

What the Claw Goes Through Every Day

Walking surfaces, the robot area and standing time — where claw health is decided, and why feeding acts as an amplifier, not the sole cause

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When claw lesions increase, the ration is the first thing people talk about — it is the quickest thing to change. The evidence says something else: What loads the claw is the floor it stands on and the number of hours it stands there. Both are the result of barn layout, stocking density and milking routine, and on robot dairies also of walking distance and waiting time. This article sorts the evidence, gives the target values that are backed by data, and names the points where the research has nothing to offer.

Two out of three lame cows go unnoticed

It starts with the number that puts every discussion of walking surfaces into perspective. A 2025 meta-analysis summarized twenty-five years of Northwest European literature: 53 studies, a pooled lameness prevalence of 28 percent with a confidence interval of 23 to 33 percent.¹ The figure applies to the broader definition of lameness — for the narrow definition the authors report no figure at all because of excessive variation. Anyone who quotes the number should give the definition along with it.

The real finding lies elsewhere. In the German PraeRi data set, about 85,000 cows on 765 farms were locomotion-scored, and the farm managers were asked in parallel for their own estimate. The median prevalence recorded by veterinarians was 23.1 percent in the north, 39.1 percent in the east and 23.2 percent in the south. The farmers estimated 9.5, 9.5 and 7.1 percent. From this it follows that only 45.3 percent of lame animals in the north, 24.0 percent in the east and 30.0 percent in the south were perceived as lame at all.²

Two out of three lame cows are not recognized as lame in the barn. Anyone who wants to assess claw health has to score locomotion.

What bears down on the claw

Biomechanics is the part of claw health that can be measured. A research group in Leipzig measured pressure distribution on isolated, functionally trimmed hind limbs: on concrete an average of 44.7 newtons per square centimeter with a maximum of 130.3, spread over a loaded area of about 33 square centimeters — on the rubber floors tested, an average of 24.9 to 29.7, a maximum of 71.9 to 87.2, over 48 to 58 square centimeters.³ What matters is not only how high the pressure is, but where it occurs: Peak pressures were found on the plantar and abaxial part of the outer claw — exactly where the typical sole ulcer (Rusterholz ulcer) develops.

The second mechanism is overlooked more often. A cow does not slip on the straight, but in turns, when starting off and when stopping. A Dutch research group measured ground reaction forces and derived the required coefficient of friction from them: When walking straight and turning, it reached what the floor could just about provide; when stopping abruptly and starting off, it exceeded it. A Canadian series of trials on purpose-built walkways confirms this for starting, right-angle turns and a gutter — and adds a finding that too rarely gets through in advisory work: A thin layer of manure slurry increased the frequency of slips, the number of steps and the time required, and this could be offset neither by greater roughness nor by greater compressibility.⁴ A grooved floor does not rescue a dirty surface.

No floor does everything

That concrete is harder on the claw than a soft surface is well documented, and most clearly in first-calf heifers. In a Swedish trial, heifers that stood on concrete slats after calving instead of rubber-covered slats had 3.6 times the risk of lameness and 2.2 times the risk of sole hemorrhages and ulcers. During the rearing phase of the same animals, horn wear on the concrete alley was 6.08 millimeters per month compared with 2.09 on deep bedding.⁵

Anyone who concludes from this that rubber solves the problem has read only half the literature. A German doctoral thesis quantified growth and wear in 69 cows over twelve months: net horn growth of 3.4 millimeters per month on rubber compared with 1.2 on concrete, because wear fell from 3.5 to 0.3 millimeters. The change of flooring did not reduce the prevalence or severity of claw disease. The opposite error is a marginal topic in Germany and a main finding in American data: On a large dairy in the southeastern United States, toe ulcers resulting from thin soles accounted for 20 percent of recorded lesions, and thin soles as a finding in their own right for another 13 percent — more than white line disease.⁶

For infectious diseases, the ranking is reversed. A Norwegian case-control study found 2.36 times the odds of digital dermatitis (Mortellaro) for solid concrete alleys compared with slatted floors. A second Norwegian study sums up the trade-off: Solid floors are more favorable for most laminitis-associated lesions, slatted floors for the infectious diseases — but not for gait.⁷

Relieve the sole and you lose wear; get rid of the manure and you lose walking comfort. The question is which problem the herd has right now.

