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JOSE ALVAREZ
RYAN JOHNSON

FreshTec: Revolutionizing Fresh Produce

It's great to make money, but what are you really doing? We haven't won until we've made a poor farmer part of the middle class.

— Bob Wright, CEO, FreshTec

In September 2010, Bob Wright, CEO of FreshTec, examined the slices of mango that had just been placed on the conference room table. Wright, a longtime produce industry executive, had been recently hired as FreshTec's first CEO and had flown to Pismo Beach, California, for a week of meetings with FreshTec owners and founders Craig Machado and his son Christian and their newly assembled team. Machado, also an industry veteran, was passionate about FreshTec and the potential impact its patented technology could have. Machado had enlisted Wright to develop a plan to bring FreshTec's technology to market in a way that not only ensured profitability but also brought change to the fresh produce industry, which saw significant annual postharvest losses, failed to offer truly ripe and good-tasting fruits and vegetables, and faced mounting food safety challenges.

FreshTec had developed a unique packaging technology named SmartPac, which evolved from Machado's attempts to address the waste and taste issues that reduced the efficiency and productivity of the global fresh produce market. By pairing a uniquely designed plastic lid with a patented liner board membrane outside a customized corrugated produce box, SmartPac created a modified atmosphere package that significantly extended the life of fresh produce, potentially allowing produce to be picked ripe and shipped throughout the world without fear of spoilage or damage. Furthermore, the packaging included unique temperature control and food safety innovations. Machado felt that the packaging could serve larger goals as well, empowering growers in developing countries to export their produce around the world and bringing additional business and employment to less developed regions.

After six years of perfecting the technology and working to assemble the right management team needed to bring SmartPac to market, Wright and Machado considered their options. (See **Exhibit 1** for biographies of key FreshTec executives.) Until the company had a substantial source of funding and was producing revenue, Wright and his team would work without salaries. The largest obstacle Wright saw to SmartPac's market adoption was its high price—a SmartPac box cost about twice as much as a standard box. How could FreshTec convince the players in the industry to purchase a box that was double the price of a traditional box? Who was the best target for this sales pitch? Furthermore, how could FreshTec best influence growers to change their picking philosophy, which would mean picking produce ripe, to take advantage of the technology? Finally, how could a social mission not only fit in with FreshTec's rollout of SmartPac but also affect growth and define growth options?

Senior Lecturer Jose Alvarez and Research Associate Ryan Johnson of the Global Research Group prepared this case. HBS cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective management.

The Fresh Produce Senescence Problem[1]

From the moment a fruit or vegetable was harvested from its parent plant, it underwent a process of aging and eventual decay known as senescence. Senescence was marked by two main activities: respiration and transpiration.

During normal respiration, plants converted oxygen and carbohydrates (acids and sugars) into water, carbon dioxide, and heat—all three of which were emitted from the plant. The mother plant replaced used carbohydrates in the produce (fruits or vegetables) still connected to it; once the produce was harvested, of course, those nutrients could not be replaced. Respiration continued post-harvest until the sugars stored in the produce no longer sustained it; after that, the produce broke down and lost quality.

Transpiration was the process of losing water. Most produce contained 80% to 95% water at harvest; however, as with respiration, the mother plant could not replace lost water post-harvest. As fruits and vegetables lost water, they lost weight, cell structure, firmness, and appearance—in other words, they began to shrivel and decay. After a water loss of 5% to 10%, produce wilted, shrank, and became unusable and unsalable.

Players in the fresh produce global supply chain were always in a race against senescence. While the rate of senescence varied from product to product, its onset was immediate after harvest and rarely allowed more than two weeks to deliver a product from farm to fork.

Growers harvested most fruits intended for export or a significant journey (e.g., California to Boston) well before they ripened naturally. For example, tomatoes and bananas were typically harvested when they were still completely green. Early harvesting deprived the fruit of its natural ripening process and had a negative effect on the taste, nutritional value, and quality.

If growers could slow or halt the senescence rate of produce in a safe, sustainable way without altering taste or appearance, then they could significantly change their shipping methods, shipment timing, and geographical reach. They could, for example, choose slower and more affordable transportation methods than those currently in use.

Post Harvest Loss[2]

The loss of fruit post harvest was a pervasive issue throughout the globe. Estimates put postharvest losses at around 25% worldwide and up to 50% in developing countries, which lacked infrastructure to carefully harvest, handle, and transport fruits and vegetables.[3]

Already battling the natural process of senescence, growers faced additional complicating factors that made the fresh produce global supply chain even more precarious and led to a large waste problem that was prevalent throughout the globe.

Physical Injury

Due to its high water content and typically soft texture, fresh produce was extremely susceptible to physical injury. Physical injury could occur during almost all steps of the supply chain, from harvest to delivery. During shipping, it could occur from packing fruits or vegetables in damaged or splintered boxes or crates, from overpacking boxes, and from dropping, throwing, or walking over containers. Injuries to the produce such as scrapes, cuts, or bruising (both internal and external) not only created entry points for bacteria and mold but also sped up the senescence process (both respiration and transpiration).

Temperature Injury

Postharvest fruits and vegetables were susceptible to injury from both cold and hot temperature extremes. While temperature tolerance varied across types of produce, nearly all produce saw significant effects, such as rapid decay, from exposure to freezing temperatures as well as to high temperatures. If exposed to high temperatures and not cooled down, produce became unusable. A successful effort to cool produce after a simple exposure to high temperature often kept the produce in a salable state.

Disease

Disease in postharvest produce was most commonly caused by fungi and bacteria. Disease was spread by microscopic spores and was often not visible to the grower, packer, shipper, or retailer. While disease entered produce most easily through cuts or scrapes in the skin, an undamaged product could be infected through its lenticels or through the stem or calyx cavities. Infection could happen at nearly any point during the harvesting, packing, and delivering process with the use of contaminated or improper equipment or handling techniques. Typically, modernized industrial packinghouses used fungicide and washing operations for fresh produce before it was shipped to its destination.

The Fresh Produce Supply Chain

Fresh produce was grown in many locations worldwide. However, certain areas proved more economically viable than others for large-scale production due to the length of growing seasons, the availability of labor, and land costs. China, the European Union, India, Brazil, the United States, Mexico, Chile, and South Africa were the world's largest producers of fresh produce.[4] The U.S. fresh produce supply alone was valued at $113.2 billion.[5] U.S. exports of fresh fruit and vegetables totaled $5.9 billion in 2009, and imports totaled $11.7 billion; those figures translated to approximately 5% of world exports and more than 10% of world imports by value.[6] The largest private company producing fresh produce was Dole, which had developed a grower-to-retailer supply chain of its own, contracting with growers and packers and then distributing and marketing their produce to supermarkets, mass merchandisers, wholesalers, and food service operators in more than 90 countries.[7]

Growers, while often eventually supplying a larger firm, were typically independent contractors. Larger growers dominated the export and global market, while smaller growers typically looked to the domestic market for their livelihood.

Some large growers owned packinghouses; others worked closely with a packer who handled, cleaned, and packed produce before it was sent to its destination. If the packing station was not owned by the grower, it was traditionally owned and operated by a trader or broker. The trader purchased the produce from the farmer, then cleaned it, packed it, and delivered it to sellers such as supermarkets, wholesalers, and food service operators. Sometimes there was an additional link known as a commissioning agent. A commissioning agent worked either directly with a farmer or with a trader/distributor to find the best possible price for the produce and then took a fee on that price. While it was an added cost, paying for a commissioning agent was often advantageous for farmers and traders, as those agents were well connected and could find markets that were willing to pay higher prices for produce without burdening the farmer with the time and labor associated with those efforts.

