Lean Digital Agriculture: How Farming Is Ripe for Disruption

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THE AGRICULTURE INDUSTRY HAS ALWAYS BEEN ABOUT DOING MORE WITH LESS. SINCE THE DAWN OF AGRICULTURE, FARMERS HAVE HAD TO COPE WITH AN UNPREDICTABLE ENVIRONMENT WHERE CHANGE AND ADAPTATION CAN BE REQUIRED AT AN INSTANT'S NOTICE. THESE ARE JUST TWO OF THE REASONS WHY AGRICULTURE IS THE NEXT BIG INDUSTRY THAT'S ADOPTING LEAN DIGITAL, WITH SMART FARMS AND LEAN DIGITAL AGRICULTURAL ENTERPRISES POPPING UP ALL OVER THE WORLD.

Climate change has accelerated the pressure on farmers, who now face the challenges of drought, fire, storms, and other unpredictable weather every year. The world's growing population, on track to hit 9.7 billion by 2050, is also driving demand for improved yields.

Meanwhile, a rapid acceleration in the adoption of new technologies is turning agriculture into a high-tech industry, launching the era of the "smart farm" and making it necessary for even small and mid-sized agricultural enterprises to keep up. According to the World Economic Forum, smart farm technology is essential to address rising labor costs, supply chain issues, and the other current challenges facing agriculture.

Agricultural supply chains, which are among the most complex and problem-plagued in the world, can be simplified with the use of sophisticated monitoring and analytics technologies. The use of artificial intelligence (AI) and automation can help companies deal with rising labor costs and turnover, while eliminating sources of food loss and waste, and the costs those impose.

Farmers and others in the agriculture sector are eager for new solutions to these dilemmas. Research by Deloitte shows that farmers are willing to pay for modern technologies and integrated solutions to help them cope with the increased complexity of today's agricultural market. But these tools are much more effective when utilized within an overall system designed to optimize organizational efficiency, and this is where Lean Digital comes in. "With well-executed implementation of automation, AI, and other digital tools within a Lean Digital framework, companies could see results within a year" says Patrick Wiebusch, Co-Founder and Managing Partner at Four Principles.

How Lean Concepts Can Transform Farming

While Lean was developed by Toyota to improve operational efficiency in a manufacturing setting, the principles and practices adapt surprisingly well for use in farming. In the past few years, farms that have implemented Lean have dramatically improved yields, reduced labor and storage costs, and reduced time from field to table.

Lean Farming follows the same five principles that govern other industries: Identify value; map the value stream and eliminate waste; create flow; establish pull; and seek perfection through continuous improvement.

According to Jana Hocken, author of The Lean Dairy Farm, Lean offers significant benefits in an agriculture setting, helping farmers:

- Identify and eliminate waste in farm processes, improving efficiency
- Organize and streamline the way the farm is run to increase productivity
- Standardize processes and steps so that everything is done right the first time
- Improve engagement, performance and teamwork among staff

One area in which Lean has been particularly helpful is in managing the workflow of farm labor to eliminate unnecessary movement from field to field. Reducing wasted time means fewer employees are needed, reducing reliance on seasonal and supplemental labor, and saving money.

As in the manufacturing and technology sectors, Lean principles, tools and techniques are showing impressive results and adding economic value in the agriculture sector. Lean-based practices that are effective in the agriculture setting include:

Value Stream Mapping: A means to identify and create a detailed map of all steps in a work process to identify those that bring value and eliminate anything unnecessary, considered waste. With data showing that 40 percent of all food grown in the world goes uneaten, the agriculture industry is prime for waste reduction.

Standard Work: A process for documenting the best way to perform a task, accompanied by diagrams, photographs, and step-by-step instructions. A system such as Lean Daily Leadership Process can establish routines and communication methods so that everyone in an agricultural operation knows what to do when.

