

FRESH Ag-Tech: The Blueprint to Food and Nutrition Security that Finally Brought Prosperity to Haiti

Haiti's Food Insecurity Problem

Along Hispaniola's gently-sloping southern coast lies Haiti's FRESH paradise of Lekol-la-fre (2168 population: 98,765). Lekol-la-fre, which means 'fresh town' in Haitian Creole, is west of historic Jacmel. Its brilliant agricultural engineers developed a sustainable urban food production system that healed Haiti's hunger.



Despite plentiful rainfall and an ideal farming climate, Haitians suffered from food insecurity. In the 2000's, Haiti was the western hemisphere's poorest and second most-crowded country. Deforestation destroyed lush rainforests, causing extreme topsoil erosion and coral reef destruction. Tropical storms produced massive landslides, and seismic activity caused worry, especially after the 2010 earthquake destroyed 60% of Jacmel. Haiti's Global Hunger Index (GHI), which measures a country's ability to feed its population, was the third-highest globally. Haiti was a nation in peril.

Haiti Needed Help

Food insecurity was desperate, especially in crowded urban centers. A new food production system was needed. Jacmel's engineers took on the challenge and developed FRESH Ag-Tech, a blueprint to food security that considers the entire agricultural 'foodprint.' The Grand River's once-fertile watershed was devoted to its implementation. With guidance from a team of engineers, Jacmel's sister-city, Lekol-la-fre, blossomed and grew. The rest, as they say, is history!

A FRESH Solution

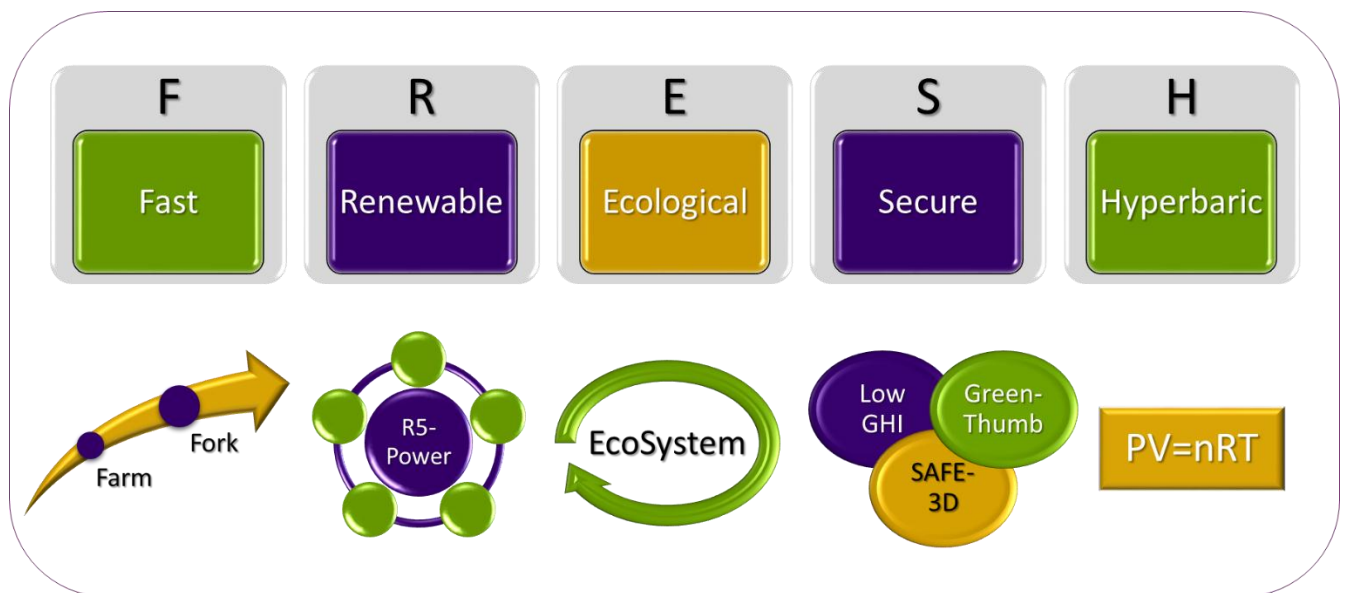
Red beans (a vegetable protein) and rice were staples in the 2000's. Haitians, however, enjoyed scarce meat proteins. Before the mid-1980's African swine flu epidemic, pork was favored. Afterward, chicken was a rare treat. Low-fat chicken is well-suited to Haiti's environment and terrain and is high in protein and niacin. Dual-purpose birds, which mature in 8-10 weeks, provide both meat and eggs, while diverse breeds insure sustainability.

