Smart Agriculture Will Help Feed the World
Improving Food Security Through IoT-enabled Ecosystems

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Food insecurity is a global problem. Despite the United Nations’ efforts to meet a sustainable development goal of Zero Hunger by 2030, the number of those affected by hunger is expected to surpass 840 million by that date.¹

As the population continues to grow, these issues are only going to worsen unless we can increase the amount of food that makes it from farm to table successfully. Fortunately, there is a movement underway within the agricultural industry to do just that — increasing yields while improving economic and environmental sustainability. And smart farm technology is at the forefront.

Within the farm setting, innovative smart agriculture devices such as sensors, robots and drones are remotely monitoring and managing processes, leading to improved yields and more sustainable practices. However, these are silos of innovation. There are other separate but interdependent systems along the food supply chain, both within and beyond the farm. Efficient and effective food production requires integrating and managing all of these systems holistically, supported by connected digital technology.

Maximizing food production through the Internet of Living Things

Improving the efficiency of food production will require the integration of the silos of innovation across the food value chain — including crop production, animal husbandry, and all the processes that go into supplying safe and wholesome food to market. By taking advantage of a connected technology ecosystem, which we call the Internet of Living Things, the agricultural industry can improve efficiency, reduce costs and ensure its ability to meet the demands of a growing global population.
How each component within these systems is managed has a direct bearing on the other components. While the food value chain includes fruits, vegetables, grains and other crops as food sources, this paper primarily explores opportunities in the production of livestock and crops for feed. Procuring the feed ingredients, manufacturing feed, and delivering the right quantity and type of feed at the right time is essential to ensuring good animal health and efficient production. Understanding the rate at which the feed is being consumed has a direct bearing on how much and when the next batch will need to be produced and shipped. Livestock waste must be monitored and controlled both as available fertilizer for the crops and to reduce its potential negative impact on the environment.

Integrated systems can maximize output and reduce waste all along the food production value chain, from production to harvest to transportation to distribution and storage. The results benefit both protein producers and society, by lowering the cost of production and improving sustainability.
The break in the smart agriculture chain

Many independent protein producers as well as agricultural businesses are taking advantage of new digital technologies to make improvements in their ability to produce enough healthy food to meet the demands of a growing world population. But the opportunities for improvement extend beyond just taking care of the animals. These include scheduling trucks to transport livestock to market at the optimum time, minimizing waste in protein processing and controlling product temperature during transport to market. In the current environment, many of these practices are primarily manual and most are siloed. This break in the smart agriculture chain means that crucial opportunities for driving greater efficiency and productivity are being missed. That’s costly to producers and consumers.

From siloed to integrated feed management

Managing feed is a critical aspect of keeping animals healthy and boosting farm productivity. Growth models, feed schedules, ingredient ordering and waste management are all processes that are part of the feed management ecosystem. Transportation of ingredients for feed is heavily dependent on the rail system.

Rail delivery windows can be unpredictable, and this can compel protein producers to order more than they need, to make sure they have enough food for their animals. This lack of predictability can also lead to demurrage costs, as rail cars sit waiting to be unloaded. And, if the animals don’t get the food they need when they need it, their health and growth will be negatively affected too, creating additional costs and reducing profitability.

Smart agriculture offers great promise to help protein producers improve breeding and disease management, keep track of livestock, monitor animal health, and hone logistics to optimize feeding and watering. These innovations help ensure the humane and ethical treatment of animals and also improve efficiency, reduce cost and increase profitability for protein producers.
Great things happen when you connect the feed supply chain

Examining ingredient and feed management practices and opportunities demonstrates how transitioning from manual, siloed processes to technology-enabled, integrated practices brings exponential benefits to the food production ecosystem. A connected ecosystem provides the foundation for automating and fine-tuning the entire process of feed ingredient procurement, manufacturing, and delivery to achieve results that lead to the greatest productivity — and profit. With smart devices connected through the Internet of Living Things, protein producers can ensure that the livestock on their farms receive the right food in the right amount at the right time.

The feed ingredients supply chain depends on the availability of crops, and smart farms are reaping the benefits of crop monitoring and automated processes for optimal conditions. By connecting information about weather predictions, temperatures, and soil conditions, smart connected devices help farmers automatically adjust irrigation systems for optimum soil moisture. They can monitor crops to determine the best time for harvest and more accurately plan transportation needs. This level of detail even enhances a farmer’s ability to make better purchase decisions when buying inputs for crop production. Further, using these different technologies to monitor crops enables the use of specifically targeted crop protection tools to optimize yields.

Protein producers can take advantage of these interrelationships by using a model that is calibrated using optimal animal growth per unit of feed consumed as the key performance indicator. By then managing their processes with connected digital technology, they can minimize the cost of feed per unit of production while making sure their animals are fed appropriately.

Protein producers need a 360-degree view of this cycle. A connected ecosystem bridges the gap in observability that is created by siloed, manual processes. Because consumption, supply and waste are all interrelated, variation, risk and uncertainty in any one of these has ramifications on others.
Another benefit of smart agriculture integration is the ability to factor changing conditions, such as weather patterns, which can affect animal feed consumption, into the feed formulation and ordering process. Weather is known to influence animal eating behavior and thus has a direct bearing on animal health and growth. These insights allow protein producers to fine-tune feed formulation and ordering based on more accurate predictions of how much food their animals will need and when.

