

Waste Minimization in Agri-Food Supply Chains through Digitization



The agricultural industry has undergone significant changes in recent years, with advancements in machinery leading to increased scale, speed, and productivity of farm equipment. These improvements, combined with advancements in genetically modified seeds, irrigation systems, and fertilizers, have led to more efficient cultivation of land and higher yields. However, the industry is now on the brink of another transformation, driven by data and connectivity. In Sri Lanka, agriculture is a vital sector of the economy, contributing significantly to 7.1% of the Gross Domestic Product in 2020 and employing 27.12% of the labor force directly and indirectly [1]. The output of the agriculture industry has a significant impact on industries such as consumer packaged goods, retail, and tourism, further emphasizing its importance [2].

However, the agricultural base of the country has been eroding over the past few decades,

primarily due to deficiencies in the supply network connecting farmers and consumers. The supply chain is suboptimal, leading to disparities and captive farmers and consumers. Furthermore, waste generation is a significant issue, with estimations ranging from 30% to 40% of total produce being wasted in recent past years, resulting in increased costs for consumers [3]. Furthermore, managing this supply chain has become very difficult as a result of the lack of transparency and measurements in the network, because we are unable to manage entities we cannot measure. To address these challenges, agriculture needs to embrace a digital transformation enabled by connectivity. While past advancements focused on mechanical and genetic improvements, the industry must now adopt more sophisticated digital tools to deliver the next leap in productivity. These technologies can help farmers make better decisions, manage risks and variability, optimize resources, and improve their financial revenues

while mitigating waste. Nonetheless, agriculture remains less digitized in developing economies compared to many other industries in globally, and there is a need for more advanced digital tools to be developed to support sustainable agriculture practices.

There are mainly three steps in the process of digital transformation. They are digitization, digitalization and lastly, digital transformation. Digitizing the existing procedures would be the first move in Sri Lanka's vegetable supply chain's transition to the digital age. This may involve converting paper-based records into digital ones, including delivery notes, purchase orders, and invoices. Through doing this, it will be possible to share data swiftly between different platforms and ensure that it is recorded accurately. Secondly, the use of digital technologies to enhance current procedures is known as digitalization. The application of technologies like sensors, IoT devices, precision agriculture using drones and analytics to monitor the flow of products through the supply chain could be considered digitalization in the context of Sri Lanka's vegetable supply chain. This will make it possible to track transport process, product quality, and inventory levels in real time. Digitalization can also enhance coordination and contact among various supply chain actors, including farmers, distributors, and retailers. Lastly, digital transformation involves the complete rethinking and redesigning of processes, enabled by digital technologies. The creation of new business models that make use of digital technologies to develop new value propositions for customers could be part of the



Figure 1. Requirement elicitation session with Manning Market trade union

digital transformation of the Sri Lankan vegetable supply chain. This might entail the development of online marketplaces that connect farmers and customers directly or the application of blockchain technology to establish a secure and transparent supply chain.

However, digitization plays a critical role in the success of a country's agriculture which is in the earlier stages of digital transformation. Even though around half of the world's food is produced on farms of 20 hectares or less, many developing nations lack the necessary data and have weak telecommunications infrastructure, making it difficult for most farmers to afford digital technologies for small farms. As an example, during the immediate impact of the COVID-19 pandemic, due to less accessibility to information and distribution channels, whole agri-supply chains were disrupted in Sri Lanka. In the absence of accessibility to dedicated economic centers, many farmers were failing to sell their harvest. Hence, it was evident that current traditional mechanisms failed, with producers struggling to sell their harvest and consumers failing to acquire desired produce leading to excessive waste. Since the produce is perishable by nature, from the production stage to the consumer stage, large quantities of agro-products go to waste. Even in normal market conditions, post-harvest waste occurs, and it is roughly estimated at around Rs. 20 billion annually in Sri Lanka [4]. Eliminating at least 50-75% of waste alone would make life better for the farming community since it can be transferred to farmers, as intermediaries already take a portion of the financial revenue. In addition to that, all stakeholders in the vegetable supply chain will be able to add value to our national economy by reducing this amount of waste.