Standing time is the currency

A cow's time budget is a zero-sum game: What milking takes is missing from lying time. A video analysis of 205 cows in sixteen freestall barns shows the range in practice. Time out of the pen for milking ranged from half an hour to six hours per day, averaging 2.7 hours, and it had a negative effect on feeding and lying time.⁸ That forced standing has an immediate effect on behavior is experimentally established; the path from standing to a full-blown sole ulcer, by contrast, is supported epidemiologically but has still not been cleanly reproduced in a trial.

The most important finding for the German-speaking region does not concern the alley. In a cross-sectional study of 103 farms in Germany and Austria with Holstein and Fleckvieh (German Simmental) cows, mean lameness prevalence was 34 percent, ranging from zero to 81 percent. The final risk model included three stall-related risk factors — mats instead of deep bedding, obstructed lunge space, a neck rail diagonal that was too short — along with lying behavior and body condition. Walking-surface variables do not appear there.⁹ That is a counterweight to an argument that is too floor-centered: In this data set, the stall mattered more than the alley.

In the robot area, both come together

A robot dairy has no milking time and no holding pen — and yet the cows spend considerable time standing at the tightest spot in the barn. A video analysis of a pen with 59 cows found: The animals visited the robot on average six times a day and waited fifteen minutes per visit, a total of 88 minutes per cow per day with a range of 5 to 322 minutes. First-lactation cows waited longer, and cows with long waiting times lay down for less time — 9.5 versus 11.1 hours.¹⁰ The study covers one farm and two observation days; it serves as an illustration, not as a benchmark.

The feedback loop is the real point. A cross-sectional study of 41 robot dairies found that lame cows gave 1.6 kilograms less milk with 0.3 fewer milkings and were 2.2 times more likely to have to be fetched more than once within six days.¹¹ The lame cow goes to the robot on her own less often, is therefore fetched, stands even more as a result — and does not get any healthier for it.

The robot makes milking time invisible, not standing time. It just spreads it over the whole day.

Where feeding plays a role — and where it does not

The clearest available test of the relative weight comes from a Swedish trial that tested flooring type and concentrate level against each other in heifers in a factorial design: The animals on concrete with high concentrate feeding had the highest sole hemorrhage scores, and flooring type had a greater influence than concentrate level. The authors named the abrupt change from pasture to housing and the periparturient period as the most important factors.¹² The animals were kept in tie stalls — so the results transfer to today's freestall conditions only to a limited extent.

A second pathway runs through the manure. In a British study, heifers on a wet fermented ration developed more claw horn lesions and softer horn than those on a dry ration. The authors' explanation was not the rumen, but long periods of standing in thin slurry. The ration changes manure consistency, the manure changes the walking surface, the walking surface changes the horn. This fits the sober state of the meta-analyses: Of all feeding-related factors, only body condition has so far made it into a robust pooled analysis.¹³ No ration parameter is among them.

Dimensions and target values — and which of them are backed by data

For alley dimensions the evidence looks different from flooring and stalls: many recommendations, few studies. The following values come from the regulations of the German-speaking countries and from the international advisory literature — useful, but almost none of them derived from a threshold analysis with lameness as the endpoint.¹⁴

PLANNING DIMENSIONS AT A GLANCE

Walking surfaces and manure removal

- Alley in new construction, dehorned animals: at least 2.50 m (8.2 ft), recommended 3.00 m (9.8 ft)
- Feed alley in new construction: at least 3.50 m (11.5 ft), recommended 4.00 m (13.1 ft)
- Crossovers after 15 to 20 head-to-head stalls, avoid dead ends
- Slot width at most 3.5 cm (1.4 in), slat width 8 to 13 cm (3.1 to 5.1 in)
- Scrape solid floors at least twice a day

Robot area

- Waiting area 15 to 20 m² (160 to 215 sq ft) per milking box, no side less than 3 m (9.8 ft)
- Passages in the AMS barn 2.5 to 3.5 m (8.2 to 11.5 ft), i.e., two to three stall widths
- Feed alley under 430 cm (14.1 ft): independent risk factor, odds ratio 1.9
- Clear space in front of the robot 6.1 m (20 ft) for one box, 7.0 to 7.6 m (23 to 25 ft) for two side by side
- Cows per robot 55 to 60 — other advisory sources cite 60 to 80
- Fetching on average 10 percent of lactating cows per day or less

Stall

- Stall width 0.83 × withers height, lying length 1.1 × diagonal body length
- Bedding at least 30 cm (12 in) of deep bedding on concrete, at least 5 cm (2 in) compressed on mats
- Barn area at least 9 m² (about 97 sq ft) per cow including lying area

Of these values, only the feed alley width is derived from an analysis with lameness as the endpoint. The figures on robot capacity differ considerably between advisory sources — anyone planning is choosing between two schools of thought, not between right and wrong.