Sweet potatoes are native to the Caribbean and popular in Haiti. The root vegetables mature in 8-12 weeks and have a 12-month shelf life when cured. They are high in carbohydrates, fiber, Vitamins A and C, and potassium. Planting several varieties, and rotating with crops such as red beans, assures soil sustainability.

Agricultural engineers maintained resources to supply both chicken and sweet potatoes for Lekol-la-fre's citizens for 4 meals/week (4 servings/chicken and 12 potatoes/plant). To achieve this, FRESH required sustained maintenance of 1,000,000 chickens and 350,000 sweet potato plants.

Technology and Infrastructure

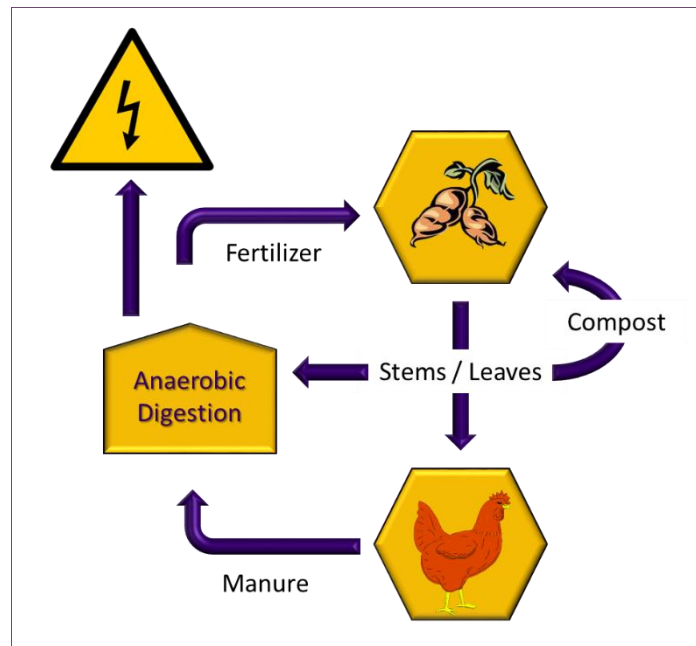
FRESH Ag-Tech is an intersection between sustainable food production and energy self-sufficiency. It is based on AgriTectureTower infrastructure and Waste-to-Energy power systems. FRESH is Fast, Renewable, Ecological, Secure, and Hyperbaric:



FRESH is FAST from farm to fork, since the farm is in Lekol-la-fre! Local production lessens refrigeration needs and reduced transportation costs means more affordable food. HydroHyperLoop moves people and cargo, including food and water, throughout Lekol-la-fre and beyond.

FRESH is RENEWABLE. R5-Power provides Reliable, Revenue from Robust, Redundant, and Renewable energy sources. Osmotic, piezoelectric, wind, and space-based solar energy are harvested. Waste-to-Energy biogas is also generated below AgriTectureTowers. Chicken and vegetable waste is anaerobically digested to produce electrical and thermal power!

Waste-to-Energy is part of FRESH's ECOLOGICAL closed-loop ecosystem. Manure is converted to energy and fertilizes loamy soil that grows sweet potatoes. Soil is enhanced by composted vegetable stems and leaves, which are also a major food source for the chickens.







High GHI levels are history since FRESH is SECURE. SAFE-3D infrastructure, which is based on 3D-printed, graphene and biopolymer-based Seismic Activity Foundation Enhancement, improves structural stability and eliminates earthquake concerns. Triple-redundant IntelliTrellis controls and GreenThumb holographic communicators also provide utility and communication security.

Finally, FRESH is HYPERBARIC. At constant volume and temperature, the Ideal Gas Law ($PV=nRT$) shows that increased pressure allows for increased oxygen. Due to higher than atmospheric oxygen concentrations, Hyperbaric AgriTectureTower environments increase crop yields, and livestock stay healthier!

Key Elements

Chicken and sweet potatoes are well-suited to Haiti’s climate. Their selection considered water, air quality, space, feed/soil nutrients, and energy requirements. Light-filtering, active-membrane walls and magenta LED’s provide plentiful light to AgriTectureTower growing environments.

Inputs to produce one kilogram of the meat proteins considered for FRESH are provided below. Sweet potato inputs are also shown.

