval International, Tumba, Sweeden).

Days in milk (DIM), milk yield, entry to RMS, and concentrate consumption in RMS data from Holstein cows (N=124 1st lactation and N=57 2nd lactation).

Table 1. Summary of database[1]

RMS Unit	Cow (N)	DIM	Milk (L)	Entry to RMS	Concentrate intake in RMS (kg)
1st	30	197	37.3	3.08	4.33
2nd	51	391	28.8	2.72	2.90
3rd	56	33	27.8	2.88	3.50
4th	44	148	32.2	2.89	3.29
Mean ➔		189	30.7	2.89	3.29

[1]RMS = robotic milking system; DIM = days in milk

Cows were fed to meet nutrient requirements for dairy cows (NASEM, 2021). On a dry matter basis, PMR ration contained 1.55% straw, 13.15% alfalfa hay, 41.57% corn silage, 20.99% protein concentrate (RasyoLife, Mugla Türkiye), 17.14% corn flake, 2.05% palm oil, and 3.55% premix of vitamins, minerals, buffering agents, yeast-sodium bicarbonate-magnesium oxide, toxin binder, salt, limestone, and dicalcium phosphate (RasyoLife) [Roughage : Concentrate, 56.27 : 43.73; crude protein, 15.43%; neutral detergent fiber, 33.75; starch, 25.82%, ether extract, 5.25; and ash, 8.36%].

Cows were projected to consume 2 to 7 kg (crude protein, 22.27%, starch, 64.64%, ether extract, 4.59%, and ash 6.96%), 0.8 kg increment for 5 L extra milk after 20 L yield.

Data (Table 1) were subjected to one-way ANOVA and regression analyses.

RESULTS AND DISCUSSIONS

There was no difference in entry to RMS but concentrate consumption in RMS was higher in older cows than younger cows (Table 1). This could also be related to increased frame size and milk yield.

Table 2. Parity effect on performance of dairy cows housed with robotic milking system[1]

Parity	DIM	Milk, L	Concent. intake in RMS, kg	Entry to RMS
1 (N=124)	222	27.98	2.97	2.89
2 (N=57)	121	36.73	3.99	2.89

[1]RMS = robotic milking system unit; DIM = days in milk

As lactation advanced or DIM prolonged, entry to RMS decreased (Figure 1), due to lower milk yield associated with lower concentrate consumption in RMS (Figure 2). The linear regression equations revealed that these decreases started from 3.05 entry to RMS and 3.57 kg concentrate consumption in RMS.

Entry to RMS was associated with 8.1 L increase in milk production (Figure 3). Each kg concentrate consumption in RMS was associated with 4.7 L increase in milk production (Figure 4).

The study questioned if concentrate consumption increased the number of entries to RMS. Concentration consumption in RMS slightly encouraged voluntary entry to RMS (Figure 5).

