Dairy Cow Personality Traits: A New Frontier for Precision Feeding Management

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Abstract

Dairy cattle, as well as other agricultural animals, demonstrate distinct behavioral repertoires, or personality traits. These traits, such as boldness, activity, and exploration, influence many aspects of a dairy cow's daily behaviors and how they react to stressors. In addition, the unique combination of several personality traits in each cow, along with her social dominance, comprise the concept of coping style, which may be a more holistic predictor of how cows will react to management strategies or challenges in their environments. There are many precision technologies available to measure dairy cow behavior and production at the level of the individual animal. These technologies may help to provide information about many associations between personality traits and feeding behaviors, as well as how cows with different personality traits respond to different feeding strategies. The role of personality and coping style on dairy cow behavior and production are of interest as they may present opportunities to optimize the use of precision management technologies for dairy cattle, such as those offered by automated milking systems **(AMS)**, as well as to inform feeding strategies. Utilizing dairy cattle personality traits and coping styles to optimize feeding management on an individual cow basis has potential to improve production efficiency, as well as cow level welfare.

Introduction

The study of animal behavior inevitably involves identification of behavioral variation, both within and between individuals in a population. In recent years, the perception of this variation has shifted from being regarded as noise in data, to being a valuable source of information on the distinct behavioral repertoires of individuals (Jensen, 2016). These behavioral repertoires have been studied in the form of temperament, as well as the more complex forms of personality traits and coping styles. In dairy cattle, personality traits impact several aspects of their daily behavior, including their feeding behavior. In addition, the unique combination of multiple personality traits in each cow, as well as her social dominance, determines her coping style and the degree to which a cow will adapt her behavior in response to changes in the feeding environment, feeding management, or dietary ration. A better understanding of how personality traits and coping style influence feeding behaviors, as well as how they affect how cows respond to changes in nutrition and feeding management, can help identify opportunities to use precision feeding to ensure optimum nutrient intake, influence milking behaviors, and meet individual behavioral needs.

This paper firstly discusses the concepts of personality and coping style with respect to dairy cattle, as well as briefly outlines the

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goals of precision feed management and the associated technologies that are available for dairy cattle. Finally, studies demonstrating individual variation in dairy cow feeding behavior, and associations with personality traits and coping style, are reviewed and discussed in light of how these results might inform precision feeding management. We expect that by considering cow personality and coping style in designing precision feed strategies, actual nutrient consumption will more accurately reflect formulated rations, production will be more efficient by reducing nutrient waste, and ultimately, cow level welfare will improve through ensuring that individual behavioral needs are met.

Personality Traits and Coping Style

In animals, personality is defined as a set of correlated individual behavioral traits that are consistent over time and contexts (Koolhaas et al., 1999). These behavioral traits can be flexible, but the degree of plasticity is generally consistent within individuals over time (Neave et al., 2018). Personality traits may be used to explain between-cow differences in dominance rank, coping abilities and behavioral plasticity, as well as physiology (Finkemeier et al., 2018). Five personality traits are commonly ascribed to most animals (Réale et al., 2007), although with slight variations depending on the species. In dairy cattle, these traits include: exploration, activity, aggressiveness, sociability, and boldness, which are often assessed by evaluating an animal's response to novelty (e.g. unfamiliar environment, object, human, conspecific, or food) and/or social isolation (Finkemeier et al., 2018). In addition, it is unclear if dominance should be considered as a distinctive sixth trait, or if it is a result of the interaction of several other traits (Koski, 2014). Some traits are highly correlated, while others are more independent (Uher, 2011). Thus, inter-trait relationships form the foundation of the coping style of the animal.

Coping style represents the qualitative dimension of the stress response (Koolhaas and Van Reenen, 2016), and encompasses intentional cognitive or behavioral attempts to manage a stressor, either through approaching and facing the problem or avoiding it by diverting attention away from it (Affleck and Tennen, 1996). The goal of the coping process is to reduce the effect of aversive stimuli (Korte et al., 2005), and coping style is most commonly described as three discrete categories: proactive, reactive, or intermediate (Wechsler, 1995; Koolhaas et al., 1999; Uher, 2011). Proactive individuals tend to be more aggressive towards conspecifics, exhibit more dominant behavior, are more explorative, bold, and active, as well as demonstrate strong activation of the sympathetic nervous system in challenging situations. On the other hand, reactive individuals tend to be more submissive, less exploratory and active, and have a strong hypothalamic-pituitary-adrenocortical **(HPA)** response towards challenges (Carere et al., 2010; Coppens et al., 2010; Koolhaas et al., 2010). Assessments of coping style often involve physiological, as well as behavioral measures, due to the involvement of the sympathetic nervous system and HPA axis in the animal's response. Behavioral measures are often similar to those used in personality or temperament assessment, and physiological measures may involve cortisol (e.g. Boissy and Le Neindre, 1997), heart rate/ heart rate variability (e.g. Kovacs et al., 2015), or eye temperature (e.g. Lecorps et al., 2018). Individuals with a proactive coping style tend to exhibit less behavioral plasticity when faced with changing or unpredictable conditions, while individuals with a reactive coping style tend to exhibit more behavioral plasticity in these conditions (Koolhaas et al., 1999). Factors that affect coping style include genotype, ontogeny, life experience, age, as well as social support

from conspecifics (Koolhaas and Van Reenen, 2016), and coping style is often correlated with dominance rank, cognitive ability, and physiology (Finkemeier et al., 2018).