Brokers often worked with numerous farms and rarely branded the farmers' products, instead aggregating similar products from many farms for large-volume shipments. Brokers typically assumed much of the risk in the selling process, commonly buying the farmer's product at harvest and navigating the delicate process of delivering produce that had not spoiled, was not diseased, and was presentable for sale. Reported margins for brokers ranged from 10% to 50%.[8]

Retailers, food service operators, and wholesalers typically owned and operated regional distribution centers where the produce was dropped off, consolidated into mixed loads, and trucked to stores in the area. This allowed retailers to control delivery to stores and ensure a steady supply of product. Supermarkets typically made a 25% to 55% gross margin on fresh produce; that margin was significantly higher than margins for other products they carried in the stores.[9] The margins varied greatly due to the perishable nature of produce and required proper timing and controls. Average loss (shrinkage) for fresh produce at the retail level was 5% to 12%. On average, produce accounted for 10% of total supermarket sales yet yielded about 20% of net profit dollars.[10] (See **Exhibit 2** for a flow chart of the global fresh produce supply chain.)

The global nature of the market allowed for the supply of fresh produce to continue throughout the year with limited to no interruption. Minor gaps in supply existed for some fruits and vegetables when there was no growing season throughout the world. (See **Exhibit 3** for examples of products that have growing-season gaps.) However, more common was a year-round supply with a noticeable drop in quality and consistency of the product during off-peak growing seasons. Growers and distributors that could consistently deliver high-quality produce during off-peak times and meet the market's constant demand held a significant advantage when selling to retailers. The nature of the Western consumer market was such that consumers expected access to produce of tremendous variety year-round.

The need to deliver consistent produce year-round was reinforced by consumer studies that highlighted taste as the number one issue on consumers' minds when purchasing produce. When surveys asked how important taste was in purchasing produce, 87% of consumers indicated it was "very important."[11] Furthermore, one of the most common consumer complaints regarding produce was "didn't taste good."[12] Consumers began to turn toward local produce during local growing seasons because they felt it offered superior taste. Issues related to the produce being picked too soon and shipped too far were identified by consumers as primary causes for poor taste in fresh produce.[13]

The year-round demand for fresh and tasty produce significantly impacted decision making around transport type and therefore cost and carbon footprint of fresh produce distribution. The cost of shipping fruit in a standard shipping box halfway across the world on a plane, often necessary to keep it fresh and salable, was very significant. Air transport also significantly increased the carbon footprint of fresh produce. Grocery chains, especially in Europe, had begun to note the carbon footprint of products in their stores in response to consumer concerns. Packaging technology that would allow global produce distribution to shift from truck and air freight to truck, train, and ship freight would help ameliorate both the cost and the carbon footprint problems raised by the year-round demand for quality produce. (See **Exhibit 4** for estimated vessel voyage times from Latin America to key ports.)

Packaging Fresh Produce[14]

Packaging for fresh produce varied by region, purpose, and personal preference. Ideally, packaging was low cost, low maintenance, strong enough to protect produce, easy to lift and maneuver, and reusable or recyclable. The ultimate goal of packaging was to help the supply chain deliver an intact, undamaged, nondiseased, salable, fresh product in an easily handled and counted container that was low in cost.

Natural materials such as bamboo, straw, or palm leaves were used as packaging in the developing world and were attractive for their low cost and reusability. However, they were unattractive to large-scale, more established production because they were awkwardly shaped, hard to clean, hard to pack for transport, and often had sharp edges that could damage produce.

Wood boxes offered a reusable and easy-to-stack shipping option but had been increasing in cost since the 1990s. Wood boxes also were heavy, which added significant shipping cost. Moreover, they carried yeast and mold spores, were difficult to clean for reuse, and were prone to splintering and thereby potentially damaging the produce.

Reusable plastic cartons were another option for packaging produce. They could be custom-designed and were strong and lightweight. However, they were expensive to produce, were attractive to thieves in developing countries for alternative uses, and required considerable logistics for use in a continuous cycle.

Corrugated cardboard boxes were the industry standard for fresh produce operations. They were affordable to manufacture in bulk; could include branding and product information on the box; could be custom-designed for size, shape, and strength; and were lightweight. However, cardboard was susceptible to moisture and could be damaged by rough handling.

Modified Atmosphere Packaging

Modified atmosphere packaging (MAP) broadly defined any type of packaging system that attempted to modify the atmosphere inside the package to extend the life and freshness of the produce. MAP was the result of an imperfect science that had risen in popularity since its success in preserving fresh-cut vegetables and salads in the 1990s. Iterations of MAP for fresh produce had focused on filling a container with a carbon-dioxide-rich gas mixture or using a bag that retained the produce's naturally produced carbon dioxide. As produce respired and removed oxygen from the air, the atmosphere reached an equilibrium that contained low levels of oxygen and high levels of carbon dioxide. At low oxygen levels, respiration and therefore aging took place at a much slower rate than at high oxygen levels. Maintaining the correct balance in the atmosphere was important because if oxygen levels dropped too low, the produce could not breathe and would die.

While all MAP options aimed to make their advantage the extended life and freshness of the product, each struggled with a multitude of issues. In the case of a package using a sealed injected atmosphere, the atmosphere could not adjust as the product respired, the produce could not be cooled by refrigeration because the package had no air holes, and the packing process required a special vacuum or gas injection process. In the case of the bag-in-a-box method, the bag constricted natural respiration and lacked sufficient circulation to be cooled by refrigeration, and the box had to be sealed by hand to avoid puncture.

Other issues—such as those linked to the packager's inability to manipulate temperature after sealing, standardization to typical produce shipping requirements, durability and strength in shipping, and scalability across different types of produce—left MAP commercially unviable without significant improvements.

History of FreshTec

Craig Machado's inspiration for FreshTec came from a long career working in a produce distribution system he saw as broken. "I spent years thinking there has got to be a simple way to solve the issues surrounding produce that boiled down to freshness, taste, bruising, spoilage, waste, and accessibility." Reflecting on his experience in nearly every step of the supply chain, Machado felt the clearest opportunity was in packaging technology.

Machado explored opportunities and designs in MAP, which was frequently used to significantly extend the life of fresh-cut produce. After meeting in the late 1990s with SunBlush (a leading packaging technology firm) to discuss liner board technology, Machado believed he could develop a functional, commercial MAP application for fresh produce. He began to brainstorm and sketch designs, and then patented and developed the first prototypes of the SmartPac box in 2003.

Later in 2003, Machado met Perry Lidster, a Canadian scientist who had worked on packaging technologies, specifically in oxidization and MAP. The two spoke about SmartPac, and Lidster quickly became interested in joining forces because he too saw the opportunity to improve the fresh produce supply chain. "We need to make the distribution system more efficient. Inappropriate distribution is costing the world food," Lidster explained. "We can produce enough food for everyone, but we can't get it to them. Even here in North America, up to 50% of produce is lost."

Lidster brought to the team an impressive résumé and extensive experience working on fresh-cut fruit oxidization and modified atmosphere packaging. Lidster used his lab in Vancouver to help Machado determine the atmospheric balance for each variety of produce and to bring scientific credibility to the young company.