Total Productive Maintenance (TPM): A Lean approach to asset management that engages all managers and employees in analyzing equipment and identifying problems to prevent malfunctions, breakdowns, accidents and other losses. TPM can be valuable in maintaining harvesters, tractors, irrigation systems, spraying equipment, transport trucks and other equipment. Not only does TPM lengthen equipment life, it prevents breakdowns that could cause crop losses at critical times such as harvest.

Kaizen: A process for implementing change through group input. Kaizen has strong applications in agriculture, where the majority of the work is done by those quite literally on the ground and who may be best positioned to see opportunities for improvement. Involving all workers in the change process ensures that new systems will have full buy-in and will stick.

Cross-Functional Teams: A way of organizing the workforce with representation from all aspects of a task or process. In agriculture, the team-based approach central to Lean is particularly effective, eliminating the redundancy caused by multiple people performing overlapping tasks. The result: Fewer trips to the field or barn, fewer circuits by inspectors, and less labor needed. The team-based approach to continuous improvement also leads to innovation, with each member of the team feeling comfortable to make suggestions. An open-minded and flexible team can take advantage of new ideas for improvement, trying out new ways of doing things and testing out new solutions.

Other Lean Organizational Tools: Many farmers and agricultural enterprises are having success with 5S, a Lean system for organizing tools for maximum efficiencies. Based on 5 Japanese words for different aspects of cleanliness and systemization, 5S eliminates unused tools and supplies, organizes and arranges those that are needed for maximum efficiency, and establishes a system for keeping everything in its place. Six Sigma, a data-driven system of standardization, is also useful in agriculture. Six Sigma uses a set of statistical tools designed to eliminate variation, prevent defects, and reduce the likelihood of error.

The Lean approach of analyzing an entire system, or value stream, allows farmers to see the whole picture, using root cause analysis to identify problems "upstream" and attack them at their source. Take the example of an insect infestation in produce that requires time- and labor-consuming inspection at every stage of processing and shipping. Identifying and eliminating the source of the insect breeding is far more time- and cost-effective than increasing the number of inspections.

Another case study comes from Clay Bottom Farm in Indiana, where farmer Ben Hartman redesigned his harvest and delivery system to be entirely demand-based, eliminating the waste of intermediate storage. Instead of harvesting produce and moving it to a cooler for storage, Hartman waits for a vendor order, then brings a refrigerated delivery vehicle into the field, harvesting directly into the truck.

The customer receives the produce fresh from the farm within a few hours of being picked and thus is happier with the quality, while Clay Bottom Farm has saved the cost of storage and cut labor by half, since the food does not have to be loaded twice. Other improvements Hartman documents in his book, The Lean Farm, include implementing a 5S system to organize the workforce and workflow, and holding kaizen events that have resulted in new tools and processes to avoid workforce injury.

"Lean farming starts with the right mindset, so farmers can look at their business holistically and identify opportunities to minimize waste and improve efficiency," says Mehdi Chelhi, Partner at Four Principles. "The next step is to re-think your production flow and transform it from supply-based to demand-based, just-in-time production. Lean management consultants can help farms and agricultural enterprises develop Lean solutions to do this as well as build the right foundation, so all employees are on board."

How Digital Tools and Smart Farms are Transforming Agriculture

New digital tools and technological advances are enabling the agriculture sector to take a giant leap into the future, supporting a type of precision farming that would have been impossible even a decade ago.

Farmers use real-time weather forecasting to make day-by-day and even moment-by-moment decisions on when and how much to irrigate, fertilize, apply pesticides and harvest. IoT-driven automated and semi-automated systems carry out those instructions using sensors to read environmental conditions and make minute adjustments. Meanwhile, advances in seed science are making crops more resistant to pests, disease, and fungus and more tolerant of heat and drought.

Controlled-environment agriculture introduces even more precision and control. Indoor farms and greenhouses use carefully plotted algorithms and climate control to adjust inputs like ventilation, temperature, artificial lighting and humidity. Other sensor-based delivery systems ensure optimal growing conditions that can be adjusted in real time. Automation, AI and robotics are decreasing reliance on labor and in some cases allowing operations to be completely automated.