In agricultural animals, personality traits and coping style may help explain why some animals thrive and others struggle under different management conditions or when faced with certain challenges. On farms, dairy cows may often face challenges in their social, milking, and feeding environments. In the feeding environment, these challenges often take the form of changes in ration composition or location, and the level of competition for feed access (i.e., due to overcrowding). Precision technologies offer opportunities to better understand how personality traits and coping style influence dairy cow feeding behavior, and thus can be used to better manage cows at the individual level.

Precision Feeding Management and Technologies

Precision feeding management is one aspect of the broader concept of precision livestock farming, which aims to use advanced technologies to automatically collect data at the level of the individual animal in real-time (Schillings et al., 2021). In dairy cattle, numerous technologies are available to measure different variables relating to health, behavior, production, and environmental conditions through activity/motion, cameras (video), pH, temperature, positioning, sound, and pressure sensors (as reviewed by Kooij and Rutter, 2020). In terms of the feeding behavior of dairy cows, feed intake can be measured directly through automatic feed bins (currently only done in research settings), or indirectly through location sensors and accelerometers (Kooij and Rutter, 2020). For example, accelerometers in a cow's ear tag or collar can use head position and movement to measure eating or rumination time, and in turn, these behaviors could be used to estimate the cow's feed intake. In addition, AMS can record the amount of concentrate feed dispensed to each cow during milking, besides their capabilities for recording many variables related to milk behavior and production. Camera technologies to assess the amount and composition of feed at the feedbunk for the group level are also available to supplement individual cow data. Schillings et al. (2021) suggested that a greater variety of precision livestock farming technologies at later stages of development are available to the cattle sector compared to other agricultural species. Precision technologies have mostly been used to monitor variation within cows, using deviations from each individual's average to detect changes in physiological status or detect disease (King et al., 2017). However, understanding the role of personality traits and coping style in feeding behavior and responses to feed management offer opportunities to leverage variation between cows to better implement precision feeding strategies.

Dairy Cow Personality and Concentrate Feed in Automated Milking Systems

Providing a concentrated feed within an AMS unit is a common strategy to encourage voluntary milking events (Melin et al., 2005; Bava et al., 2012; Schwanke et al., 2025). However, in practice, there is wide variability in how much concentrate is provided to cows, as well as in how effective this is in motivating cows (Prescott et al., 1998). At greater AMS concentrate allocations, cows often do not consume the total allocation (Bach et al., 2007; Bach and Cabrera, 2017), have greater daily variability in AMS concentrate intake (Menajovsky et al., 2018; Paddick et al., 2019; Schwanke et al., 2019), and substitution of the partial mixed ration **(PMR)** is observed (Hare et al., 2018; Schwanke et al., 2019).

To investigate the role that dairy cow personality traits might play in AMS concentrate consumption, PMR substitution, and variability in feed intake, we recorded feed intake under two differing amounts of AMS concentrate allocation (6.6 vs 13.2 lb/day) and a common basal PMR (Schwanke et al., 2022). When cows were allocated 13.2 lb/day of AMS concentrate, more fearful cows did not meet this target intake (Figure 1A). However, in that study, more fearful cows were also more consistent in their daily variability in total DMI between the two treatments, whereas less fearful cows had greater variability on the lesser AMS concentrate allocation and less variability on the greater AMS concentrate allocation (Figure 1B). We hypothesized that the more fearful cows were less willing to put their head into the feeder within the AMS, which is a condition on which concentrate would have continued dispensing during milking. In addition, cows who were more alert-curious consumed less PMR on a greater AMS concentrate allocation and more PMR on a lesser AMS concentrate allocation, compared to cows who scored lower on this trait and had similar PMR intakes on both treatments (Figure 1C). This indicates that cows who are more alert-curious may be more responsive to changes in the AMS ration and may be more likely to substitute PMR at greater AMS concentrate allocations. The associations between personality traits and feeding behavior observed in that study have the potential to help identify cows that would respond well to higher AMS concentrate allocations, avoiding cows that do not consume their full ration and end up consuming less nutrients than intended, as well as other cows being oversupplied nutrients through consuming any AMS concentrate left behind by other cows.

To follow up on this, we designed an experiment to investigate how personality traits interact with AMS concentrate provision to influence how well cows transition to an AMS from a conventional milking system. Cows were allocated either 4.4 or 13.2 lb/day of AMS concentrate and their feeding and milking behaviors were recorded (Schwanke et al., 2024a). Within the group that had a greater AMS concentrate allocation, less active cows had a lower risk of kicking off their AMS milking equipment compared to cows who were more active. However, 8 weeks after introduction to the AMS, the less active cows were more likely to kick off milking equipment and there was no interaction with the amount of AMS concentrate allocated. Thus, AMS concentrate could be strategically targeted to certain cows in order to improve milking behaviors and ensure a smoother transition to an AMS.

Considering that AMS concentrate is commonly used to motivate cows to visit an AMS (Shortall et al., 2018), but cows' relative motivation to voluntarily milk with and without a feed reward are highly variable (Prescott et al., 1998), our most recent study aimed to investigate whether personality traits influence cow's motivation to voluntarily milk in an AMS (Schwanke et al., 2025). We tested how cows responded to having the minimum interval between milkings extended from 6 to 9 h (thus reducing the allowed milking frequency), how cows responded to having supplemental AMS concentrate reduced from 11.9 to 0 lb/day, and how they responded to going back to the original milking interval (6 h) and AMS concentrate (11.9 lb/day) after completing both experimental treatments. During both experimental periods, cows who were more active had less frequent voluntary visits to the AMS, and as a result, less frequent milkings (Figure 2A and 2B). This could suggest that more active cows might be more responsive to using precision feed strategies, such as reducing or removing AMS concentrate to facilitate gradual dry-off in an AMS. Overall in that study, personality traits

had a much larger impact during the baseline periods with "standard" AMS settings, and the experimental changes to milking interval and AMS concentrate allocation eliminated many associations between personality traits and feeding behaviors, indicating the need to balance cow behaviors with appropriate management strategies.