Three gaps have to be named. For turning radii, bottlenecks and passages as quantified risk factors, there is no study with an effect estimate — the argument rests indirectly on the friction measurements. On the slat scraper as a disruption to cow traffic, there is no robust primary study. And a direct link between scraping frequency and claw health is not documented; only the two parts of the chain are.

Early detection is the biggest lever

Two randomized trials by the same British research group test the same treatments and reach opposite results; the only difference is timing. In 167 newly lame cows, 24.4 percent recovered after 35 days with therapeutic trimming alone and 56.1 percent with a block and an anti-inflammatory together. In cows that had already been lame for more than two weeks, the shares after 42 days were 15.4, 14.8 and 16.0 percent — no treatment effect anymore.¹⁵

That makes locomotion scoring the real intervention. The international guideline recommends a five-point scale, scoring ideally every two weeks, and a target of about 90 percent of cows at score 1. The cost side shows what is at stake: A bioeconomic model puts the cost at €307.50 per lame cow per year.¹⁶ The larger part of it never shows up as an invoice, but as milk not produced, a longer calving interval and early culling — which is why claw health so rarely stands out in the farm accounts.

A case from consulting practice

The following case comes from a recent herd analysis and shows a herd in which the floor is the cause and the ration plays a supporting role. Farm and animals are anonymized; the figures are unchanged.

ROBOT HERD, ABOUT 120 MILKING COWS, 33 KILOGRAMS (ABOUT 73 LB) OF MILK PER COW PER DAY

Lesion pattern

Over four years of the farm's own hoof trimming records, 64 percent of the documented cows had a finding at least once, and 34 percent had a block glued on at least once. Most frequent individual findings: horn quality, fissures and laminitis in 27 percent, white line disease in 22 percent, sole ulcer in 15 percent.

The warning signal

At one trimming session in August, all four claws of every animal were scored for the first time: 22 out of 22 cows with a finding, including 20 white line lesions, 18 of them on a hind claw. Lactations 1 to 7 and days in milk between 40 and 420 were affected — no fresh cow cluster, no age pattern.

The robot metrics

2.6 to 2.8 milkings plus 2.5 to 3.3 refusals per cow per day over a full year — five to six trips to the robot every day, almost half of them without a milking, each involving walking there, waiting, turning and walking back on the most heavily used stretch of concrete in the barn.

The feeding side

Across 366 daily records, the monthly fat-to-protein ratio ranged from 1.07 to 1.13 and fat content from 3.81 to 4.09 percent. No month pointed to chronic ruminal acidosis at herd level — that clears the basic design of the ration, but says nothing about individual groups.

The documentation trap

Fully documented trimming sessions found a lesion in 60 percent of cows, incompletely documented ones in 14 percent. The difference lay in the check box, not in the claw.

The order of investigation

First, walking surfaces and the robot area — grip, condition of the concrete, edges, bottlenecks, turning areas. Second, standing times and waiting time at the robot. Third, trimming interval and sole thickness. Fourth, the concentrate curve at the robot, not because of the amount of starch but because of visit frequency. And only after that the ration itself.

Two things can be generalized. A lesion pattern without a stage-of-lactation pattern argues against a transition cause and for a load-related cause. And the first complete documentation of all four claws creates an apparent deterioration that is in fact a jump in documentation.

Twenty white line lesions in a single day across all lactations are a statement about the barn, not about the feed bunk.

Ten tools for everyday barn routine

The first five tools cost nothing but time and attention. The last five cost money or a remodel.

TOOL 1 — THE COW'S-EYE WALK-THROUGH

Objective: see where the claw is working

Walk through the barn once through the eyes of a cow. Where does she take short, cautious steps? Where does she slip? Where does she turn on the spot? Where is there crowding? The critical points are well known: robot exit, waiting area, passages, water trough area, tight turns. The friction measurements say the same thing — on the straight the grip is sufficient, in turns and when starting off it is not.

TOOL 2 — SCORE INSTEAD OF ESTIMATING

Objective: see the problem in the first place

Five-point locomotion score, every two to four weeks, at the same spot, by the same person. Target about 90 percent at score 1. Anyone who keeps this up for three months knows more about their barn than any consultant's report can tell them — and spots the animals in which treatment still works.

