

Technology Offers Fresh Ways to Reduce Food Waste



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With a new wave of COVID-19 spreading through many parts of the US, leading to beach closures and July 4th fireworks being cancelled, the challenges of the last few months look set to continue. Even in states where businesses are allowed to reopen, and more people start to travel and enjoy outdoor dining, we all are forced to adjust to the ‘new normal,’ as the threat of this coronavirus will last at least through the end of 2020. Things are not going to return to the way they were any time soon, meaning that the issues revealed by the pandemic facing the food & ag industry need to be tackled, particularly the deficiencies in the supply chain, and the problem of the growing levels of food waste that result. Even as more restaurants reopen throughout the US, there is no guarantee that this will lead to a decline in food waste, because it will be some time before foodservice sector (hotels, restaurants, schools, and stadiums) sales return to pre-COVID 19 levels.

In part I of my article about food waste: [“COVID-19 exposes paradox of simultaneous food shortages and food waste”](#), I covered the economic impact to consumers’ wallets and the environmental impact to the planet. Now, I am going to focus on different technologies that have the opportunity to fundamentally reduce food waste, bring economic benefits to farmers and consumers and, at the same time, provide an important path toward a more sustainable food & ag sector.

It is not just more environmentally conscious consumers who are calling for new ways to reduce food waste. Following on from strong investor activity in ag biotech, alternative protein, digital / precision ag, and indoor farming over the past few years, investors are increasing funding to companies with technologies that reduce food waste. In the past couple of months, AgroFresh, Apeel Sciences and

Imperfect Foods completed large financings, which is an indication that the investment community understands the impact that these innovative technologies and business models will have in reducing food waste. According to the U.N. Food and Agriculture Organization, 30% of food is wasted globally across the supply chain, contributing 8% of total global greenhouse gas emissions. If food waste were a country, it would come in third after the US and China in terms of its impact on global warming. Like the prior generation of investors that funded renewable energy, electric vehicles, and smart grid technologies, today's investors understand that there are viable solutions to climate change and are looking to back innovative companies.

Today, a broad range of food waste solutions are emerging, which attack waste and inefficiency in different areas of the food & ag supply chain. In this article I will focus on the two areas receiving the most traction: shelf life extension and use of imperfect produce. Two other areas that also show tremendous promise are: IT for managing food inventory more effectively; and turning food waste into fertilizer and pet food. However, most of the companies working in these areas, like Spoiler Alert and KDG Ag, are still early stage and working through new business models, and remain under the radar of most investors. Indoor farming is also an area poised to have a significant impact on reducing food waste, but I will discuss that sector in an upcoming article addressing the rise of a more decentralized food system.

Making Food Last Longer

One key method of decreasing food waste is to extend the shelf life of food, which is a major issue for highly perishable foods like fruits, vegetables, and animal proteins (beef, pork, poultry & seafood). Today wax, fungicides, chemicals, stay-fresh packets, and plastic packaging are typically used in the food supply chain to extend shelf life. These current product offerings are underwhelming as they contain chemicals that are bad for consumers and negatively impact taste, or cover food in plastic packaging that is bad for the environment and only offers limited ability to extend shelf-life.

One of the first companies to create more effective shelf-life-extending technologies was AgroFresh (AGFS – NASDAQ), which was part of Dow Chemical prior to being spun off in 2015. Back in 1996, it developed 1-MCP (1-Methylcyclopropene) based technologies, which suppress ethylene development and its degrading effects on produce. AgroFresh initially focused on apples, which traditionally use wax as a coating. AgroFresh has faced some challenges, from having significant debt on its balance sheet

coupled with declining margins after its initial patents expired. But, in 2017, it acquired Tecnidex, a leading provider of fungicides, waxes, and biocides for the citrus sector, and entered into alliances in 2018 with It's Fresh, a British technology company, and Pagoda, China's largest fruit retailer. These moves, plus renewed investor interest in its food waste mitigation technologies enabled AgroFresh to close a \$150 million convertible preferred stock financing with Paine Schwartz Partners, a leading private equity firm focused exclusively on sustainable food chain investing.