With Lidster focused on atmospheric balance inside the box, Machado and his son focused on the industrial design of the SmartPac package. In doing so, Machado lived with the realization that it would not be easy to change the industry. "My main goal was making something that required the least amount of change from the packing sheds, from the distributors, to create something that fit into the existing system. That's why we used standard boxes," he explained. In fact, he added, "standardize standardize standardize" was a mantra during the development of the technology. In July 2004, he officially formed FreshTec LLC.

By the beginning of 2005, Machado had created a second-generation prototype that was ready for testing. This second prototype included a MAP system and added thermodynamic efficiency, or the ability to cool the contents in the box rapidly, provided by a uniquely designed and patented lid. While initial feedback on the prototype was strong—Machado having run successful experiments shipping broccoli from California to Japan and peaches and nectarines from Chile to California—concerns existed about possible mold and bacteria buildup.

In late July 2005, the momentum behind the company slowed as Machado weathered the loss of his wife and other close family members and took time to attend to his personal life. Lidster meanwhile remained focused on the science and technology, working to perfect the atmospheric balance for various fruits and vegetables and reacquiring the patent for the liner board technology from his research partner, the University of British Columbia.

By late 2007, Machado and his son were reinvigorated and began to solidify the young company's mission and move toward growth. In early 2008, Machado and his son formed a partnership with a local California cherry grower to develop a SmartPac system for fresh sweet cherries. Through this partnership and other tests, Machado reinforced his belief that a solid antimicrobial and food safety solution was needed.

In March 2008, Machado and Lidster resumed their collaboration and agreed that a way to control the growth of mold and bacteria inside the box was necessary for widespread adoption of the technology. Simultaneously they looked to create a solution that would address additional food safety concerns such as disease, infection, and insect infestation, an issue of rising importance and focus in the produce industry. (See **Exhibit 5** for fruits and vegetables of concern and corresponding hazards.) After 18 months of brainstorming and multiple redesigns Machado and Lidster reached a food safety solution that addressed the issue and would not be subject to any regulatory restrictions. "With the sanitation solution in place, we felt we had moved through the embryonic technology stage [and] had the product we envisioned from the start." By September 2010, FreshTec had developed 5 carton designs and 10 product-specific applications. The SmartPac technology was ready for market.

The Technology

FreshTec's MAP technology was not unique as a stand-alone product. SmartPac created the passive atmosphere similar to that created by other MAP products, but two aspects of the technology, both patented, set it apart: First, it had an effective way to exchange heat from the box that complied with industry pressurized cooling and also allowed cooling of sealed contents through simple refrigeration. Second, it had a natural oxidation sanitization system that cleaned and sterilized the produce while in transit. (See **Exhibit 6** for list of patents protecting SmartPac technology.)

Passive MAP

When carbon dioxide was emitted from fruits and vegetables in the natural senescence process, the SmartPac patented liner board membrane and patented system captured it, gradually decreasing the oxygen content in the carton. (See **Exhibits 7** and **8** for a diagram of the membranes and photos of the lid and box.) The atmosphere in a SmartPac box, customized to the specific fruit or vegetable packed inside, prevented the ripening and softening of produce tissue and maintained the structure of produce cell walls. By maintaining the strength of tissue and cells, spoilage was vastly reduced, microbial growth was limited, and ripening was slowed. The effect of the atmosphere inside the SmartPac box was, in a sense, "putting the fruit to sleep," allowing it to ripen up to 10 times slower than if it were on a tree or vine. The lid and membrane also created a high-humidity atmosphere and conserved the water content of the fruit, keeping weight and appearance consistent. A passive MAP system extended the life of fresh produce, made it possible for produce to be picked ripe, and delivered to the consumer with improved flavor and quality by cheaper modes of transport (e.g., ship vs. airfreight and rail vs. truck) while maintaining better food security, safety, and traceability.

Thermodynamic Efficiency

Traditional cardboard produce cartons contained air holes to allow refrigerated air to pass through them, thereby keeping the product cool or bringing it down to the desired temperature. MAP systems traditionally struggled with cooling efforts because the box needed to remain sealed in order to maintain the equilibrium and slow down the ripening process. The patented SmartPac lids were designed with four raised corners and a depressed center. The corners supported the weight of the cartons stacked on top and created a three-quarter-inch gap through which air could pass over a long, flat surface and cool the contents in the box. This design allowed for three major benefits. The first was compliance with standard cooling practices that allowed produce to be packed warm and then pressure-cooled; this was achieved in a sealed environment that kept out airborne infections. Second, pressurization was not necessary to cool the product, which allowed for a simple refrigerated environment to bring produce to the desired temperature. And finally, the impact of variation in temperature had fewer deleterious effects during the delivery process.

Active MAP for Food Safety

SmartPac included a natural oxidation system that brought a unique food safety solution into traditional MAP systems. For packagers plagued by issues with mold growth and microbial growth in the high-humidity environment, the oxidation system served as a sanitizing system for the produce. The lid in the SmartPac system was designed with a central compartment that held sachets containing dry oxidizers (a chemical mix that was approved by the U.S. Food and Drug Administration). The sachets were activated by the humidity created in the box and released a gas that covered the produce. The placement of the sachets ensured that the gas would cover the produce but that the dry oxidizer in the sachets would never have direct contact with the produce. The built-in sanitization system eliminated mold; reduced high-risk pathogens such as *E. coli*, salmonella, and listeria; and eliminated microbial activity, allowing for a slower ripening and decomposition process. The FreshTec team was also working on a solution that killed some insects, allowing for possible avoidance of costly and time-consuming fumigation processes. (**Exhibit 9** compares SmartPac technology and traditional shipping boxes.)

Developing Interest in FreshTec

As SmartPac technology neared completion from 2008 to 2010, Machado looked to build business globally and explore opportunities in underdeveloped markets. "We knew that SmartPac would allow us to deliver fresher products to the most valuable consumer markets and open up markets that hadn't been fully developed. You have to realize that America is only 5% of the population of the world. There are masses of growing populations that are beginning to build economies that can afford and desire nutritious, good-tasting produce." Machado focused on a two-pronged sales pitch. The first prong was explaining how SmartPac would benefit the end consumer, pointing out how it would allow produce to be picked ripe and therefore be juicy, have a good texture, and have an optimum sugar-to-acid ratio and vitamin retention. The second prong pointed toward industry cost savings and benefits such as easing logistical and freight concerns, lowering the carbon footprint by allowing for flexibility in transportation options, reducing spoilage and waste, improving traceability and food safety, and allowing access to new markets. (See **Exhibit 10** for examples of sales pitches from FreshTec presentations.)

Panama

Panama was of particular interest to Machado, who first traveled to the country in November 2008. "Agriculturally the country is behind, but it has water, people, resources, no hurricanes, and two ports. It is easy to distribute out of there, easy to get in and out of, and they have a free trade agreement with Canada. With our SmartPac technology, Panama can ship the best-tasting, freshest fruit to the United States, Canada, and even to Europe without worries about it spoiling or being damaged." Machado's vision went beyond just a strategic port and agricultural opportunity, however. When he met with representatives from Panama's government in 2009, he highlighted the benefits that FreshTec could offer Panama and encouraged them to think of branding all the produce leaving Panama in a FreshTec box with a "Panama Fresh" label. He suggested a partnership with the University of Panama to study freshness technology and agricultural practices, and he highlighted the number of jobs that increased produce exports could create in Panama and how FreshTec could help grow Panama's role in the world produce market. (See **Exhibit 11** for an example page from FreshTec's presentation to Panama.)

