

Can Artificial Intelligence Be Used for Breeding?

AI in Cattle Breeding: Possibilities, Practical Examples, and How to Get Started

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In the past, breeding was guided by experience, observation, and intuition. Then performance testing, breeding values, and genomics were introduced. Today, a new tool is available: artificial intelligence. A field report from the barn and the data lab shows what AI can—and cannot—achieve in practice.

From the Barn to the Data Lab—and Back

Anyone who grew up in cattle breeding knows the craft inside and out: the smell of fresh hay, the silence of a barn before morning milking, the hours spent weighing which bull is a good match for which cow. For a long time, this knowledge was inextricably linked to personal experience—intuitive, tried and tested, passed down from generation to generation.

Today, a new tool has joined the mix: artificial intelligence.

The author of this article grew up on a Bavarian dairy farm with about 50 Holstein breeding cows. Breeding was part of everyday life: getting up at four o'clock, milking, feeding, assisting with births, and planning matings. At age 15, following his father's serious accident, he took on breeding responsibilities early on. By the time he graduated from high school, the family had to give up the herd. Nevertheless, his passion remained. He studied theology and education in Passau, Freiburg, Israel, and the U.S. He traveled to South Africa, India, and all over the world—but never lost touch with Holstein breeding. V

In February 2025, he returned to active Holstein breeding—by purchasing two breeding calves at the MASTERRIND Exclusive Auction in Verden, together with breeders Volker and Timo Carstens from Visselhövede.

"Now you've really caught the cow fever," Volker Carstens said with a laugh at the time. And he was right.

The specific impetus to explore AI came a little earlier: A customer reported that he was saving about 40 percent of his working time by using ChatGPT. That statement was the wake-up call. This time, the author didn't want to—as he once did with PCs or smartphones—only jump on board once a technology was already well established. He wanted to understand early on what was truly possible.

This dual perspective—breeding practices on the one hand, digital transformation on the other—forms the basis of this article.

What AI Can Do Today—and What It Can't

So far, many people have used AI primarily for writing emails or texts. That's helpful—but in breeding, it's only a very small fraction of what's possible. In agricultural practice, AI is most effective where large amounts of structured data are available and where humans reach their limits in the face of such data volumes. Genomic data, performance data, pedigree information, breeding values—these are classic areas where AI can process correlations that are virtually impossible to handle manually.

What AI cannot do, however, is provide the direct experience in the barn. It doesn't see an animal. It doesn't sense its temperament. It doesn't know the specific history of a farm, a family's personal breeding goals, or the intuition for what will be in demand on the market next year. AI is a powerful analytical tool—not a substitute for the experienced breeder.

AI does not replace a breeder—but it makes them significantly stronger.

Three Examples of Applications with Real Added Value

Three real-world examples where AI systems can concretely support breeders and lighten their workload:

1. Breeding Planning and Mating

Bull selection is one of the most frequent and far-reaching decisions in day-to-day breeding. Genomic data, expanding bull programs, and differentiated breeding goals are making this choice increasingly complex. Anyone looking to mate several dozen cows today is faced with a selection of hundreds of tested or genomically evaluated bulls—each with specific strengths in conformation, udder, legs and hooves, health traits, and production performance.

AI systems can provide a structured approach here: A cow's genomic profile is analyzed, and the identified weaknesses are compared with the range of available bulls—such as those from the farm's own semen bank or the current offerings of an artificial insemination organization. The result is a well-reasoned, prioritized selection of two to three suitable bulls, accompanied by a brief explanation of why this combination appears to be a sound choice.

Important: This is not about replacing the breeder's judgment, but rather providing a structured second opinion. Especially with larger herds or complex embryo transfer (ET) programs, this approach can help reach decisions more quickly and systematically without overlooking key aspects. Inbreeding and outcrossing management can also be better controlled in this way.

For embryo transfer programs, the application goes even further: AI develops a comprehensive rotation strategy for the OPU and ET use of a top sire—initially several flushes with very high total breeding values, followed by targeted balancing bulls, and then phases for specific traits such as polled, red factor, or slick. Particularly revealing: A bull that the breeder personally liked was clearly excluded—with a sound breeding rationale that was entirely transparent.

2. Herd Analysis and Breeding Strategy

While individual mating presents a classic operational problem, the focus at the herd level is on something else: strategic development across multiple generations.