TOOL 3 — DOCUMENT ALL FOUR CLAWS

Objective: make trimming sessions comparable

Score all four claws for every cow, even if three of them say no finding. Only then can sessions be compared, and only then can you check whether a measure has worked. If operating the app in the trimming chute fails because of the gloves, decoupling helps: one spoken sentence per cow into a voice recorder, transferred afterward at the desk.

TOOL 4 — THE STANDING-TIME CLOCK

Objective: put a number on the time budget

On a normal day, write it down: When are cows locked up, and for how long? How long do breeding, hoof trimming and the vet check take? How long does the group stand outside while stalls are bedded? Add it all up. More than three hours outside the normal routine means lying or feeding time is missing. On a robot dairy, this includes waiting time at the robot. Anyone without sensor data can stand at the robot for an hour one afternoon and count how many animals are waiting and for how long.

TOOL 5 — FOUR ROBOT METRICS

Objective: make the walking load visible

Milkings per cow per day, refusals per cow per day, cows per robot, share of fetched cows. If refusals approach the number of milkings, every cow is walking to the robot five or six times a day. For fetching, the guideline is: on average ten percent of lactating cows or less.

And keep the feedback loop in mind: The cow that has to be fetched most often is disproportionately often the lame one.

TOOL 6 — MAKE SOLE THICKNESS A RULE

Objective: eliminate the invisible error

Agree with the hoof trimmer that dorsal wall length is measured, not estimated, and that a minimum sole thickness is maintained. Claws trimmed too thin are a finding that only shows up as lameness weeks later — and then gets blamed on the floor.

TOOL 7 — THE SCRAPING SCHEDULE

Objective: get rid of the slippery film

Scraping at least twice a day is the minimum standard of the Tierschutzleitlinie (animal welfare guideline); in practice, scraping considerably more often works. The point is not cleanliness as such, but grip: A thin layer of slurry costs secure footing, and this can be offset neither by grooves nor by rubber.

TOOL 8 — RUBBER WHERE IT COUNTS, NOT WALL TO WALL

Objective: provide relief where it matters

Priority goes to the areas with turning, waiting and crowding: robot or parlor exit, waiting area, passages, feed alley. Wall-to-wall rubber reduces wear so much that the trimming interval has to be adjusted — otherwise you trade one problem for another.

With infectious diseases, check the direction: Solid floors are the less favorable surface for digital dermatitis. Anyone who lays rubber there has to factor in manure removal.

TOOL 9 — THE STALL BEFORE THE ALLEY

Objective: tackle the documented main cause first

In the risk data from the German-speaking region, lying comfort mattered more than the walking surface. Check first: neck rail position, lunge space, brisket locator height, amount of bedding, stall width relative to the largest quarter of the cows in the herd — and stocking density. Stocking above one hundred percent of stalls costs lying time.

With heifers, neck rail position determines whether they learn to use the stall at all. Anyone integrating first-calf heifers should design this area most generously.

TOOL 10 — PLAN THE TRANSITION PHASE

Objective: no wave of lameness eight weeks after the remodel

Freshly poured or grooved concrete, a change from pasture to housing, a new grouping: These are phases of increased load. During these weeks, score more often, avoid extra cow moving, and move hoof trimming forward rather than postponing it.

The reason is physiological: Horn growth adapts to a changed rate of wear only with a delay. The weeks in between are the ones in which the sole gets too thin.

Conclusion: the claw bears the consequences with a delay

The evidence adds up to a picture that is less convenient for practice than the feeding hypothesis, because it points to things that cannot be changed in a week. Concrete produces almost twice the sole pressure on a considerably smaller area, and it does so exactly where the sole ulcer develops. The friction reserve is enough for walking straight, not for turns and stop-and-go. A thin layer of slurry costs grip that no groove pattern can restore. And on a robot dairy, milking time disappears from the daily routine and reappears as waiting time. Feeding is not a sideshow in all this, but it plays a different role than assumed: Where flooring and concentrate were tested directly against each other, flooring weighed more.

For the herd analysis, this establishes an order. First sort out the lesion pattern: If white line lesions and sole ulcers dominate, the issue is load and horn quality; if digital dermatitis and foot rot dominate, it is moisture and hygiene — two problem areas with partly opposite solutions. Then determine the window in which the lesions developed, eight to twelve weeks back. Then stalls, walking surfaces and standing times. And only after that the ration.

The claw bears the consequences of barn management. It just bears them with a delay — and that is why the connection is so often overlooked.

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All farm, personal and animal names in this article are anonymized.

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