Machado saw significant opportunity in the export of melons from Panama and elsewhere in Latin America. Because melons were heavy but cheap, it was uneconomical to air-freight fresh melons to North America. However, the SmartPac system allowed shipment of ripe melons by sea. Additionally, melons were particularly susceptible to salmonella, a concern all but eliminated by the SmartPac oxidation system.

Mexico

Nico, a newly formed Mexican produce export company based in Sinaloa, engaged Machado in early discussions about a partnership. Adolfo Clouthier, a fourth-generation member of a grower family and a director at Nico, had been interested in the SmartPac technology for a number of years. He had previously worked in the Sinaloa government, studying agricultural business trends in that region and brainstorming ideas on how to bring growers together in an informal cooperative. Having returned to the private sector, Clouthier saw value in the technology that SmartPac offered. Eager to break Sinaloan produce free from brokers and redistributors, Clouthier felt that large opportunities existed in Europe, Canada, the United States, and even Japan, where growers could receive higher prices at market than Mexican brokers were willing to pay. However, air freight to those markets was too expensive, and sending produce via ship was not feasible due to spoilage. Based on a test in February 2010, Clouthier saw how Sinaloan and other Latin American produce could reach new markets using SmartPac technology.

Southern Africa, South America, and the Netherlands

Machado saw opportunity in the flower and fresh produce markets of southern Africa and also of South America, the largest exporter of fresh-cut roses. Large growers and shippers of fresh flowers, specifically those based in the Netherlands, were interested in SmartPac for the flower industry. Not only would the SmartPac system allow flower shippers to send flowers farther over a longer period of time, but it would also address the issue of high demand during peak times like Valentine's Day and Mother's Day, which challenged growers and distributors. Such spikes and lulls in demand could be balanced out by storing flowers in SmartPac boxes until they were needed. SmartPac could extend the freshness of the flowers more effectively than traditional refrigeration could. The same companies were also interested in working with SmartPac to ship South African fruits and vegetables to Europe by boat. Many retailers in Europe were beginning to be required to mark produce shipped by air as having a large carbon footprint, noting its impact on global climate change. If the same produce could be shipped by sea and arrive in good condition, a much lower carbon footprint could be shown to the consumer.

Food Service

Machado felt that food service companies, such as large fast-food companies, would be interested in using SmartPac technology. Due to strict quality, size, ripeness, and food safety standards, fast-food restaurants would be interested in FreshTec's ability to deliver a riper product that was safer and more consistent than those shipped by traditional methods. Machado envisioned the SmartPac box serving as the restaurants' storage container for fast-food produce in their refrigerators, where they had limited space and commingled products. Additionally, the SmartPac technology offered increased food safety and true traceability, allowing for total accountability when issues arose. Machado felt confident that SmartPac could also offer food service companies a significant overall savings. (See **Exhibit 12** for a food service case study on tomatoes developed by FreshTec.)

Challenges Moving Forward

After a week of meetings and strategy discussions with Machado and the rest of the newly assembled FreshTec team, CEO Bob Wright felt confident that SmartPac technology could have a big impact. "I really believe this is a disruptive technology," he said, "but with that you have both great opportunity and great challenges." Trying to stay grounded amid Machado's boundless enthusiasm and idea generation, Wright looked to examine the main hurdles to success for FreshTec.

Who Pays?

Wright recognized that bringing a new, more expensive technology into a conservative and tradition-bound industry would be difficult. "The number one issue, and there is always one, is that it's going to cost an extra $1.00 to $1.50 a box. Who is going to pay for that extra buck? No grower is going to do it." Wright was concerned that FreshTec would become a niche product for high-end retailers that could afford to charge a premium price for produce. He felt that FreshTec needed to turn to retailers and food service providers and convince them of the benefits of the SmartPac technology. While there was some history of retailers setting packaging requirements with programs such as Orchard Ripe, such programs were rare. It would require a strong sales pitch from the FreshTec team to convince retailers that SmartPac would achieve value on two fronts: first, saving them money on previously wasted, decayed, dead, and spoiled produce, and, second, adding value by delivering fresher, riper, better-tasting produce.

Machado remained optimistic about interest in FreshTec:

> If you are reaching new markets, that couldn't be reached before, then the cost isn't going to be an issue. Who is going to pay for it? Well, some growers know that they have to do something; they see new markets, and they don't see a way to get to them. There is only one plane, and you can put four pallets a day on it—well, that doesn't work. So they have to go by vessel, but that takes 19 days. So, voilà, we are their option. Who will pay for it are people who have to have it. It's not a luxury item. Being a luxury item makes it hard; you have to go sell it. The easiest one is if you go to someone who has to have it—if they don't have the technology, they can't exist. That's why I look at Latin America and Mexico and Africa, reaching new places and old places more economically.

Implementation

Wright also saw significant challenges in bringing the SmartPac technology to scale. While the FreshTec team had seen success in small-scale trial runs, large-scale operations brought a whole new set of challenges. Wright explained:

> It's a new technology, so suppose a big food service company says, "Okay, we'll try it out." Well, then the implementation and proving it is going to be hard. You have got to prove it all

> the way from the grower to the franchise owner, and a lot can go wrong. So you've got to get the grower to pick it ripe, pack it ripe, ship it under the right conditions, distribute it right—it could be a big learning curve. When you start running truckloads versus one-off experiments, a lot of things can happen. So we almost need a partner who believes in us enough to say, "All right, I'm going to be patient while you scale up."

Wright felt that certain types of produce might be easier to start with, fruits and vegetables on which the SmartPac system had been tested thoroughly and that were typically picked ripe already, lessening the learning curve with growers. Wright said, "There will be easy commodities and more difficult ones. We see broccoli, blueberries, and Roma and round tomatoes for food service. But regardless of the commodity, we have to execute, we have to deliver."

Both Machado and Wright agreed that they would need a strategy and a substantial training team to help convince and teach growers about their technology. Wright pictured an operations team that would visit partner farmers and instruct them on the purpose of the box, show them in person what type of produce to pick, and prove to them that the box worked. "Growers aren't used to picking ripe produce; they just aren't used to it. You are going to tell them to pick at a certain stage of ripeness, and they'll pick right before it or right after it—and you'll need to tell them again and again when to pick. This is going to be very hard work."

Machado agreed that work needed to be done, but he relished the opportunity to share the technology with the farmers. He envisioned dynamic demonstration centers being set up in concentrated areas to inform growers and packers of proper techniques and methods when using the SmartPac technology. He recalled some of the preliminary field testing that had already been done: "The fun part is when the grower takes the box and is kind of skeptical and then he calls you up in 20 days and says, 'I think you've got something here.' And then they ask, 'When does it go bad?' And I just tell them, 'You tell me.'"

Options on the Table

Wright knew that there were a number of options for moving the SmartPac technology to market. Much would depend on the amount of funding the company could secure and what types of partners presented themselves, but he believed that FreshTec would benefit from having clear strategies in place for a number of scenarios. He felt pressure to quickly find an avenue toward positive cash flow and revenue production, saying, "Right now, we aren't paying any salaries and we aren't covering any rent." Furthermore, having a social mission was important to FreshTec's founder, and Wright intended on finding a way to ingrain it into FreshTec's company culture.

Partner to scale with Wright felt that ideally FreshTec would find a willing retail or food service partner, one that was large enough to supply a significant volume and that would be willing to team up on a specific item. The ideal retail partner would be interested, for example, in receiving ripe Roma tomatoes at its stores throughout 30 or 40 states. The partner would then work with its existing supply chain on implementing the SmartPac box into the system. FreshTec's main role outside of producing the box would be to support the process all the way through by educating the farmer, the packer, the distributor, and the end user.

