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Human Risk Meets Technology: Are they Substitutes or Complements?

Over the last several decades, our team has attended conferences across the U.S. and internationally on farm management, applied economics, and animal production. The rapid advertising and adoption of precision livestock technologies has been one consistent trend that has stood out. These technologies include virtual fence, health monitoring, optimized feed delivery, inventory systems with many now advertising the incorporation of artificial intelligence. The pitch we hear is always the same: more efficiency, fewer labor headaches, better profitability.

That pitch is appealing because human resource risk is real and livestock producers tend to be more at risk than other industries. Human Resources could be broadly defined as anyone and everyone involved in your operation: family, hired managers, employees, contractors, and service providers. But the reality is that people are people. They get sick, get hurt, quit, retire, make mistakes, or simply underperform. Couple that with finding reliable labor in rural towns and the appeal to limit or fully replace human resource risk is an easy one to buy into.

Human resource risk

Human Resource risk is generally measured within two factors: loss frequency (how often does a human resource problem cause a loss?) and loss severity (how big is the loss?). If your top ranch hand misses three days during calving, that's frequency. If those days cost you \$2,000 in extra labor and two lost calves, that's severity. Both matter when deciding whether to invest in better management practices, cross-training, or technology.

If we choose to invest in technology, then we need to be critical, if it is in fact replacing our labor needs (a substitute) or if it is a tool to work alongside your employees (a complement). The answer is different for each operation but the way we evaluate each technology changes how we should think about staffing, training, and our operation's overall risk exposure.

Is technology a labor substitute or complement?

Let's explore the most common categories of livestock technology and consider a key question: does each technology replace a worker or does it require a worker to capture its value? Our focus will be on the U.S. cattle industry, though the same logic broadly applies to crop production and other agricultural sectors. With this, it's important to recognize that perfect substitutes and perfect complements are generally rare, though they tend to occur more often in crop production than in livestock.

In livestock systems, technologies usually fall somewhere between these extremes. For instance, a particular innovation may not fully replace labor (i.e., serve as a perfect substitute for labor hours), but it might still reduce the need for labor more than it enhances the quality or effectiveness of existing labor.





Animal tracking

This category includes everything from virtual fence to GPS-enabled ear tags. The promise is fewer trips to pasture to check fence, move cattle, or monitor water. These systems use cell or tower connectivity with phone and desktop apps for moving virtual boundaries and checking cattle location. Setting and adjusting boundaries still takes time, even if it takes less time than physically moving electric fence. The biggest savings realized from implementing this technology comes from fewer trips to check fence and water, but many producers go to pasture for other tasks anyway, so the marginal time saved may be smaller than expected.

Our verdict: *Most of these technologies are a complement. Producers using intensive rotational grazing may see real labor savings. For most operations, virtual fence technology works best alongside existing labor rather than replacing it completely.*

Animal health

These technologies detect movement patterns and sometimes record animal vitals to alert operators when an animal may be sick or injured. This can partially replace visual inspection, which is a skill that requires significant training and experience. Cattle also tend to hide weakness during visual checks, so technology-based detection may catch problems earlier. That said, someone still must pull and treat animals once a problem is flagged. Most animal health technologies are in the detection rather than administering medicine or deciding on treatment protocols.

Our verdict: *It is a partial substitute for detection, but a complement for treatment and decision-making. You still need skilled people that are potentially completing fewer visual checks. Real cost savings come in the form of reducing negative health outcomes rather than labor savings.*

Feed and water management

These technologies deliver feed, monitor feed use, and monitor water consumption that inform animal feeding programs and treatment timing. On the feed side, it often focuses on measuring and mixing ingredients, tracking consumption, and using GPS on feed trucks to get the right ration to the right pen. On the water side, it's often focused on remote tank monitors, trough sensors, and automated pump controls that let you check water levels and start or stop pumps from your phone.

Remote sensing can eliminate trips to check a tank in a far pasture and automated feed batching reduces both the skill and time required compared to doing it by hand. However, pumps can break, sensors need calibration, and feed equipment requires maintenance. The labor shifts from routine physical tasks to monitoring dashboards and responding to alerts which can result in fewer hours, but a different kind of hour.

Our verdict: *This is the strongest case for substitution. These technologies can eliminate specific routine tasks, but they still require someone to maintain, monitor, and troubleshoot. The value depends on having people and processes in place to respond.*

Data: the key factor

All technology shares one requirement: good data, collected, cleaned, and maintained so the underlying models work. Some data is easy to gather such as measuring feed consumed at an individual bunk. Other data is not. Measuring

Takeaways

Most precision technologies in livestock production complement labor, they don't replace it. Plan staffing accordingly.

Perfect labor substitutes are rare in livestock production. If technology changes a task rather than eliminates it, your labor needs stay the same or shift to a different skill set.

Use loss frequency and loss severity to identify where human resource risk hits your operation hardest.

Evaluate each technology by listing the specific labor tasks it addresses and asking: does this eliminate the task or just change who does it and how?



daily or weekly weight gain on an individual animal remains extremely difficult. Artificial intelligence can help with some data collection, but it still depends on the foundational knowledge the ag industry has been built on. Without proper training, ongoing feedback, and critical evaluation of the management decisions these models suggest, even good data can produce bad decisions.

Evaluating technology through a labor lens

In our evaluation of the technologies available to livestock producers, we have found that most are complements to labor, not direct substitutes. That distinction matters, since human labor remains a key component of a livestock operation, even if technology is adopted.

Finding ways to better utilize labor, reduce or eliminate tasks, and save money on labor expenses still matters. If technology were a perfect substitute for labor, then it would eliminate a labor task or employee, and the human resource expense and risk should go down. But perfect substitutes for labor we have found are rare in livestock production. Most situations still require a person at some point in the process to make a decision or perform a task.

Most technologies are complements making labor more efficient without

eliminating people. In some cases, adding technology to a livestock operation may even increase the need for labor. In many cases, the human resource risk profile shifts rather than shrinks.

This means that, for most livestock operations, when adopting precision technologies the labor challenge doesn't go away. You may need fewer people doing things like visual pen checks, but then you'll need people who can run software, troubleshoot connectivity, interpret dashboards, and still perform tasks like pulling and treating animals. These are ultimately just a different skillset and potentially a harder one to hire in rural communities.

Conclusion

Before investing in technology, list the specific labor tasks it claims to address, then ask honestly whether it eliminates that task or just changes it. If it changes it, make sure you have or can find people with the right skills to capture the value. A complement only works if you have the people to match it. A second tractor with no one to drive it is just a depreciating asset.



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Contributing authors:

- Elliott Dennis, Livestock Marketing Specialist - University of Nebraska-Lincoln, elliott.dennis@unl.edu
- John Hewlett, Ranch/Farm Management Specialist - University of Wyoming, hewlett@uwyo.edu
- Jay Parsons, Risk Management Specialist - University of Nebraska-Lincoln, jparsons4@unl.edu
- Jeff Tranel, Ag and Business Management Specialist - Colorado State University, Jeffrey.Tranel@ColoState.edu

Editing and Layout: John Hewlett, hewlett@uwyo.edu

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