AI can help systematically evaluate genomic data for the entire herd and create a detailed profile of strengths and weaknesses. This often reveals that certain traits occur more frequently—not by chance, but as a result of earlier breeding decisions. Conformation, udder health, or fertility may have been specifically improved or stabilized over several generations—but in some cases, they may also have drifted unintentionally in an unfavorable direction.

In practice: At the Carstens farm, all genomic herd data were analyzed. The AI generated a clear strengths-and-weaknesses analysis and identified areas for improvement. Based on this, a precise breeding strategy was defined—including first-, second-, and third-ranked bull recommendations for each animal, tailored for practical use in daily barn operations.

Such an analysis can answer key strategic questions: Where do the herd's genetic strengths lie? Which weaknesses occur most frequently? How is the herd's inbreeding coefficient developing? Which traits should be specifically improved in the coming years? AI systems can simulate various breeding strategies and illustrate their projected effects on herd development.

For farms that have not previously been able to access regular breeding counseling, this opens up analytical potential that was previously virtually inaccessible.

3. Conformation Assessment via Image Analysis

One area with particularly high potential for development is AI-supported analysis of animal photos. Modern image recognition systems can derive information about body structure, leg conformation, pelvic angle, and udder conformation from high-quality images—taken in a standardized manner from defined perspectives.

Initial tests show surprisingly precise results: In linear evaluations based on photos, the deviation from the actual classification was usually no more than one point—depending on image quality and perspective. This means, for example, that the Triple-A system—an established method for the morphological assessment of breeding animals—can be usefully supplemented by an AI-supported preliminary evaluation, especially when combined with genomic profiles.

AI does not replace an experienced judge or breeding consultant. The human eye—which observes an animal in motion, assesses its stance, and senses its body tension—remains irreplaceable. However, AI can help objectify assessments, put subjective daily variations into perspective, and provide additional insights. This is particularly helpful for farms without regular access to a breeding consultant.

Tools and Data Infrastructure

Technically, a range of mature systems is now available to breeders interested in AI-supported work. In practical applications, large language models are predominantly used: ChatGPT (OpenAI), Gemini (Google), Claude (Anthropic), and Perplexity are among the most widely used platforms. In addition, NotebookLM (Google) offers interesting

Options for the structured analysis of larger documents—such as breeding reports or herd statistics.

The analyses incorporate the following data sources, among others:

- Genomic breeding values for individual animals
- Pedigree information and ancestry data
- Professional articles, interviews, and publicly available technical information
- Our own practical knowledge from breeding and consulting

AI does not operate freely in this process, but rather in a controlled, structured, and professionally embedded manner. What matters is not the individual tool, but that the system is used reliably, transparently, and in conjunction with professional expertise. Added value arises where data, experience, and practical logic converge.

The quality of the results depends heavily on the quality of the questions. Those who feed AI only with generic queries will receive generic answers. Those who, on the other hand, ask precise, context-rich questions and provide relevant data will experience a significantly higher quality of support. In technical terms, this is referred to as prompt engineering—the art of interacting with AI systems in a way that allows them to truly realize their potential.

Practical Guide: Bull Selection in Five Minutes

The following procedure shows how AI-assisted bull selection can be integrated into everyday barn operations. Two documents are required: the cow's genomic data from the VIT/Netrind system (as a PDF) and the profiles of the current bulls from the semen tank (also as PDFs).

Step 1: Open the chat and enter the prompt

Paste the following start prompt directly into ChatGPT or a similar system:

"You are a professional sire analyst for Holstein cattle and provide mating advice based on the uploaded PDF data. Please analyze the cow included in the first PDF using the genomic data and compare her with the bulls from the other PDFs (bulls currently in the semen tank). Always use our defined breeding goal: Economically productive Holstein cows with high lifetime production and functional conformation, expected to produce at least 12,000 kg of milk annually with $\geq 4.0\%$ fat and $\geq 3.4\%$ protein. Healthy udders, sound legs and hooves, and good fertility ensure a long productive life. Inbreeding should be avoided. Use only the bulls included in the uploaded PDF files. Do not use any other data, lists, or online sources. If a bull is not listed in the bull PDF, it must not be suggested. Please suggest 3 suitable bulls from the semen bank for mating with the cow—including a ranking, a brief justification, and an indication of which of the cow's weaknesses the bulls will correct through mating. Then create a brief matrix (traffic-light system) showing which of the cow's weaknesses each bull corrects and which traits remain neutral or carry a risk."