Personality Traits and Competition for Feed Access

Dairy cows often experience the challenge of being regrouped and having increased competition for feed (DeVries, 2019), particularly when transitioning from early lactation to later stages of lactation. Cows will often demonstrate greater variability in their feeding behavior and meal patterning to cope with these challenges (Crossley et al., 2017), with some cows reducing their feeding time and compensating by consuming feed more efficiently, while others attempt to maintain the same feeding time as under lower competition condition (Val-Laillet et al., 2008).

To gain a better understanding of how personality traits impact the degree to which cows alter their feeding behavior to cope with feed competition, we exposed cows to two different levels of feed competition: a low competition ratio of 1 cow to 1 feed bin and a high competition ratio of 3 cows to 2 feed bins (Schwanke et al., 2024b). Under low competition, cows who were more active-explorative tended to spend less time feeding (Figure 3A), but tended to have a greater eating rate (Figure 3B). There were no differences in how cows with different scores on the active-explorative trait adjusted their feeding behavior under greater competition; however, those cows who were more active-explorative had more consistent milk yield across the two treatments (Figure 3C), suggesting that they were able to cope better with this challenge in the feeding environment. In addition, cows who were more fearful increased the number of feed bin visits they made under greater competition, whereas cows who were less fearful instead increased their eating rate compared to under low competition (Figure 3D). Together, the results of this study illustrate how cows of different personality traits adopt different feeding strategies under different conditions in the feeding environment, with varying degrees of success. Furthermore, this might help target cows who would benefit from less competitive feeding environments.

Personality Traits and Feed Sorting/ Preferences

In grazing ungulates, subordinate animals often have slower bite rates compared to dominant animals, likely due to maintaining greater vigilance for predators and more dominant herd mates, as well as having to select forage to a greater degree to compensate for lower value grazing areas (Thouless, 1990). Neave et al. (2022) likewise reported that dairy cows who were calmer during restraint and more investigative towards a novel object (perhaps reflecting a proactive coping style) spent more time grazing compared to their more reactive, less investigative counterparts. Conversely, when kept in confined systems, dominant animals often have slower feeding rates, likely because they are able to maintain their position at the feeder (Favati et al., 2014). These slower feeding rates may also reflect greater degrees of feed sorting, allowing more dominant cows to select more desirable components of the ration (often those higher in energy), consequently leaving behind a ration that has already been sorted for subordinate cows to consume. Ultimately, both groups could be consuming drastically different rations than the one that has been formulated for the group. For example, Hosseinkhani et al.

(2008) demonstrated that when there was more feeding competition, although the overall degree of sorting was not affected, cows did sort more in the first 4 h after feed delivery, as well as had faster feeding rates, fewer meals per day, and tended to have larger, longer meals. These behavioral differences indicate a risk of cows consuming a more varied ration as competition for feed increases. In addition, Hosseinkhani et al. (2008) suggested that cows did not decrease their sorting behavior when competition for feed increased because cows that engage in a lot of sorting are highly motivated to do so. A greater understanding of how personality traits and coping styles influence feed sorting could help inform ration formulation to enable cows that are motivated to sort their feed to do so, while still consuming the desired nutritional intakes and ensuring that less competitive cows also meet nutritional goals, perhaps through supplemental feed at alternative locations to the feedbunk.

In addition to some cows appearing to be highly motivated to sort their feed, some cows may prefer to have access to a wider variety of feeds. Meagher et al. (2017) tested the preference of heifers to eat from a bin containing a constant TMR compared to a bin that contained a different forage type each day, as well as their preference for an unflavored TMR compared to a TMR with a different flavoring agent added each day. Although at the group level, the median percentage of feeding time spent in the varied forage bin was 20% and the median percentage of feeding time spent in the varied flavor TMR bin was 6%, the percentage of time spent by individual cows in the varied bins ranged from 0 to 46% for forage and from 0 to 93% (depending on which side the varied bin was placed on) for the flavor trial. Additionally, the proportion of time spent in the varied forage bin was correlated with the proportion of time spent in the varied flavor bin, and heifers who had a lower latency to touch a novel object (perhaps reflecting an explorative or bold personality trait) were more likely to consume higher proportions of varied feed in the flavor trial. Thus, providing cows with opportunities to consume varied types of feed may help fulfill individual behavioral motivations related to feeding behavior.

Future Directions

While there has been an increase in knowledge in recent years regarding how personality traits influence feeding behavior and responses to feed management, there has been less work in dairy cattle explicitly studying the influence of coping styles on these aspects. There is however, some promising work in this area with beef cattle (Wesley et al., 2012; Creamer and Horback, 2024). Since coping style takes into account the combination of multiple personality traits, it likely offers a more holistic predictor of how dairy cow feeding behavior and response to challenges in the feed environment or changes in the feed ration. Future work in dairy cattle should pursue this line of research, as well as studying the effects of specifically designing diets and feed management strategies with personality and coping style in mind on production and behavior.

In addition, there are opportunities to leverage advanced technologies like artificial intelligence and machine learning to automatically assess cow personality and coping style, as well as to dynamically formulate rations based on the day-to-day requirements of individual cows. Furthermore, better integration and cross communication of the various sensor and precision technologies available in the dairy industry would facilitate better individual management of cows and provide clearer management recommendations for producers.

Conclusions

A growing body of literature has collectively provided us with a greater understanding of how dairy cow personality traits influence feeding behavior and responses to feeding strategies. Future research is needed to determine more conclusively how coping style relates to feeding behaviors and response to feeding strategies, as well as the impacts on behavior, production, and welfare as a result of incorporating personality traits and coping styles into precision feeding management.