Although AgroFresh successfully built a business focused on the shelf life of apples, the next generation companies are gaining market share with more innovative technologies that are safer, more environmentally friendly, and don't affect the product's taste. Apeel has developed an edible, plant-derived coating that acts as a little extra "peel" to the surface of fruits and vegetables, doubling, or even tripling, the shelf life of many produce types without the need for refrigeration. It does this by slowing the rate of water loss and oxidation - the main factors that lead to spoilage. Apeel's solution is applied at supplier sites before being shipped to retailers. Another advantage of Apeel's technology over competitors like AgroFresh, is that it is FDA GRAS (generally recognized as safe) and approved for use on both conventional and USDA certified organic produce.

Apeel has developed coatings for various categories of produce, starting with avocados, which are available at stores in the US, Denmark, and Germany, achieving an over 50% reduction in wasted avocados. Since 2018, Apeel has saved over 5 million avocados at grocery stores from going to waste and is on track to save 20 million pieces of fruit (organic apples, limes, oranges and mandarins) from ending up in landfills in 2020. Apeel's technology has doubled the shelf life of asparagus, which has the highest carbon footprint of any fruit or vegetable,¹ as most of the asparagus consumed in the US is grown in Peru and needs to be exported by air due to its short shelf life. Using Apeel's technology, asparagus can be transported to the US and other countries via sea, which Apeel expects will cut the shipping costs by almost 90% and lower greenhouse gas emissions by over 85%. In Europe, the plastic wrapping used to extend the freshness of cucumbers is a major problem for consumers, as many are unable to recycle this plastic with their residential recycling, with the result that consumers have been known to tear off and discard the plastic wrapping at the grocery store. Apeel English cucumbers, based on a partnership with the Houweling's Group is predicted to double the shelf-life of Houweling's English cucumbers as well as reduce plastic waste by over 60,000 pounds per year.

¹ Life Cycle Inventory and Carbon and Water Food Print of Fruits and Vegetables, February 6, 2012

Apeel recently announced the completion of a \$250 million financing round led by GIC, a Singapore sovereign wealth fund, at a valuation of \$1 billion+, making it one of the highest valued private AgTech companies. This new capital puts Apeel in a position to help reduce food waste around the world by building out a global coalition of producers and suppliers that can bring longer-lasting produce to food retailers and foodservice. To date, Apeel has raised over \$350 million from a broad syndicate including GIC, Viking Global, Andreesen Horowitz, Upfront Ventures, Bill & Melinda Gates Foundation, S2G Ventures, TAO Capital, and DBL Partners. The amount of capital raised by Apeel is remarkable, for a company that only was founded in 2012, but it's the impressive list of deep-pocketed investors covering AgTech & FoodTech, Biotech, ESG & Impact, that makes this financing so important.

Hazel Technologies uses a different strategy: inserting a small packaging enclosure into the produce box during the packing process to reduce the respiration rate and increase resistance to ethylene, which results in improved produce storage and arrival quality. Hazel Technologies works with over 30 different types of fresh produce and, because its technology requires minimal time and investment from packers, Hazel Technologies believes it has an advantage over AgroFresh and Apeel. Packers don't need to purchase or lease new equipment to implement its technology nor must customers have available space to position new equipment on or adjacent to the existing processing line. In 2018 and 2019, Hazel Technologies cumulatively treated nearly 1.6 billion pounds of produce, which its management estimates stopped nearly 140 million pounds of produce from going to waste and prevented nearly 100,000 tons of carbon dioxide equivalent (CO₂E) from being emitted. In 2020, Hazel Technologies is on track to treat over 3 billion pounds of produce, preventing up to 500 million pounds of produce from going bad, while keeping 300,000 tons of CO₂E from being emitted. Hazel Technologies has been able to grow its business operations to 150 customers in 12 countries, despite raising just \$17.2 million to date.