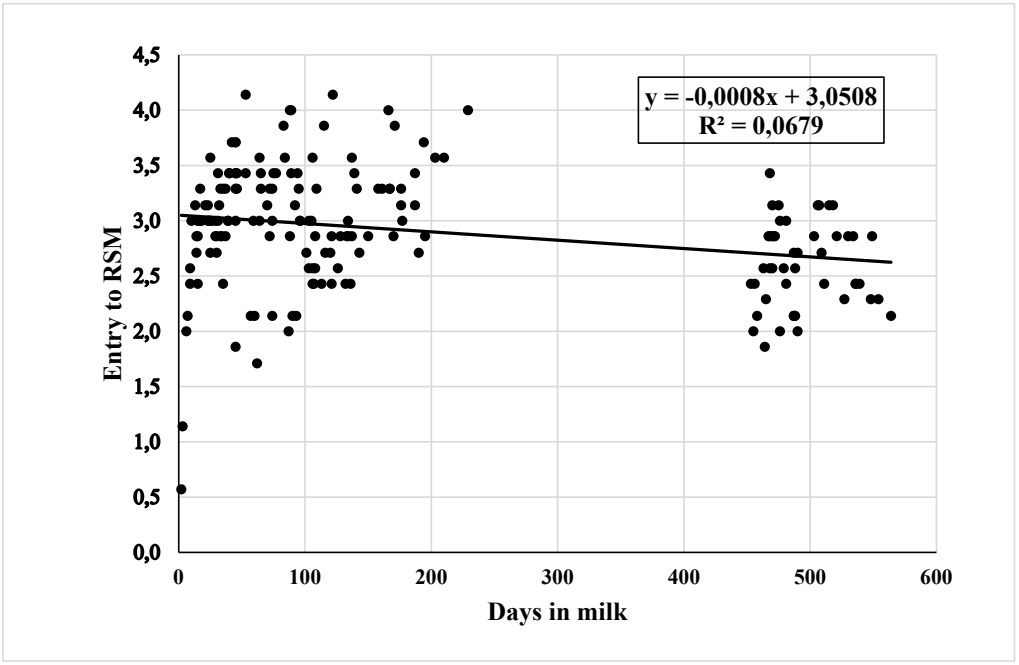


Figure 1. Relationship between entry to robotic milking system (RMS) and days in milk

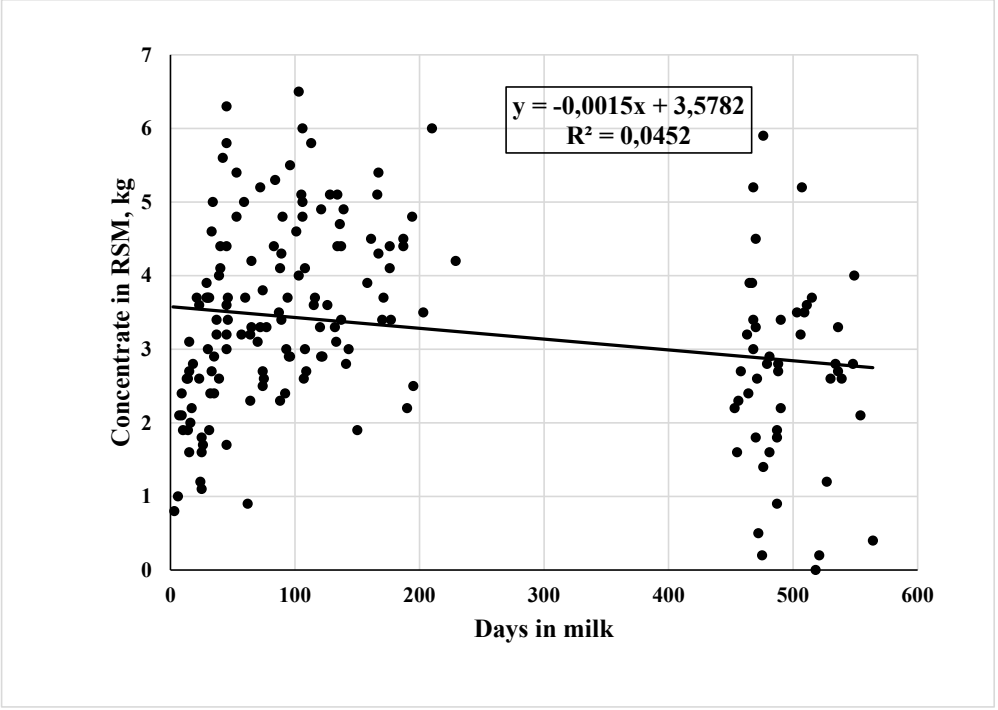


Figure 2. Relationship between concentrate consumption in robotic milking system (RMS) and days in milk