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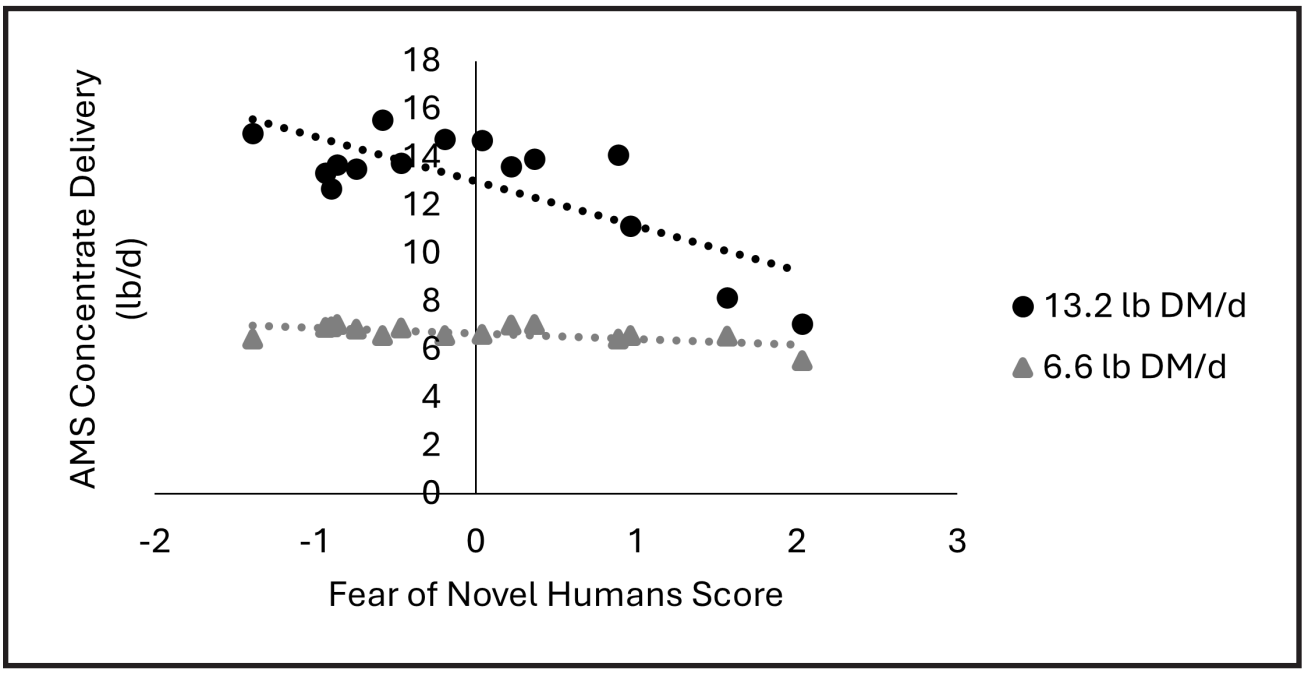

Figure 1A. Association between the personality trait "fearful of novel humans (where a high positive score on the personality trait indicates a more "fearful" cow) and automated milking system (AMS) concentrate delivery. Fifteen cows were provided either 13.2 or 6.6 lb/day of AMS concentrate, with 14 days of data per treatment. Figure is adapted from Schwanke et al. (2022).