Cambridge Crops is looking to extend shelf life for the cut produce, consumer packaged goods (CPG), and animal protein industries. These industries similarly suffer from a significant amount of food waste or rely heavily on single use plastics. Cambridge Crops has developed a solution using just water and salt to isolate a protein found in natural silk. This protein is used to create a protective layer that keeps a wide range of foods fresher for longer. The earliest iterations of the Cambridge Crops technology were born out of Professor Fiorenzo Omenetto's Silk Lab at Tufts University and co-invented with MIT Professor Benedetto Marelli. Most consumers probably don't think about food waste happening in the protein sector as much as in the produce section, because much of the waste occurs prior to being purchased by consumers. With more and more consumers troubled by the environmental impact of

raising beef and hogs, and to a lesser extent poultry and seafood, there is a strong imperative to find ways to reduce the amount of animals raised for food, with reducing food waste being one of the easiest solutions to the problem.

Despite its early stage of development, the food technology sector has caught the eye of one of the world's wealthiest people. Bill Gates mentioned Apeel and Cambridge Crops as two companies working on innovative ways to reduce food waste in a blog post he published on March 26, 2019 about ways to reduce the amount of greenhouse gases caused by the agriculture sector. As competition heats up in the coming years, it will not be surprising to see multiple winners in this sector, with no one technology poised to lock up the whole market. Commercial success for Apeel, Cambridge Crops, and Hazel Technologies could have a tremendous impact on the global trade of produce and protein, enabling farmers and ranchers to reach new markets around the globe, and customers to eat their favorite foods no matter the time of year.

Finding a Home for Ugly Food

Other companies are looking to decrease food waste by finding uses for products that typically don't end up on store shelves because they are oddly shaped or surplus. Companies, like Full Harvest and Imperfect Foods, have developed innovative business models that ensure that food, which would otherwise go uneaten, get left in fields or sent to landfills, will end up in consumers' stomachs. Full Harvest is focused on commercial customers, like food, beverage, and pet food producers. Commercial users of fruit and vegetables are excellent buyers for this type of produce, which is turned into other products (food, juice, and pet food) without the end consumer being aware of or caring about how the fruit looked at harvest or whether it was surplus. One advantage of Full Harvest is that food & beverage companies purchasing on its marketplace can save money, typically 10% - 30%, while farms receive additional revenue for produce that would otherwise rot in fields, increasing some farms' yields by up to 30% and farmers' profit per acre by up to 12%. To date, Full Harvest has sold 20 million pounds of produce, and estimates that using those surplus crops, and thus mitigating food waste, has saved over a billion gallons of water, and 7 million kilograms of carbon dioxide (CO₂) emissions. Additionally, Full Harvest is a conduit connecting growers and processors, enabling the supply chain to become more efficient, which is another necessary component of reducing food waste.

Today, growers are struggling with surplus produce due to the sudden drop in demand by the food service sector (hotels, restaurants, schools, and stadiums), which pre-COVID-19 accounted for roughly

55% of all food sales. Full Harvest is uniquely positioned to assist growers in finding commercial customers that are looking to purchase produce. With the food service sector unlikely to recover in 2020, Full Harvest has an opportunity to rapidly grow its business by becoming the marketplace for connecting growers with food, beverage, and pet food producers. For an ag sector that is just starting to embrace IT, Full Harvest has the chance to assume a role similar to Amazon or eBay in connecting buyers and sellers globally. The result will be a more efficient produce market, which decreases transaction costs and puts more funds in the growers' wallets.