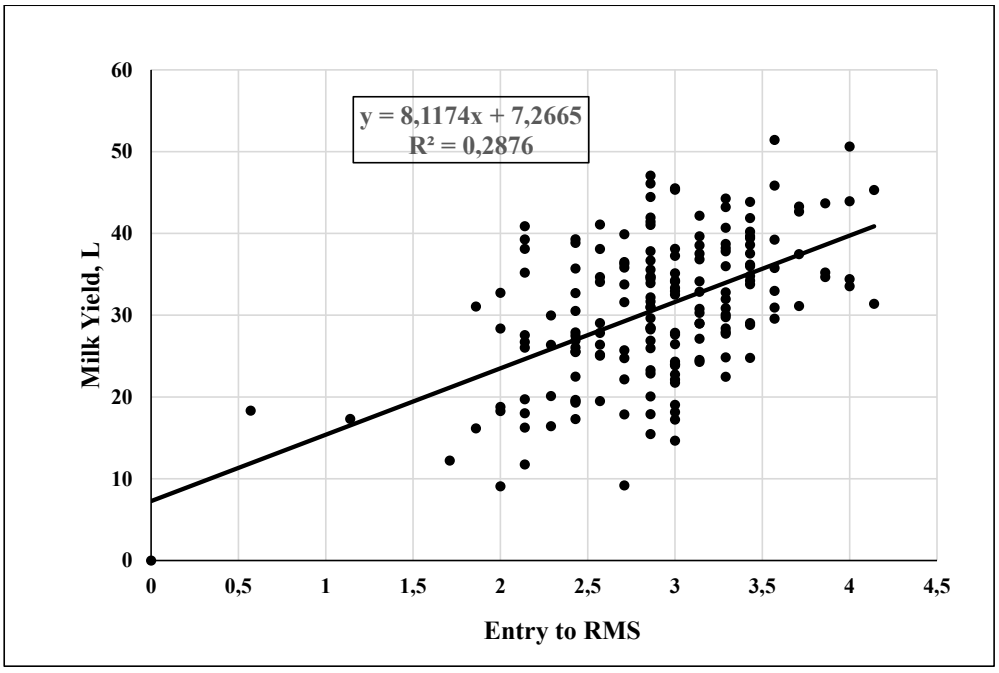


Figure 3. Relationship between entry to robotic milking system (RMS) and milk production

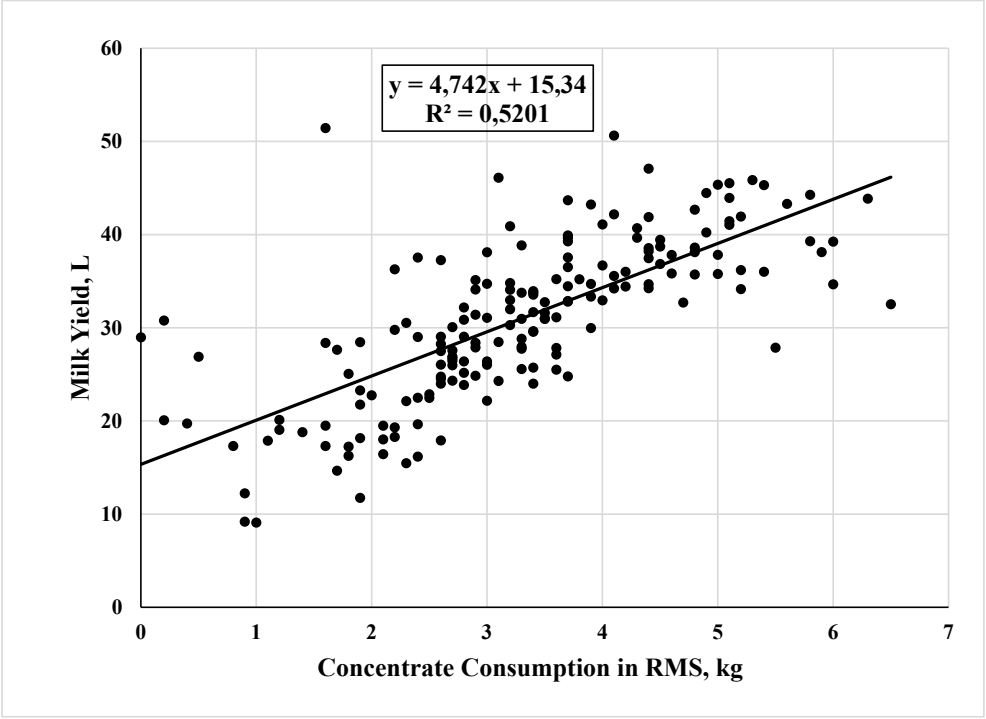


Figure 4. Relationship between concentrate consumption in robotic milking system (RMS) and milk production