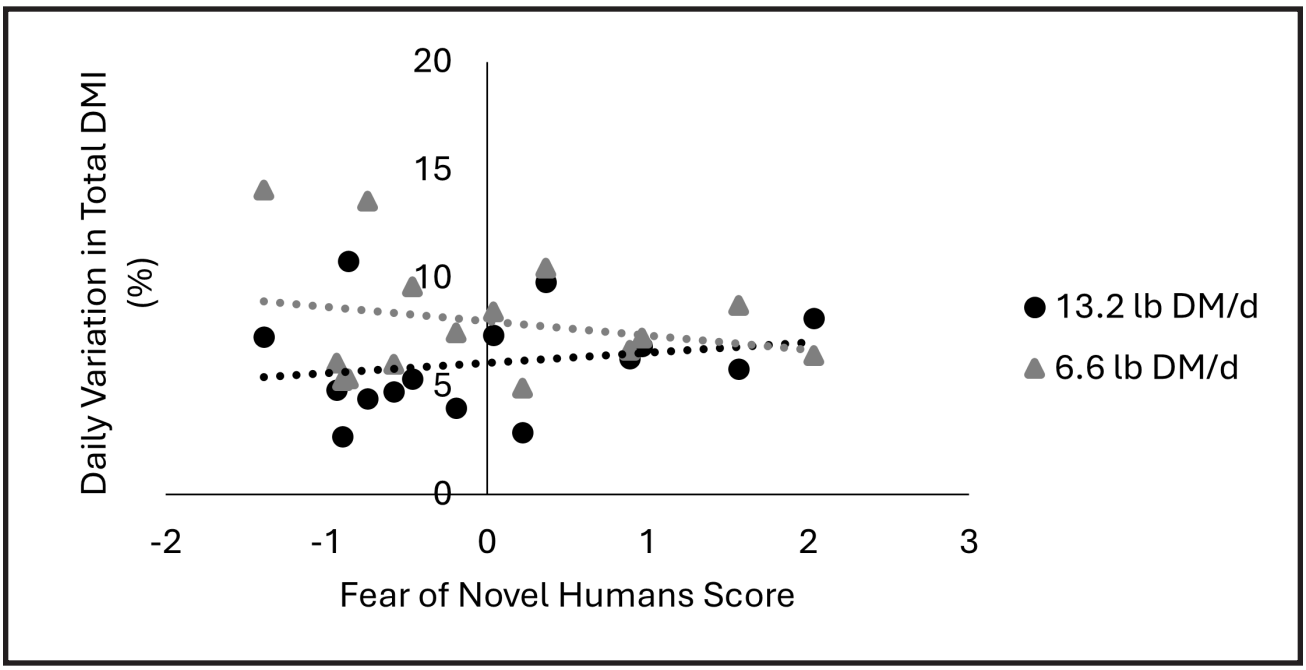

Figure 1B. Association between the personality trait "fearful of novel humans (where a high positive score on the personality trait indicates a more "fearful" cow) and the daily variation in total DMI. Fifteen cows were provided either 13.2 or 6.6 lb/day of AMS concentrate, with 14 days of data per treatment. Figure is adapted from Schwanke et al. (2022).

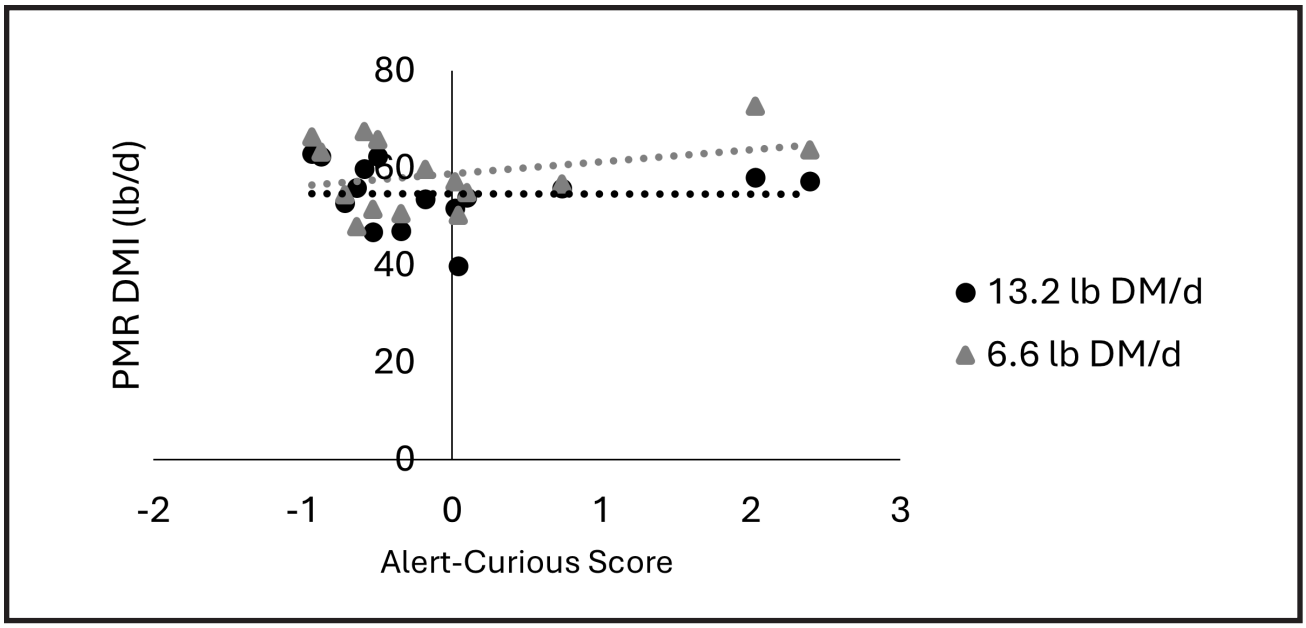

Figure 1C. Association between the personality trait "alert-curious" (where a high positive score on the personality trait indicates a more "alert-curious" cow) and partial mixed ration (PMR) intake. Fifteen cows were provided either 13.2 or 6.6 lb/day of AMS concentrate, with 14 days of data per treatment. Figure is adapted from Schwanke et al. (2022).