For livestock producers, radio-frequency identification tagging, lidar and video cameras are being used to monitor animals and their growth. The data gathered from these processes can be integrated with other data to predict weight more effectively and determine exactly when and how much food needs to be ordered. Sensor data and analytics help predict the best time to harvest the animals and plan for transportation in advance to improve efficiency.

For example, in the production of protein from pigs, the growth of the pig can be analytically linked to the congestion and network performance of railroads. Predictions for feed consumption and pig growth can be used to model demand at the feed mill as well as logistics optimization in delivery. For mills that are supplied by the railroad, analytics can be used to better understand and predict raw material delivery windows based on ordering dates and network performance of the railroad to better service the supply requirements. This approach can transform a historically unpredictable mode of supply into a “moving inventory,” reducing the need for safety supply that must be maintained, allowing for better logistical planning around delivery, and directly linking the supply chain to the metrics that matter to the producer — the growth and well-being of the animals.

Connected technologies that support this integrated ecosystem include:

• **Machine vision for assessing supply and demand.**

• **Proactive fleet management to ensure that transport needs are met.**

• **Supply chain logistics optimization to keep the entire process running smoothly.**
These types of capabilities extend to every aspect of the farm and food life cycle, whether the product is crops, livestock — or both. The ability to see across the entire product life cycle and make crucial adjustments along the way can help farmers to minimize waste, risk and cost while maximizing yields, predictability and profits. The end result is a more eco-friendly industry and a greater ability to help reduce food insecurity.

An integrated ecosystem generates universal improvements

Smart farming is a significant step toward achieving sustainable agriculture and improved food security. It provides the opportunity for protein producers to make decisions that lead to greater productivity and reduced waste. By expanding smart agriculture practices to encompass the entire product life cycle and taking a holistic, 360-degree view, protein producers can further extend their influence in supplying food from farm to table. In this way, the Internet of Living Things helps each farm answer important questions about specific processes or operations. Those answers can be built upon to address larger issues of the entire industry.

By connecting the food supply chain from end to end, the Internet of Living Things has the potential to help the agriculture industry understand how much food is available, how much is needed and how to fill the gap — at a time when the gap is growing. The industry can implement the following technologies to help improve this situation:

- Sustainable practices, enabled by technology, can help protein suppliers minimize their environmental footprint while increasing productivity.
• Digital devices can optimize fleet levels for the food supply chain, the raw materials needed to keep animals healthy will be delivered at the optimum time, and products that leave the farm will get where they need to go without spoilage.

• Data analytics can help each supplier improve their own operations, which contributes to improvements across the entire ecosystem and can ultimately lead to helping the world reduce food insecurity.

Powering good with the Internet of Living Things

The feed and ingredient management process provides a perfect scenario for digital transformation. By taking a 360-degree view of the entire product life cycle, livestock producers can be proactive in planning and responding to events. This holistic view bridges any gaps in observability and allows them to minimize risks and maximize outcomes. The Internet of Living Things is the enabler. The end result of this type of integrated ecosystem is more accurate forecasts, improved yields, a reduction in food production costs, more environmentally sustainable and profitable farms, and ultimately, more food to feed the world.

Hitachi is working with companies around the globe to develop digital technology solutions for the entire agricultural industry ecosystem. We’re committed to partnering with others to create and connect technologies that can improve food security, promote environmental sustainability and help protein producers be profitable in an increasingly challenging environment. Supply chain integration is a crucial element in this effort. Putting nourishing food on everyone’s table will require a holistic approach to creating an integrated food supply ecosystem that serves everyone’s needs.

Learn more about how food producers are using the Internet of Living Things to help secure the global food supply.

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Udayan’s expertise is in applying digital technology capabilities to architect solutions that address the double bottom-line and delivering a positive social impact while fulfilling business requirements across manufacturing, transportation and smart spaces. Udayan delivers full stack solution architecture and design support by leveraging a wide range of Hitachi and broader ecosystem technology capabilities for a wide range of solutions including predictive maintenance, asset management, ML/AI-based failure prediction models, process re-engineering, manufacturing intelligence solutions, and innovative applications of video analytics including lidar.

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Brad Howard is an experienced data scientist and engineer. His role in the Global Social Innovation Business is the application of data analytics to solve real-world problems and support the overall solution architecture. His expertise is in the analysis and ML-supported automation and optimization of complex processes/operations to drive efficiency and value for Hitachi customers.

M. Terry Coffey, Ph.D. Industry Expert

Dr. M. Terry Coffey received his B.S, M.S. and Ph.D. from the University of Georgia. He has worked for the University of Florida’s Department of Animal Science; the North Carolina State University Department of Animal Science, where he developed a program focusing on research in nutrition; and Murphy Family Farms, now Smithfield Foods, Inc. In 2011, Dr. Coffey was named Smithfield Foods Hog Production Division’s first Chief Science and Technology Officer and remained in the position until his retirement in 2020.

Dr. Coffey has authored and co-authored over 75 peer-received publications as well as numerous articles and research reports. He has a distinguished record of professional and public service on numerous community, state, regional, and national organizations and served on many organizations’ boards, including the Board of Trustees at the University of North Carolina at Wilmington and the Board of Directors of the American Society of Animal Science.