Step 2: Take photos of data sheets and/or upload PDFs

Upload the cow PDF and bull PDF(s) to the chat.

Step 3: Review the results and make a decision

The system provides a prioritized list of recommended bulls with justifications, as well as a traffic-light matrix showing which of the cow's weaknesses are corrected by which bull.

Normally: choose the top-ranked bull. If that one isn't available, choose the next best one.

Tip: Instead of using PDFs, you can simply take a photo of the prompt and the genomic data sheets from a printout and/or your computer and upload them.

Or use the free GPT app “Holstein Cattle Mating Planner” developed by the author:

<https://chatgpt.com/g/g-697c4e8f1c4481919a78831591517007-anpaarungsplaner-rinder-holstein>



Opportunities and Clear Limitations

Special Opportunities for Farms

Analytical capabilities that were once reserved for specialized consulting services are now more easily accessible to individual farms. This does not mean that professional breeding consulting is becoming obsolete—quite the contrary. But it does mean that breeders can be better prepared for discussions with consultants, present data in a more structured way, and critically evaluate recommendations.

Keeping a Clear Eye on the Limits

The danger lies in blindly relying on algorithms. Without expert knowledge, critical evaluation, and accountability, AI can exacerbate undesirable trends. AI remains a tool—what matters most is the attitude, competence, and integrity of the people who use it.

Getting Started Without Fear of Technology

No one needs to be a tech expert to use AI effectively. The advice is intentionally kept simple:

- Create an account with a trustworthy AI system—for example, ChatGPT or Gemini.
- Start small—with specific questions from your own day-to-day life on the farm and in your business.

- Talk to the AI as you would talk to a person.
- Gradually get the hang of prompting—and don't hesitate to ask for help along the way.
- Don't blindly accept answers; instead, compare them, refine them, and ask follow-up questions.
- Take advantage of discussions with colleagues and training opportunities.
- Stay confident: You can't break anything with AI—but you can think much more clearly.

The best way to get started is with specific questions from your own everyday life. For example, if you export your cooking data into a spreadsheet and provide it to an AI system with a clear question, you'll quickly realize what analytical possibilities arise. AI works best where experience, intuition, and data come together.

Practical tip: The 4-step prompt formula for a high-quality prompt:

1. Who am I? – the *person*
In what role or capacity am I addressing the AI?
e.g., employee, manager, project lead Important: from which perspective am I working?
2. What exactly is this about? – the *context*
What situation am I in? Organization, company, project, target audience
Framework conditions, specific details, goal, or problem
3. What specifically should happen? – The *Task*
What exactly should the AI do?
analyze, organize, explain, compare, formulate in the desired format (list, table, text, guide)
4. How should the AI think? — its *role* *In what role should the AI respond?*
e.g., neutral analyst, experienced advisor, sparring partner—technical, pragmatic, critical, understandable

Example of a 4-step prompt:

"I am a dairy farmer and make management decisions for my farm (*human*).
My farm has about 150 cows and uses milking robots (*context*). Suggest 5 specific measures to improve fertility management and briefly explain the rationale for each (*task*).
Respond as an experienced, hands-on consultant for fertility and herd management—providing expert, well-founded, and easy-to-understand advice (*Role*)."

Conclusion: The Interplay of People, Experience, and AI

Cattle breeding has always been a combination of expertise, experience, and passion. These three elements form the foundation—and that will never change.

Artificial intelligence expands this foundation with a new tool: one that makes complex data sets manageable, structures decision-making processes, opens up new

perspectives, and provides analytical capabilities that were previously virtually inaccessible. Those who view AI as a sparring partner rather than an autopilot will benefit from it.

The key difference lies in the approach: AI-supported breeding decisions are not automated decisions. They are more informed decisions—made by people who have access to more information in a more structured way than ever before. The responsibility for breeding decisions remains with humans.

The future of cattle breeding does not lie in technology alone. It lies in the interplay of a breeder's intuition, decades of experience, and the ability to use new tools wisely. Those who master this interplay will have a real competitive advantage—not because they have more data, but because they derive better decisions from that data.

| *Together we are stronger: People + Experience + AI.*

About the Author

Helmut Demmelhuber is a management consultant based in Tübingen, Baden-Württemberg, and an expert in the application of artificial intelligence in cattle breeding. He grew up on a Bavarian dairy farm and has been actively involved in Holstein breeding again since 2025. He advises breeders and breeding organizations on the practical integration of AI into cattle breeding.

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