Local farmer packing operation A second option—one that was a slower way to grow but that allowed for an easier and less stressful transition into becoming a revenue-producing company—would be for FreshTec to partner with local farmers in California. As Wright said of those farmers, "They have already got the ripe idea in their head, they have a hunger to export and make more money, and they've seen the technology and they believe in it. This is something we can supervise and support closely, much more easily. Then we build it from there."

Buy-sell A third option was for FreshTec to take the place of the broker and run a buy-sell operation. Such a scenario would require a much larger up-front investment from an investor and would involve significant logistical challenges. FreshTec would focus on countries and growers that could not reach emerging markets and look to profit from the improved economics SmartPac offered. Wright said, "What if you take the risk yourself? I'll buy the tomatoes at wholesale, supervise the packing, and then sell them to the retailer at the same price they are paying now—and they get a riper, better-tasting tomato. The loss and repack cost that they have paid before goes away, and we make a deal to share the savings. It's a great way to do it. You can build a brand around it, but it takes a lot more money, a lot more relationships, and a lot more work."

Picking the Right Option

Picking the right option, Wright knew, required answering key questions: What was the best way to break into the market? What opportunities offered the best opportunity not just in the short term but to make a lasting impact? How could he get the best value for the SmartPac technology? How could he avoid the pitfalls of rapidly scaling up? How could he sustain the social mission envisioned by Machado? How would he manage the transfer of decision-making power from Machado?

Exhibit 1 Short Biographies of Key FreshTec Executives

Bob Wright, Chief Executive Officer

Recruited from U.S. subsidiary of Tesco Plc, where he was responsible for supply chain, quality, operations, engineering, and demand planning. Built an award-winning, energy-efficient, and sustainable food-safe produce factory. Implemented a short supply chain strategy with a risk-based approach to microbiological testing and food safety. Prior experience: leadership positions at ReadyPac, Tanimura & Antle, Monterey Mushrooms, and Earthbound Farms. Hands-on experience in manufacturing, selling value-added packaged products, quality systems, engineering, and supply chain logistics/procurement.

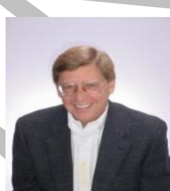
Craig Machado, Founder and Chairman

Over 40 years of experience in food industry product development, marketing, and sales. During a 20-plus-year executive career at Albertson's, he managed merchandising, marketing, and distribution of retail & wholesale grocery products. Served as VP of marketing and merchandising at Calgene Fresh, Inc., where he supervised the development, marketing, distribution, and eventual rollout of several branded product lines. As director of sales and marketing of Apio Inc., he created the source-packed party tray, employing MAP technology, which now enables Apio/Landec to dominate this market segment. Board director of a publicly owned Internet technology company.

Perry Lidster, Chief Technical Officer

Perry Lidster, PhD, Innovative Food Systems Corp. (Canada), brings 30-plus years of expertise in development of natural, safe packaging facilities and materials for fresh produce. In previous executive roles, including CEO and as lead scientist, he provided business development and commercialization support and syndicated financing for food packaging, agricultural, and forestry biotechnology companies.

David Swanson, Chief Financial Officer

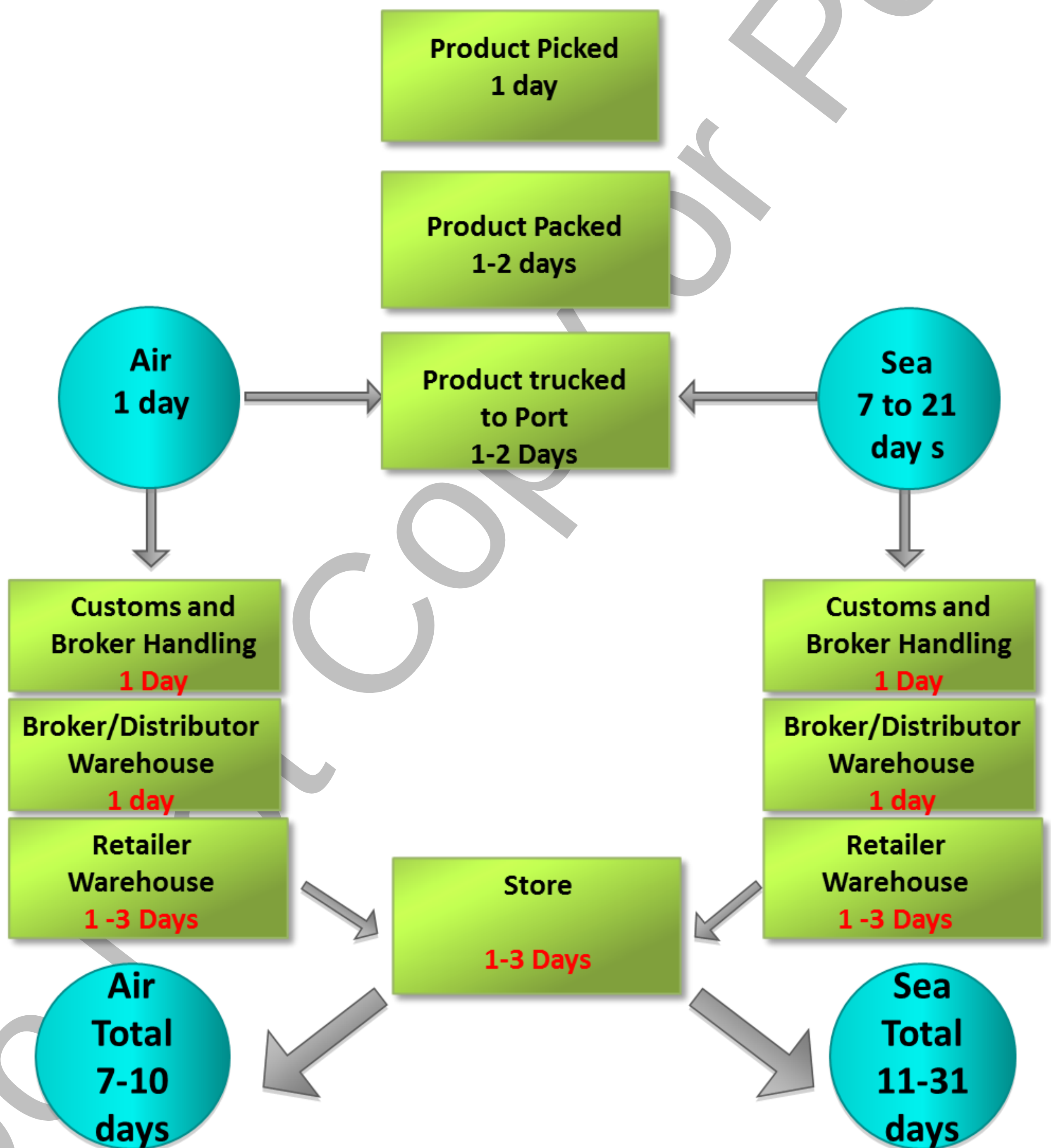


Over 25 years of senior-level financial experience. Participated in the founding of three Silicon Valley start-ups. CEO and Founder of Lithopro, an offset printing company that provided printed material to Apple, Borland, Intuit, The Learning Co., Novell, etc. CFO and cofounder of Next Generation Services, an RMA, offsite auditing, and recycling business providing services to Microsoft, IBM, etc. (sold to Zomax Optical Media). CFO and equity partner with Litec, Inc., providing systems integration, engineering, and CNC services to Lam Research, Applied Material, etc. (sold to Hillman Group).