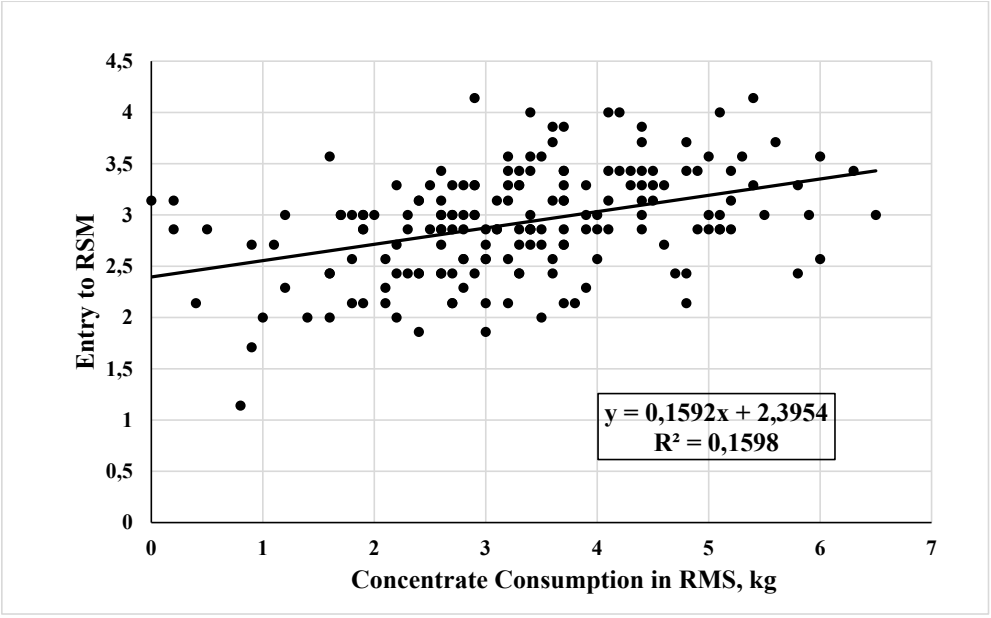


Figure 5. Relationship between concentrate consumption in robotic milking system (RMS) and entry to RMS

A palatable feed offered in the RMS unit is one of the motivating factors for cows to visit the RMS, with the other one being the availability and quality of the PMR in the feed bunk. Pellet feeding *vs*. steam-flaked barley was compared (2 kg/d) in terms of dry matter intake, entry to RMS, milk yield, and milk composition, and PMR consumption (Johnson et al., 2021). Cows receiving the steam-flaked barley fewer entry to RMS (2.71 *vs*. 2.90), tended to have a longer interval between milkings (541.7 *vs*. 505.8 min), spent more time in the holding pen before entering the RMS (139.9 *vs*. 81.2 min/d), and had lower total box time (19.7 *vs*. 21.4 min/d) than cows fed pellet feed. However, their milk yield (44.0 kg/d) and milk composition [fat (1.62 kg/d) and protein (1.47 kg/d)] were similar.

Paddick et al. (2019) offered from 0.5 to 5 kg concentrate in RMS reported no changes in milk yield. This response was attributed to compensation of total intake through PMR at bunk formulated to be *isocaloric*. Namely, cows projected to consume more concentrate in RMS consumed less amount of PMR at feed bunk. Therefore, daily visit to RMS remained unchanged. Despite single type concentrate formulation in this study, concentrate pellet in the RMS unit differing in nutrient density based on production level or lactation stage can be formulated.

In agreement with the present study, Siewert et al. (2019) reported that primiparous cows in free-flow systems produced less milk and had lower entry to RMS than multiparous cows until the late lactation stage. That concluded that there was a potential lagging performance for primiparous cows in early lactation as compared with multiparous cows.

Castro et al. (2012) evaluated efficiency of 34 RMS efficiency and reported that a RMS unit milked 52.7±9.0 cows daily at 2.69±0.28 milkings per cow, with a total milking downtime of 1,947±978 h/yr and a milk yield of 549,734±126,432 kg/yr. The predictor variables cow and milk flow rate had a greater level of influence on the milk yield per AMS than milkings per cow and rejections, which explained the 87% of the variation.

It is expected that health status of cows may influence performance in PMS. In this study, cows were not categorized and evaluated based on their health status. This is important for nutrient enriched concentrate option for cows with negative energy balance due to decreased number of entries to RMS, especially for ketotic cows having sluggish appetite (King et al., 2018). Cows with acidosis, as ascertained

by claw lesions, fecal inconsistency, and reduced ruminal intensity had an averaged entry to RMS was 2.2 milkings per day. After limiting concentrate dispensing in RMS and increasing roughage in PMR, entry to RMS reached an average of 2.6 milkings per day (Wichern et al., 2015). This can infer that amount of concentrate allowance in RMS and its starch level are important to maintain projected entry to RMS, thereby to achieve robotic efficiency and milk yield

CONCLUSIONS

Milk production level and entry to RMS as well as concentrate consumption in RMS are positively correlated.

It appears that genetic capacity drives entry to RMS and concentrate consumption in RMS.

The more entry to RMS and more concentrate consumption in RMS increased milk production.

Literature suggests that nutritive value and palatability of concentrate in RMR may attract more visits to increase milk yield.

Further studies should investigate PMR effect on performance in RMS. More studies are also needed for ingredients and nutritive value of concentrate offered in RMS.

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