Other companies, including Imperfect Foods, sell directly to consumers, many of whom are less concerned about the look of this produce, either due to its lower costs or their interest in helping to minimize food waste. Imperfect Foods was founded in 2015 with a mission to eliminate food waste and build a better food system for everyone. Like Beyond Meat and Impossible Foods, Imperfect Foods has implemented a business-to-consumer (B-to-C) sales model, differentiating itself from other food waste mitigation technologies that are business-to-business (B-to-B). The B-to-C sales model will help Imperfect Foods benefit from the sustainability trend, as more consumers choose to support directly, innovative companies that can help save the planet. The desire to eat in a more sustainable way is also behind the rapid growth in sales of alternative proteins, as consumers look to eat less meat, which is a significant driver of greenhouse gas emissions. At the same time, COVID-19 has led more families to switch to grocery delivery services to avoid having to visit supermarkets. Consequently, Imperfect Foods is poised to take advantage of two significant trends: sustainability and grocery delivery.

As a sign of investor interest in the food waste sector, Imperfect Foods recently closed a \$72 million Series C funding round to help finance its expansion plans and mission to reach more customers with affordable and fresh groceries. The financing round was led by Insight Partners and supported by existing investors, including Series B lead Norwest Venture Partners. These funds will enable the expansion of its grocery delivery service across the US, increase capacity in new and existing fulfillment centers and expand its product offerings.

A Global Problem

More than 820 million people around the world deal with food insecurity, according to the United Nations' Food and Agriculture Organization. Yet each year, \$2.6 trillion worth of food is wasted both by consumers and producers. The global problem of food waste is starting to receive the recognition

needed to solve this issue: Apeel and Full Harvest were both selected as World Economic Forum (WEF) Technology Pioneers, the former in 2018 and the latter in 2019. Their selection is a significant honor and acknowledgement of the game-changing technology they have developed, putting them in the same category as previous WEF Technology Pioneers Airbnb, Google, Kickstarter, Mozilla, Spotify, and Twitter.

Over the last five decades, the industrialization of agriculture has enabled farmers to implement production efficiencies to drive down food costs. Today, U.S. consumers spend over 40% less of their disposable personal income on food than they did 55 years ago.² As food costs have declined, consumers have become less concerned about food waste. At the same time, according to the US Center for Disease Control, food portion sizes at restaurants have more than doubled since 1950. Larger portion sizes have had a terrible health impact, causing the average male to weigh 28 pounds more, and the average female 24.5 pounds more, than their counterparts 50 years ago. Needless to say, these larger portions have also led to increased food waste, evident by the fact that restaurants contribute 40% of food by weight that ends up in landfills according to ReFED, a nonprofit committed to reducing US food waste. Even in cases where consumers bring home leftovers, much of that won't be consumed and still ends up getting thrown away. As a result, today, 52 million tons of food in the US is sent to landfills, accounting for over 20% of landfill volume. To put it another way, the National Resources Defense Council estimates that a US family of four wastes an average \$1,800-worth of food each year, accounting for most of the spending on food that is wasted.

Like many of the largest problems facing society today, such as COVID-19 and climate change, food waste mitigation can only be solved by the global community coming together. In the case of food waste, all key stakeholders, from farmers to distributors and retailers to consumers, must do their part to address this problem. Only once all parties better understand the role they play in causing food waste, and how implementing technology solutions and education about portion size reduction can lead to better health for consumers, economic benefits for farmers and consumers, and a positive environmental impact, will society be able to make a material impact on this problem.

Despite the fact that we have a long way to go to significantly reduce food waste, I remain optimistic that companies, like those featured in this article, as well as companies working in ag biotech, automation & robotics, digital ag, indoor farming, and supply chain technologies will deliver innovative

² USDA Economic Research Service, Food Expenditure Series, October 24, 2018.

technology and business models that can be applied throughout the food & ag supply chain. The challenges are clear: the global population is expected to reach over 9 billion by 2050; farmers face increasingly strict regulations over use of water, crop nutrients and energy at the same time that arable land used for food production continues to decline; and the impact of climate change on food production is becoming more pronounced. Society is going to need to figure out how to use current resources more efficiently to feed the world. As this article makes clear, reducing food waste looks to be the easiest and most effective solution.