Source: Company documents.

Exhibit 2 Example of the Global Fresh Produce Supply Chain

Example of Produce Picked in South Africa and Sent to New York

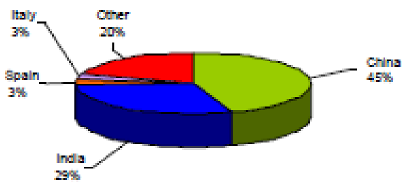


Source: Casewriter research.

Exhibit 3 Growing Gaps in Broccoli and Tomatoes

Broccoli Production

World Broccoli and Cauliflower Producton 2004



In Metric Tons	
China	7,334,500
India	4,800,000
Spain	493,600
Italy	487,391
Other	3,258,634
Total World	16,374,125

Source: Food and Agriculture Association (FAO) of the United Nations

Broccoli Availability

United States

Locations	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Arizona												
California	P	P	P	P	P	P	P	P	P	P	P	P
Texas												

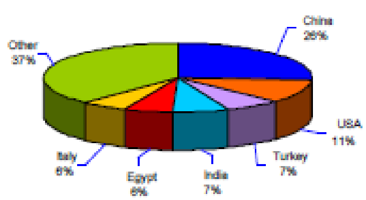
P = Peak

Competitors

Countries	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Canada												

Tomato Production

World Tomato Production 2004



In Metric Tons	
China	30,142,040
USA	12,400,000
Turkey	8,000,000
India	7,600,000
Egypt	6,780,000
Italy	6,500,000
Others	44,528,811
Total World	115,950,851

Source: Food and Agriculture Association (FAO) of the United Nations

Tomato Availability

United States

States	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
California						P	P	P	P	P		
Florida							P			P		
Michigan												
North Carolina												
South Carolina						P						
Virginia												

P= Peak

Tomatoes are available in the following types: round/globe, vine-ripe/cluster, Roma, cherry, grape, greenhouse, and hydroponic.

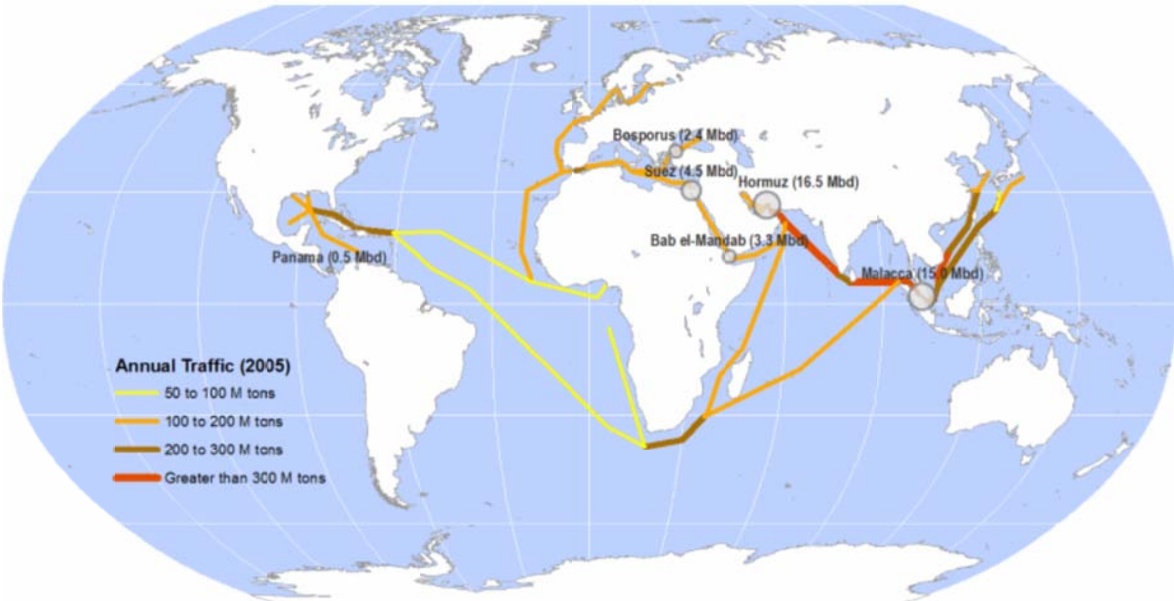
Most states grow tomatoes, but California and Florida provide about 90% of the nation's upplies.

Competitors

Countries	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Canada												
Mexico	P	P	P	P	P	P						
Europe												

Source: U.S. Fruit and Vegetable Availability and Handling Charts, August 2005, http://www.fas.usda.gov/htp/Hort_Circular/2005/09-05/Handling%20Charts.pdf, accessed October 2010.

Exhibit 4 Estimated Vessel Voyage Times from Latin America to Key Ports



Middle East	**29 + Days**
Mediterranean	**29 + Days**
Europe / UK	**15 to 16 Days**
Asia	**12 to 26 Days**
Spain	**12 to 16 Days**
Caribbean	**12 to 19 Days**
Canada	**8 to 14 Days**

Vessel Voyage Periods are not inclusive of Loading and or Discharge Days required or Delays

Source: Company documents.

Exhibit 5 Fruits and Vegetables of Concern and Corresponding Hazards

Commodity	Hazards	Reasons for ranking
Level 1 Priorities		
Leafy green vegetables (spinach, cabbage, raw watercress, lettuce and salad leaves (all varieties), fresh herbs (cilantro, basil, parsley), chicory)	Enterohaemorrhagic *Escherichia coli, Salmonella enterica* *Campylobacter* *Shigella* spp. Hepatitis A virus, Noroviruses *Cyclospora cayatenensis* *Cryptosporidium* *Yersinia pseudotuberculosis* *Listeria monocytogenes*	1. Multiple outbreaks reported in at least 3 regions of the world – including illness and deaths. 2. Grown in large production and wide and increasing consumption, especially in the pre-cut sector. 3. Expanding in countries where not traditionally grown, for nutrition reasons and as convenience food 4. Processed and distributed using very diverse systems, new to many countries. 5. Potential for amplification exists, especially for fresh cut produce, both at individual scale and small wet-market scale. 6. Complex production and distribution – multiple control points on farm to minimize potential for contamination and post-harvest to minimize cross contamination – multi-step approach needed. 7. Extensive international trade.
Level 2 Priorities		
Berries	*Cyclospora cayatenensis* *Cryptosporidium parvum* Noroviruses (frozen berries) Hepatitis A	1. Outbreaks in several regions. 2. Extensive production for some types of berries. 3. Production varies according to berry type and includes wild berry collection. 4. Limited if any amplification. 5. Humans main source ... extensively handled products. 6. International trade but certain berries frozen first (still have problems with those – viruses).
Green onions	Hepatitis A virus *Shigella* spp.	1. Outbreaks reported in one or two countries only. 2. Smaller production but increasing. Widely consumed. 3. Similar production systems in different countries, although size might vary. 4. Pathogen may be in the leaf cavity where there is potential for amplification. 5. Handling at harvest appears to be critical. 6. Internationally traded.
Melons	*Salmonella enterica* Lower priority: Enterohaemorrhagic *Escherichia coli* Norovirus	1. Outbreaks in several regions of the world. 2. Widespread production with year-round availability. 3. Similar production techniques worldwide, but may be differences in the practices to keep growing melons off ground. 4. Supports pathogen growth very well. 5. Irrigation water, water used in packing houses – hydro cooling can be a source of contamination. 6. Widespread international trade.
Sprouted seeds	*Salmonella enterica* Enterohaemorrhagic *Escherichia coli* (+ enterotoxigenic *E. coli*) *Bacillus cereus*	1. Outbreaks in a number of regions in the world. 2. Regional differences, small production units. 3. Depends on type of sprout. 4. Ample opportunity for pathogen growth. 5. Preventive controls such as pre-treatment of seeds, control of irrigation water, testing of water and seeds prior to sprouting. 6. Sprout seeds widely traded, but not the sprouts due to short shelf-life.
Tomatoes	*Salmonella enterica* Hepatitis A	1. Numerous outbreaks but only reported in USA (outbreaks including numerous illnesses and 3 deaths). 2. Very large and extensive production, but not all go to fresh consumption 3. Diverse production – field vs. glasshouse, very short to long distribution chains, variation in post-harvest practices simple to complex, especially for pre-cut tomatoes, consumption of which is increasing in some regions, e.g. North America 5. Lack of information about the source of contamination at primary production. At post-harvest, contamination probably related to cool water use. 6. Widely traded produce.