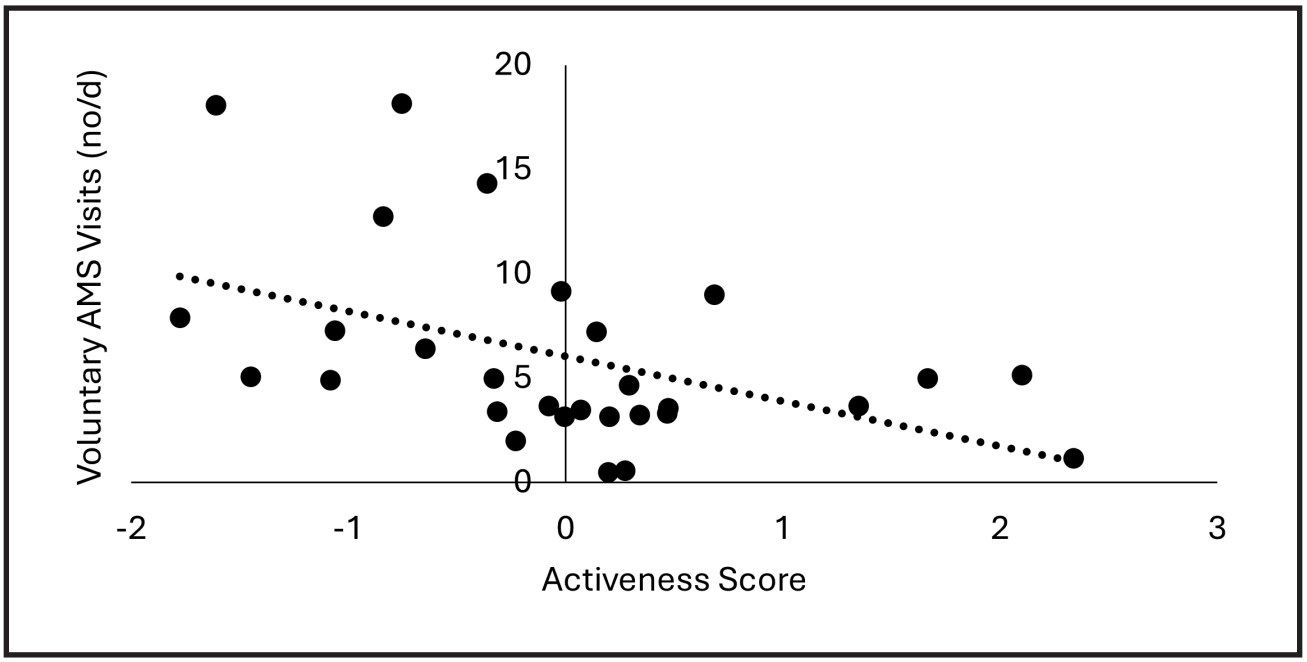

Figure 2A. Associations between the personality trait "activeness" and average voluntary AMS visits across both experimental periods of removing automatic milking system (AMS) concentrate and extending milking intervals from 6 to 9 h. A high positive score on the personality trait indicates a more active cow. Figure is adapted from Schwanke et al. (2025).

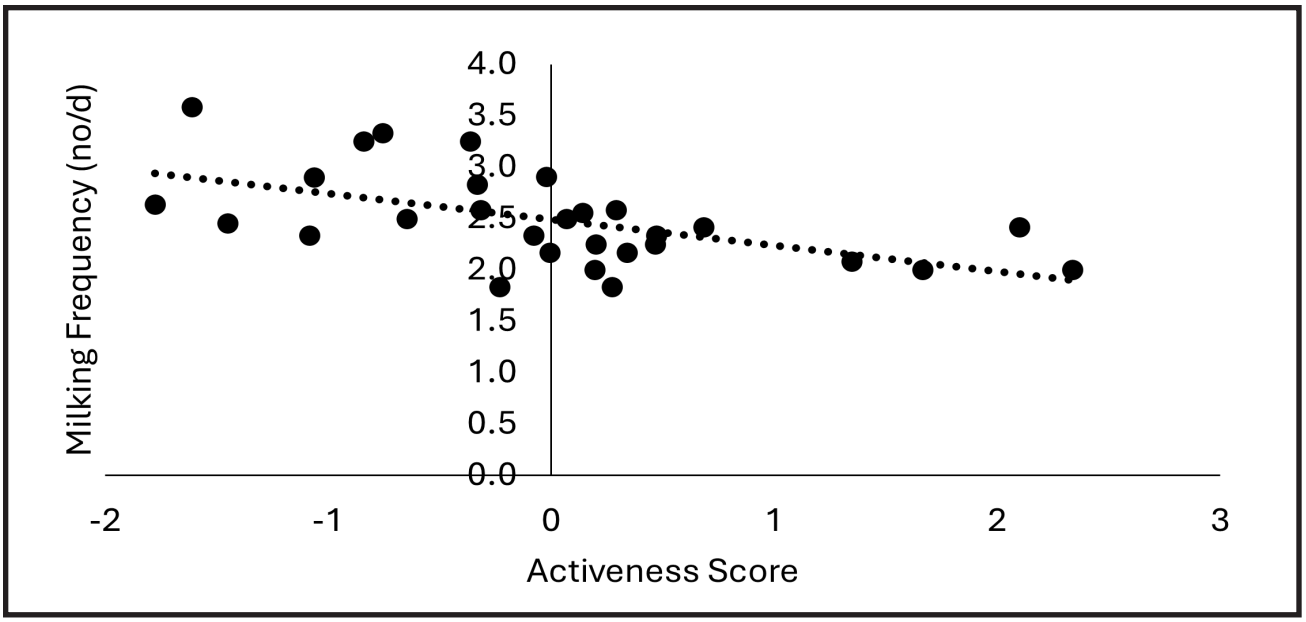

Figure 2B. Associations between the personality trait "activeness" and average milking frequency across both experimental periods of removing automatic milking system (AMS) concentrate and extending milking intervals from 6 to 9 h. A high positive score on the personality trait indicates a more active cow. Figure is adapted from Schwanke et al. (2025).