Ultra-high resolution imaging can identify symptoms of disease, dehydration, nutrient deficiency, and poor soil quality, while remote-operated vehicles such as drones can apply fertilizer and pesticides with astonishing accuracy.

Online marketplaces connect farmers directly with consumers, reduce the number of intermediaries, and streamline transit routes. Cutting out middlemen not only reduces costs and boosts income, but shortens farm-to-table time, improving food freshness and reducing food waste.

Proven Results from Lean Digital Agriculture

While the use of Lean Digital in farming is relatively recent, already some success stories are emerging, with farms and agricultural enterprises demonstrating or forecasting improvements in yield, cost savings, shorter times to market and greater resiliency to climate fluctuations.

Water use is one area where smart farming is making major advances in the MENA region. In Lebanon, Ground Vertical Farming offers a recirculating irrigation system that reduces water usage by up to 90 percent a day. In Egypt, IrriWatch is offering farmers an app-based virtual sensing technology that uses thermal satellite data to measure soil moisture and water potential and develop irrigation scheduling. In Tunisia, the start-up Ezzayra offers an Agri-manager system that calculates and tracks production costs per crop and per farm and an Intelligent Growing System (IGS) that autonomously regulates irrigation.

An example of a successful online agricultural marketplace is China's Pinduoduo, which launched Duo Duo Orchard in 2015 and Duo Duo Farm in 2019 to help raise the income of rural farmers by connecting them directly with consumers. By generating advice through AI capabilities, Duo Duo can predict the demand for various types of produce and advise farmers what to plant ahead of the growing schedule.

Operating as a partnership with local governments and agricultural research organizations, Duo Duo Farm had signed up more than 150,000 farmers by 2019 and the produce sold on the Pinduoduo platform reaped US $684 million in 2019 alone. Duo Duo plans to support one million rural online farm stores by 2025.

In Saudi Arabia, the UAE, and throughout the Middle East and North Africa (MENA) region, governments and industry are investing in smart technologies to preserve water resources, enhance sustainability, and mitigate economic losses from climate-related water scarcity.

Growing tomatoes in the desert may sound like an impossibility, but in one case study, Pure Harvest is doing just that in the UAE. Pure Harvest's indoor smart farm just outside Abu Dhabi is 70 percent more water efficient than traditional farms and built to provide optimal growing conditions insulated from the harsh climate. The term greenhouse does not fully describe Pure Harvest's facilities, which are complete indoor farms inside a triple-insulated, fully controlled climate chamber.

Ventilation and climate controls remove heat and humidity from the air, and the humidity is then recycled into water for irrigation. Produce such as strawberries and tomatoes are grown hydroponically, their roots in a nutrient-rich solution rather than soil. A sophisticated network of sensors monitors nutrient levels, light, temperature, air quality and other factors affecting growth. Currently Pure Harvest grows tomatoes and strawberries, with plans to grow cucumber, aubergine, peppers, and other vine-based crops.

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Indoor vertical farming is an ideal solution for the MENA region, where water is a scarce resource and 85 percent of all food is imported. According to a regional feasibility report by the YesHealth Group, "Indoor vertical farms offer the prospect of growing more produce locally and making better use of the region's limited water resources." The report projects that the MENA region's vertical farming market is projected to reach 1.9 billion USD by 2025, up from USD 0.6 billion in 2020.

"Lean Digital Manufacturing is the most widely successful approach to business transformation in the world, and agriculture can benefit from these same tools and techniques," says Seif Shieshakly, Co-Founder and Managing Partner of Four Principles. "What's important is to solve problems at the right time in the right way."

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Tel: +971 4 368 2124
Email: info@fourprinciples.com

UAE Office Address
Dubai Media City
Building 8
Office 212
P.O. Box 502621
Dubai, UAE

KSA Office Address
Office 203 (Lobby C Entrance)
Spaces, Diplomatic Quarter
Riyadh 12512-8052
Building number 3574
Saudi Arabia

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