Commodity	Hazards	Reasons for ranking
Level 3 priorities		
Carrots	*Yersinia pseudotuberculosis* *Shigella* spp. Enterotoxigenic *E. coli* Caliciviruses (cut carrots) Hepatitis A Parasites	1. Outbreaks in a couple of countries. 2. Little information on production but are increasingly being marketed as a convenience ready–to-eat raw food. 3. Little known. 4. In cut carrots, increased surface area, initial lethality but the effect does not seem to be long lived. 5. Depends on pathogen, handling of prepared carrots may be issue so controls exist. For *Yersinia* more information is needed to understand control options. 6. Little information but probably relatively small, although increase in value-added ready-to-eat product.
Cucumber	*Salmonella* *E. coli* *Campylobacter*	1. This group has had one or two isolated outbreaks associated with them, some of which are very recent. 2. Global production lower but may be very important produce in particular regions of the world. 3. Very diverse group of produce—some such as seeds and nuts seeing an increase in raw consumption (may need to indicate to Codex to revise relevant codes of practice). 4. Many of the produce provide good conditions for amplification. 5. Control measures depend on produce but feasible for many. 6. Traded internationally with global supply often originating from a few production areas.
Almonds	*Salmonella*	
Baby corn	*Shigella*	
Sesame seeds	*Salmonella* *Bacillus*	
Onions and garlic	*E. coli* *Salmonella*	
Mango	*Salmonella*	
Paw paw	*Salmonella*	
Celery	Norovirus Hepatitis A	
Maimai	*Salmonella*	

Source: "Microbiological Hazards in Fresh Fruits and Vegetables," October 21, 2007, 38th Session of the Codex Committee on Food Hygiene, Food and Agriculture Organization of the United Nations, http://www.fao.org/ag/AGN/agns/files/FFV_2007_Final.pdf, accessed November 2010.

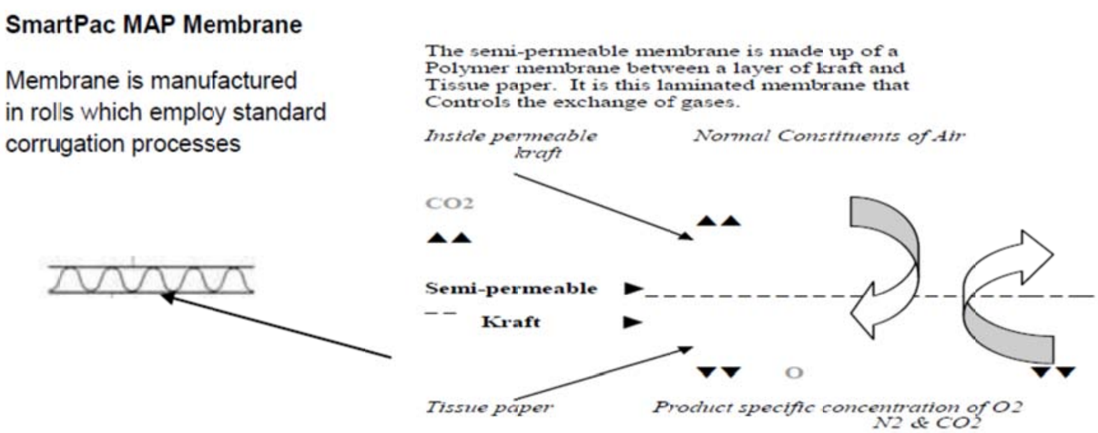
Note: There may be other hazards that are present on the produce but not (as yet) linked to outbreaks. The presence of the listed hazards on fresh produce has been directly linked to illness and these were therefore considered as the hazards of greatest concern.

Exhibit 6 SmartPac Patents and Trademarks Secured or Pending

- MAP Patent USPTO #6,880,748—Lid design for thermodynamic efficiency
- MAP Patent USPTO #7,597,240—Included corrugated linerboard technology, active MAP, industry standard sizing, stackability, transparent and antifog lid, sealing style
- US Trademark SMARTPAC #2958182
- US Trademark SPC
- Modified Atmosphere Packaging (MAP) Patent Japan
- MAP Patent Mexico #257572
- MAP Patent South Africa #2005/07478

Source: Company documents.

Exhibit 7 Diagram of SmartPac Liner Board Membrane



Source: Company documents.

Exhibit 8 Photographs of SmartPac Boxes and Lids

Source: Company documents.

Exhibit 9 Comparison of SmartPac Box and Industry Standard Shipping Carton

Comparison of Features and Benefits SmartPac™ System vs. Industry Standard Shipping Carton	SmartPac™ Container System	Industry "Standard" Carton
Serve as Shipping Container	Yes	Yes
Create Modified Atmosphere	Yes	No
Extend Life Span of Fresh Produce	Yes	No
Decrease Rate of Respiration	Yes	No
Accommodate Shipping Fruits with Increased Maturity	Yes	No
Reduce Logistical Cost and Carbon Foot Prints	Yes	No
Retain Moisture in Product	Yes	No
Reduce Weight Loss	Yes	No
Retain Texture	Yes	No
Ripening		
Provide Optimum Ripening Environment	Yes	No
Extend Life Span of Ripened Fruits	Yes	No
Use of Ice		
Required for Broccoli, Green Onions, Corn, Radishes, Sprouts Etc.	No	Yes
Eliminates Cost of Shipping "dead weigh"	Yes	No
Eliminates Melt and Water Issues	Yes	No
Protect Product from Post Pack Contamination		
Microbes and Bacteria	Yes	No
Pathogens	Yes	No
Viruses	Yes	No
Bio Terrorism	Yes	No

Source: Company documents.