Access to the right information at the right time through the right medium is crucial for people involved in the agricultural sector. This includes farmers, fishermen, foresters, policymakers, industries, and other actors in the agricultural value chain. As a country, we should act fast and act together to reframe and reposition data and applications of all types and streamline knowledge access to use as core drivers for the development of the Sri Lankan agricultural industry. At present, there are several digital platforms in Sri Lanka that can assist local farmers in improving their yields and reducing waste at the production stage and marketing stage while operating as an advisory service as well as an information sharing. A few examples of such applications are Govi Mithuru, Govi Nena, and Krushi Advisor. However, there is a pressing need

to democratize access to data and technological advances in a manner that is both practical and usable for farmers. Open data and informatics can be used to transform agri-food systems by addressing challenges related to cost, access, capacity, feasibility, quality, covering everything from input supply to production to markets and consumption.

As part of a strategic plan for transforming the agriculture sector through digitization, there are a few key stages that we should consider; planning cultivation, farm inputs, production, logistics, marketing channels, and financial services. Incorporating the issues that occur in these stages in the agri-chain can create a new agriculture eco-system for leveraging technology to provide products or services that increase overall performance, efficiency, and profitability for farmers across the agriculture value chain. Figure

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2 depicts a summary of how the As-Is state practices should be transformed through digitization to increase overall efficiency while reducing different kinds of waste involved in the supply chain, and how the To-Be state practices should be as per a study conducted at the University of Moratuwa using a NORHEDII grant funded by the Norwegian Agency for Development Cooperation (680085). This study was carried out focusing on main economic centers of the Sri Lanka that are major nodes of the Sri Lankan traditional vegetable supply chain. The To-Be state practices will unlock the value of agriculture, creating more benefits in terms of social, economic, and environment to Sri Lanka. It will ultimately eliminate at least 50% of the current waste, converting that into economic benefits for farmers and other stakeholders in the supply chain.

	Planning	Farm Inputs	Production	Logistics	Markets	Financial Services
Key Criteria	<ul style="list-style-type: none"> Sources of agronomic information 	<ul style="list-style-type: none"> Decisions on seeds Crop protection Fertilizers purchase 	<ul style="list-style-type: none"> Decisions on farming techniques Cultivation timing 	<ul style="list-style-type: none"> Availability of distribution channels Availability of storages 	<ul style="list-style-type: none"> Decision on selling channel including price and payment terms and timing 	<ul style="list-style-type: none"> Broader access to finance
As-Is State	<ul style="list-style-type: none"> Last year's performance Advices from trusted partners Decision based on experience 	<ul style="list-style-type: none"> Farmer's experience Inputs from trusted suppliers Product information from suppliers 	<ul style="list-style-type: none"> Farmer's experience Advices from trusted partners Public information such as short-term weather forecasts 	<ul style="list-style-type: none"> Long term relationship with regional distributor High logistics costs Demand and supply contradictions 	<ul style="list-style-type: none"> Limited negotiation of price and payment terms Long term relationship with regional distributor 	<ul style="list-style-type: none"> Long term relationship with regional distributor Credit based operational structure
To-Be State	<ul style="list-style-type: none"> Data management system to store farmers' data Advanced analytics for predictions and preparing a crop management plan 	<ul style="list-style-type: none"> Data enabled decision making Full data transparency via digital applications Quality management and certifications 	<ul style="list-style-type: none"> Use of precision farming techniques Real-time reports for crop information Adaptation to industrial automation 	<ul style="list-style-type: none"> Adaptation to best practices Trace products across supply chain Providing affordable options for aggregating and storing 	<ul style="list-style-type: none"> Access to online marketplaces Increased farmer negotiation power A greater share of direct sales 	<ul style="list-style-type: none"> Creating a comprehensive credit scoring Access to digital payment methods Digitization of Government services

Figure 2: Digitization of Traditional Agri-Chain

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