Food Source	Water (liters)	Air Quality (kg-CO ₂)	Space (m ²)	Feed / Nutrients (kg)	Energy (kW-hr/kg)
Beef 	15,500	27	192	46	32
Pork 	4,800	12	100	21	14
Chicken 	3,900	7	64	12	4
Sweet Potato 	1,000	3	4	2	< 1

FRESH is Energy Efficient

As indicated above, chicken production is 8-times more energy efficient than beef. AgriTectureTower Waste-to-Energy biogas systems convert 750 annual tons of waste from sustained maintenance of 1,000,000 chickens to 100 MW-hr electricity. This is enough to power Lekol-la-fre’s homes and businesses. A revenue stream is created from an additional 100 MW-hr produced from other renewable sources.

Benefits, Risks and Tradeoffs

Due to FRESH, Lekol-la-fre is a leader in life expectancy. Residents enjoy abundant supplies of nutritious food. Additional benefits include secure, diverse employment and world-class educational opportunities.

Sustainability risks were eliminated through varied chicken breeds and multiple sweet potato strains. Climate-controlled, weather-independent AgriTectureTowers eliminate chemical herbicide and pesticide needs. Waste-to-Energy systems prevent runoff issues. SAFE-3D also insures stability of infrastructure during earthquakes.

Tradeoffs during FRESH's implementation were few. Maintenance and funding cost concerns from Lekol-la-freians were addressed by presenting long-term benefits:

- Better nutrition and environmental conditions improved overall health.
- FRESH paid for itself within 18 months due to revenue from surplus R5-Power production.
- Besides chicken and sweet potatoes, FRESH produces other meat proteins and vegetables, including vegetarian-friendly proteins.

Engineers Made FRESH Work

- Architectural engineers developed Hyperbaric AgriTectureTowers.
- Civil engineers implemented the system on time and within budget.
- Biological engineers insured livestock well-being.
- Controls engineers developed IntelliTrellis control systems and GreenThumb communicators.
- Electrical engineers developed R5-Power sources.
- Transportation engineers created HydroHyperLoop transport.

Agricultural and bioenergy engineers were most crucial to implementing Haiti's food security solution. Agricultural engineers developed FRESH Ag-Tech, a blueprint to sustainable urban food production. Using a closed-loop ecosystem, bioenergy engineers created renewable energy from agricultural waste to power Haiti's future.

FRESH Ag-Tech: implemented by exceptional engineers to feed your world!

Text without Title: 926 Words 4 Graphics: $11 + 15 + 7 + 39 = 72$ Words Total: $926 + 72 = 998$ Words

References

- "2012 Global Hunger Index." *International Food Policy Research Institute (IFPRI)*. N.p., 11 Oct. 2012. Web. 25 Nov. 2014. <<http://www.ifpri.org/ghi/2012>>.
- "2013 Global Hunger Index – Country Case Study: Haiti." *International Food Policy Research Institute*. N.p., 10 Oct. 2013. Web. 05 Nov. 2014. <<http://www.ifpri.org/publication/2013-global-hunger-index-country-case-study-haiti>>
- "3D City Farms: 5 Urban Design Proposals for Green Towers." *WebUrbanist*. N.p., n.d. Web. 05 Nov. 2014. <<http://weburbanist.com/2008/03/30/5-urban-design-proposals-for-3d-city-farms-sustainable-ecological-and-agricultural-skyscrapers/>>
- Addison, Keith. "City Farms." *Journey to Forever*. N.p., n.d. Web. 05 Nov. 2014. <<http://journeytoforever.org/cityfarm.html>>
- Alter, Lloyd. "Energy Required to Produce a Pound of Food." *TreeHugger*. MNN Holding Company, LLC. 02 Mar. 2010. Web. 06 Nov. 2014. <<http://www.treehugger.com/green-food/energy-required-to-produce-a-pound-of-food.html>>
- "Behind Haiti's Hunger." *Ayiti Kale Je - Haiti Grassroots Watch - Haiti Veedor - 36_3_eng*. 10 Oct. 2013. Web. 05 Nov. 2014. <<http://haitigrassrootswatch.squarespace.com/haiti-grassroots-watch-engli/2013/10/8/behind-haitis-hunger.html>>
- Bilton, Peter. "Salicornia or Glasswort: Its Nutrition and Gastronomical Uses." *All Articles RSS*. N.p., n.d. Web. 25 Nov. 2014. <<https://food-nutrition.knoji.com/salicornia-or-glasswort-its-nutrition-and-gastronomical-uses/>>.
- Butz, Stephen, *Energy and Agriculture: Science, Environment, and Solutions*, Independence, KY: Cengage Learning. 2014. Print.
- "Calculating the Carbon Footprint." *Materials Today* 11.3 (2008): 61. *Carbon Footprint*. University of Michigan. Web. 06 Nov. 2014. <http://css.snre.umich.edu/css_doc/CSS09-05.pdf>
- Casey, Tina. "Giant Solar Battery Made Of Salt (Almost) Ready To Charge Up." *CleanTechnica*. N.p., 14 Feb. 2014. Web. 05 Nov. 2014. <<http://cleantechnica.com/2014/02/14/crescent-dunes-ready-to-charge-up-solar-salt-battery/>>
- Casey, Tina. "New 3D-Printed Battery Packs Graphene Punch." *CleanTechnica*. 25 Oct. 2014. N.p., Web. 25 Nov. 2014. <<http://cleantechnica.com/2014/10/25/new-3d-printed-battery-packs-graphene-punch/>>.
- "Chicken Manure – Frye Poultry." *Coaltec Energy*, N.p., n.d. Web. 05 Nov. 2014. <<http://www.coaltecenergy.com/projects/chicken-manure/>>
- Clark, Dean. "Salt Power: Norway Project Gives Osmotic Energy a Shake." *National Geographic*. National Geographic Society, 07 Jan. 2013. Web. 25 Nov. 2014. <<http://news.nationalgeographic.com/news/energy/2013/01/130107-osmotic-energy-norway/>>.
- Clay, Jayson. "Local Farms are Vital to Communities, But We Shouldn't Dismiss Larger Ones." *Guardian Professional*, N.p., 10 Feb. 2012. Web. 06 Nov. 2014. <<http://www.theguardian.com/sustainable-business/local-farmers-sustainable-food-production>>
- "Climate and Environmental Impacts." *Environmental Working Group Meat Eaters Guide: Report*. N.p., n.d. Web. 25 Nov. 2014. <<http://www.ewg.org/meateatersguide/a-meat-eaters-guide-to-climate-change-health-what-you-eat-matters/climate-and-environmental-impacts/>>.