Exhibit 10 Key Consumer and Industry Benefits and Positioning

Fruits

Ripe Always—"ripened and suspended in a ripe, ready-to-consumer state"

Improved Eating Experience—"juicier, better texture, sugar retention "

- **Pears, Avocados, Stone Fruit, Mangoes, Papayas, Kiwi, Bananas, Tomatoes**

Vegetables

Fresh Always—"suspended, just-picked state"

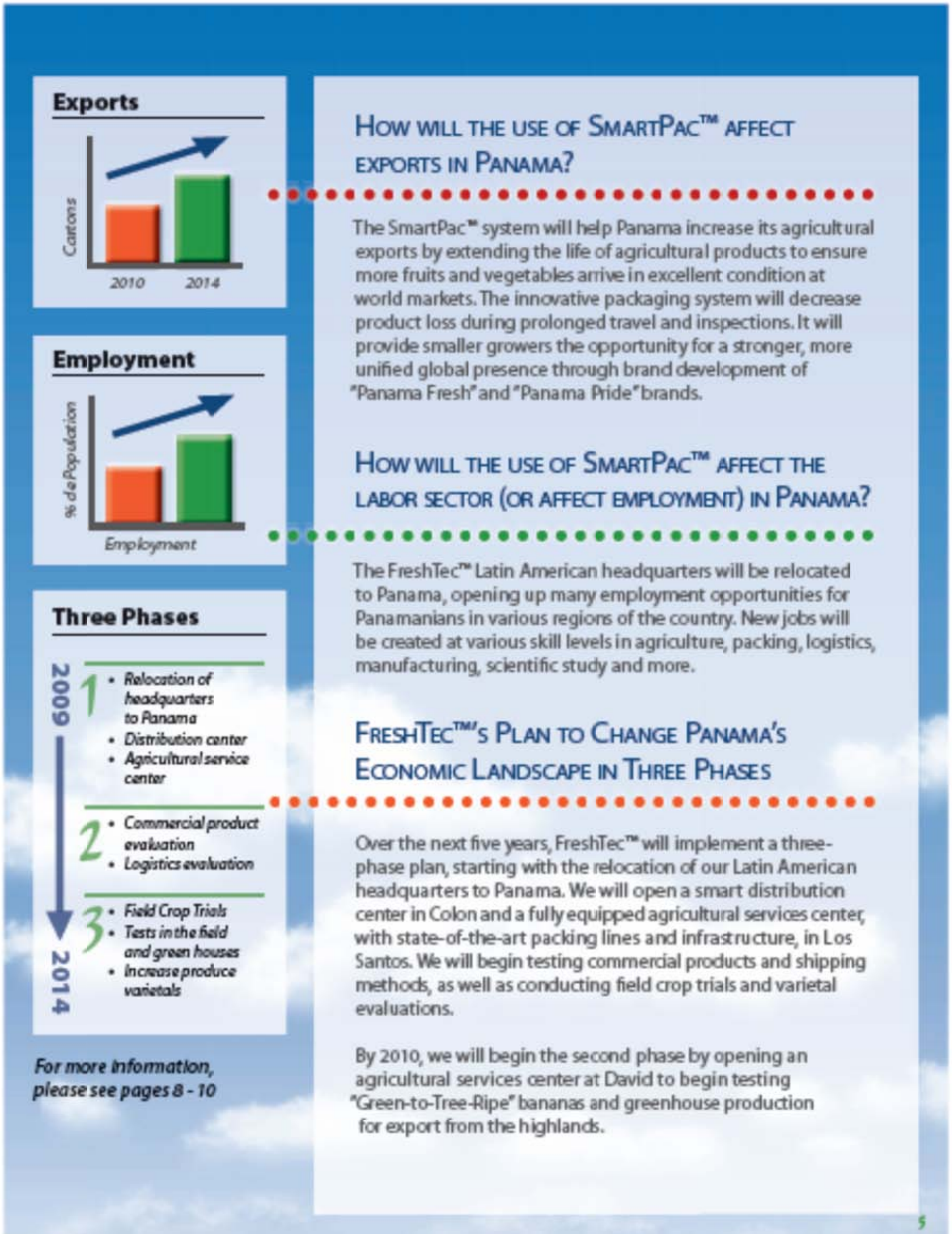
- **Improved eye appeal, buy appeal**
- **Retained . . . flavor, texture, moisture content, nutritional benefits**

Key Industry Benefits & Positioning

- **Increased Sales**
  - **Meet Consumer Expectations**
  - **More Product through the Retail Check Out**
- **Increased Consumption > Increased Purchases / Repeat Purchase**
- **Premiums Earned for Added Value**
- **Improved Logistics and Freight Savings**
- **Improved Food and Bio-Terrorism Safety Accountability**
- **Enhanced Ability to Market Crop to Meet Demand**
- **Support Contract Pricing**
- **Access to New and Distant Markets**
- **Reduced Loss from Failed Products and Delivery**

Source: Adapted by casewriter from company documents.

Exhibit 11 Sample Page from FreshTec Presentation to Panamanian Government



Source: Company documents.

Exhibit 12 SmartPac: Food Service Tomato Case Study

Cost Breakdown; per case food service tomatoes	current practice	SmartPac Costs
Carton	$0.85	$0.50
SPM membrane	$0.00	$0.30
SmartPac Lid	$0.00	$0.35
Tape and Sealing	$0.00	$0.06
Microbial System	$0.00	$0.26
FreshTec Margin		$0.50
FreshTec Royalty (to be determined)		
total cost to packer	**$0.85**	**$1.97**
delta; increased packing costs with SmartPac		$1.12
Benefits' savings over current practices;		
Repack at distributor is eliminated	$3.00	$0.00
Yield loss from repack savings (15%)	$1.50	$0.00
Loads rejected by customer reduced (2%)	$0.20	$0.00
End user yields will improve (10%)	$2.00	$0.00
Food safety risk reduction value		not quantified
Food security improvement value		not quantified
Total packaging and loss costs per case	**$7.55**	**$1.97**
Net SmartPac savings per case to supply chain		**$5.58**
Net Savings as % of sales price		**28.00%**
Data		
case sell at farm gate	$10.00	
Freight	$1.80	
total cost	$11.80	
Repack	$3.00	
sell to user	$20.00	

Source: Company documents.

Endnotes

[1] Food and Agriculture Organization (FAO) of the United Nations, "Prevention of Post-Harvest Food Losses: Fruits, Vegetables and Root Crops," training manual (Rome: FAO, 1989), http://www.fao.org/docrep/t0073e/T0073E00.htm#Contents, accessed October 2010.

[2] FAO, "Prevention of Post-Harvest Food Losses."

[3] FAO, "Prevention of Post-Harvest Food Losses."

[4] U.S. Department of Agriculture (USDA), "The World Fresh Fruit Market," http://www.fas.usda.gov/htp/hort_circular/2006/02-06/world%20fresh%20fruit%20market%202004.pdf, accessed October 2010.

[5] USDA, "The World Fresh Fruit Market."

[6] Fruitnet.com, "US Agricultural Exports Up on 2009," June 2, 2010, http://www.fruitnet.com/content.aspx?cid=6996, accessed October 2010.

[7] Hoover's, Inc., "Dole Company Background," http://www.hoovers.com, accessed October 2010.

[8] FAO, "Prevention of Post-Harvest Food Losses."

[9] U.S. Department of Agriculture (USDA), Economic Research Service, "Food Cost Review 1950–97," http://www.ers.usda.gov/publications/aer780/aer780c.pdf, accessed October 2010.

[10] USDA, Economic Research Service, "Food Cost Review 1950–97."

[11] Roberta Cook, "Growing Fresh Produce Use in Foodservice: Challenges, Opportunities, Strategies," June 2008, University of California–Davis website, http://postharvest.ucdavis.edu/datastorefiles/234-1156.pdf, accessed November 2010.

[12] Cook, "Growing Fresh Produce Use in Foodservice."

[13] Lee Mannering, "In sharing summer's bounty, taste is everything," September 2, 2010, post on blog "From Field to Fork," Produce Marketing Association, http://fieldtofork.pma.com/?p=1496, accessed November 2010.

[14] FAO, "Prevention of Post-Harvest Food Losses."