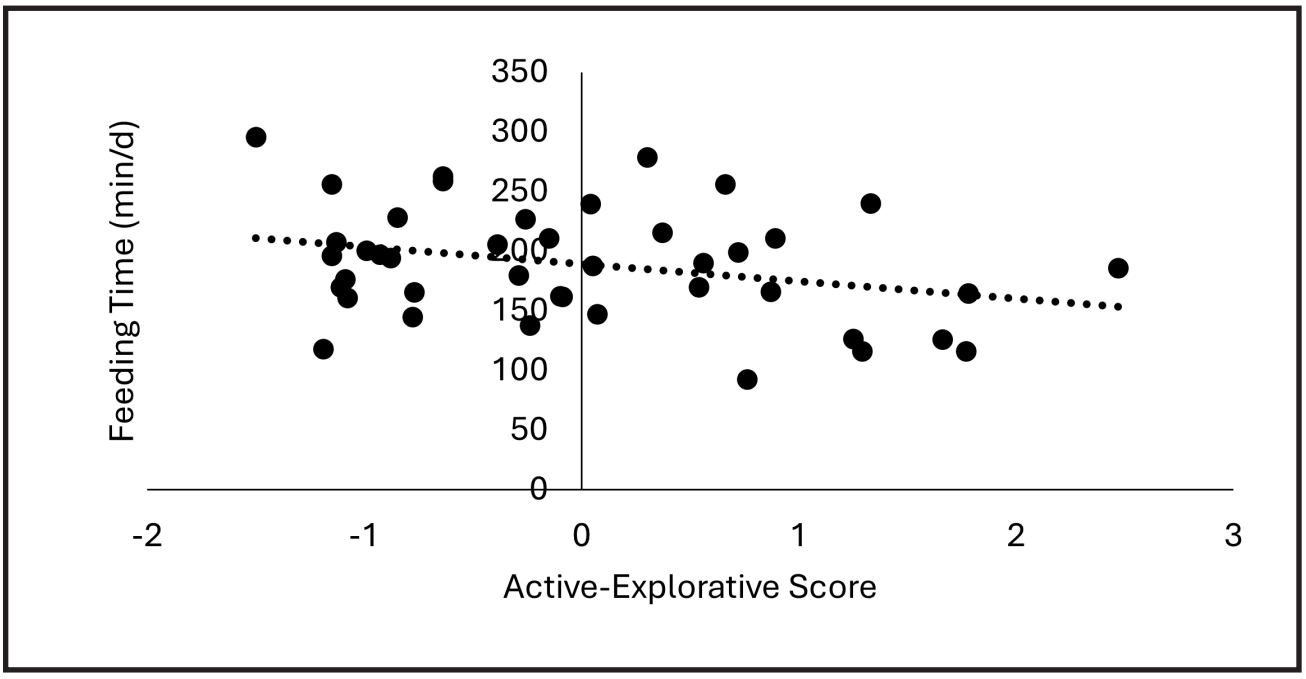

Figure 3A. Associations between the personality trait "active-explorative" and average feeding time under low competition for feed. A high positive score on the personality trait indicates a more active-explorative cow. Figure is adapted from Schwanke et al. (2024b).

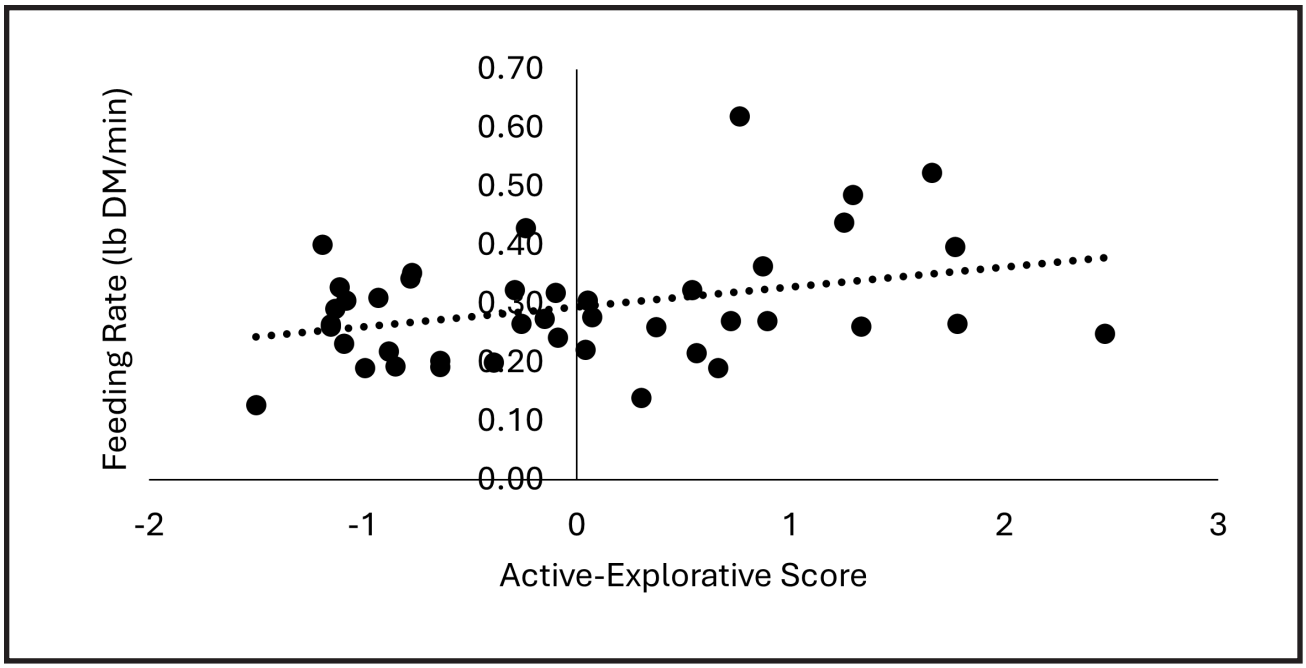

Figure 3B. Associations between the personality trait "active-explorative" and average feeding time under low competition for feed. A high positive score on the personality trait indicates a more active-explorative cow. Figure is adapted from Schwanke et al. (2024b).

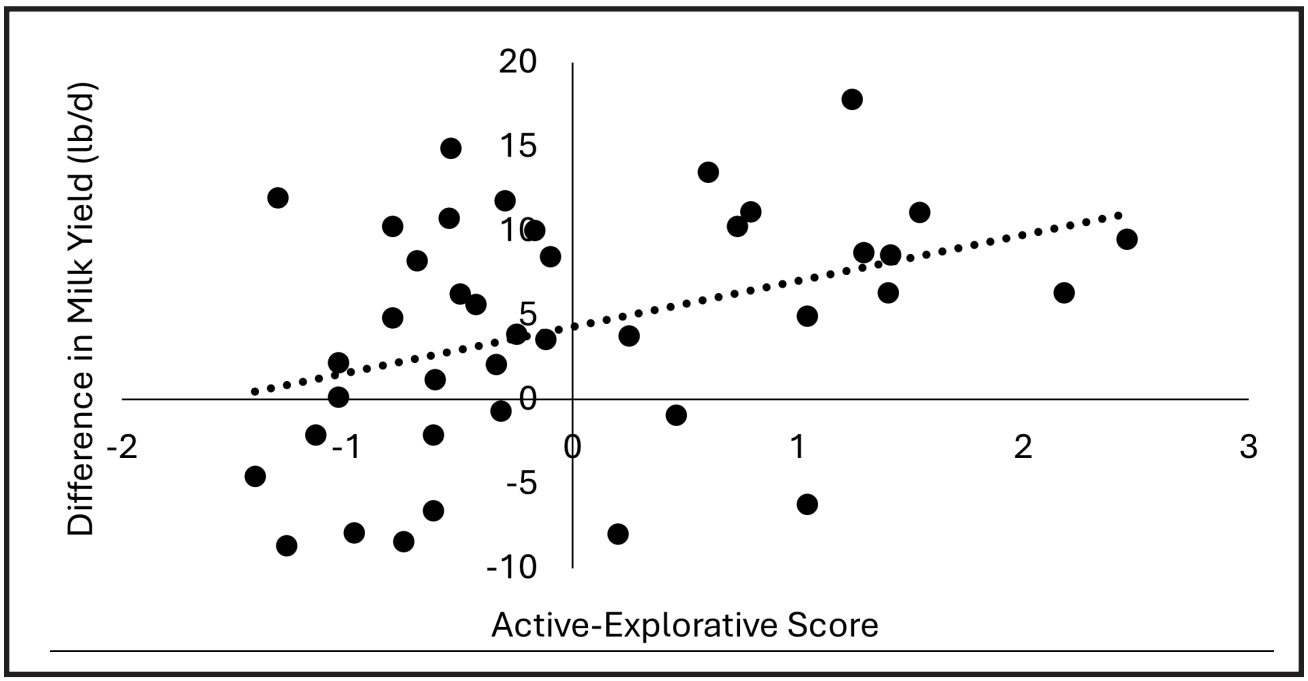

Figure 3C. Associations between the personality trait "active-explorative" the difference in milk yield between when cows were under high competition for feed compared to low competition for feed. A high positive score on the personality trait indicates a more active-explorative cow. Figure is adapted from Schwanke et al. (2024b).

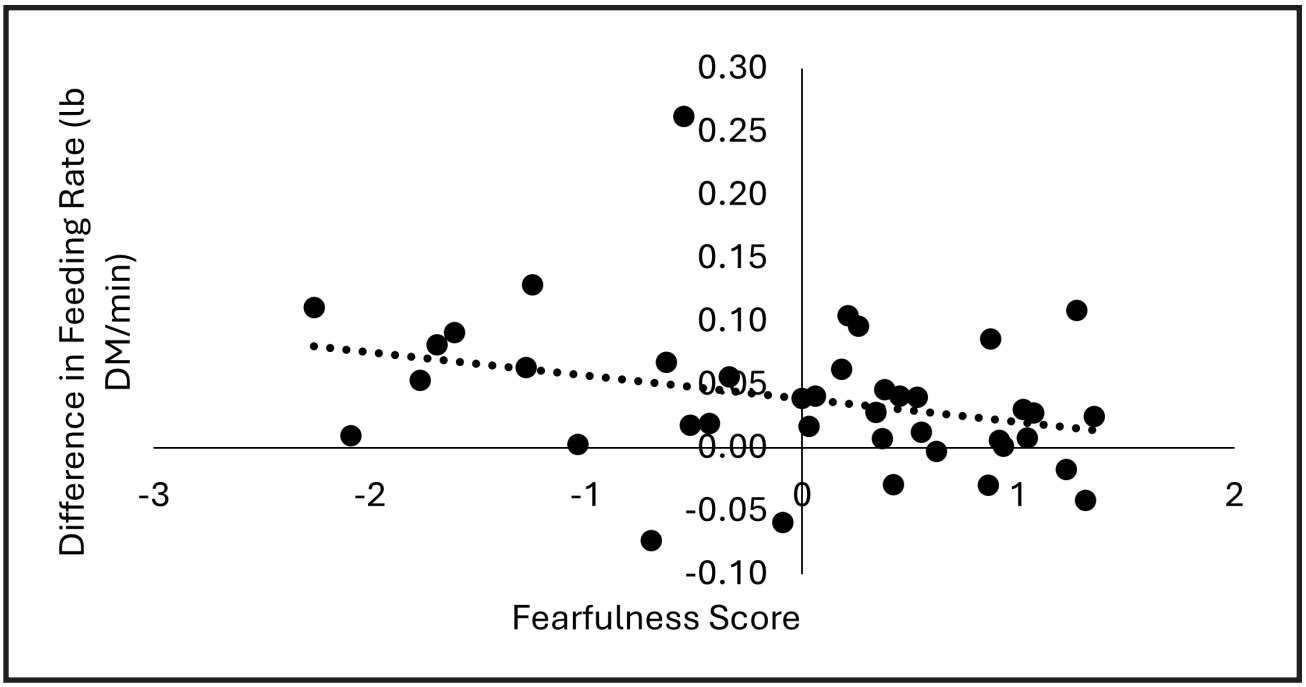

Figure 3D. Associations between the personality trait "active-explorative" the difference in feeding rate between when cows were under high competition for feed compared to low competition for feed. A high positive score on the personality trait indicates a more fearful cow. Figure is adapted from Schwanke et al. (2024b).