- "Concentrating Solar Power (CSP) Technology." *Solar Energy Development Programmatic EIS*. N.p., n.d. Web. 05 Nov. 2014. <<http://solareis.anl.gov/guide/solar/csp/>>
- Fang, Janet. "Saltwater-cooled Greenhouse Grows Crops in the Sahara." *SmartPlanet*. N.p., 11 Nov. 2013. Web. 05 Nov. 2014. <<http://www.smartplanet.com/blog/bulletin/saltwater-cooled-greenhouse-grows-crops-in-the-sahara/>>
- "Feeding the Cities: Is Urban Agriculture the Future of Food Security?" *Future Directions International*, N.p., 01 Nov. 2013. Web. 05 Nov. 2014. <<http://www.futuredirections.org.au/publications/food-and-water-crises/1406-feeding-the-cities-is-urban-agriculture-the-future-of-food-security.html>>
- "Fuel from Chicken Feathers?" *Alternative Energy News*, N.p., 22 Mar. 2010. Web. 05 Nov. 2014. <<http://www.alternative-energy-news.info/fuel-from-chicken-feathers/>>
- "Graphene Supercapacitors - What Are They?" *Graphenea*. N.p., n.d. Web. 25 Nov. 2014. <<http://www.graphenea.com/pages/graphene-supercapacitors#.VHT0b9LF-So>>
- Grozdanic, Lidija. "Billboard Produces Drinkable Water from Desert Air in Peru." *Inhabit*. N.p., 17. Apr. 2014. Web. 05 Nov. 2014. <<http://inhabitat.com/roadside-billboard-produces-drinkable-water-from-desert-air-in-peru/>>
- Haddad, Lawrence. "Global Hunger Index Launch – Uncloaking Hidden Hunger?" *Development Horizons*. N.p., 14 Oct. 2014. Web. 05 Nov. 2014. <<http://www.developmenthorizons.com/2014/10/global-hunger-index-2014-uncloaking.html>>
- Henrickson, Naomi. Personal Interview with Haiti Mission Trip Participant, 04 Nov. 2014.
- Hodson, Hal. "Giant Solar Farm Uses Molten Salt to Keep Power Coming." *New Scientist*. N.p., 23 Apr. 2014. Web. 05 Nov. 2014. <<http://www.newscientist.com/article/mg22229654.100-giant-solar-farm-uses-molten-salt-to-keep-power-coming.html>>
- Hoekstra, A.Y., and Chapagain, A.K. "Globalization of Water: Sharing the Planet's Freshwater Resources." *Blackwell Publishing*. 2008. Web. 06 Nov. 2014. <<http://www.waterfootprint.org/downloads/WaterFootprintGrowingCrops.jpeg>>
- Lee, Dongjin, Jinkyu Park, and Jeongwoo Lee. "Vertical Farm." *EVolo Architecture Magazine*, N.p., 30 Mar. 2011. Web. 05 Nov. 2014. <<http://www.evolo.us/architecture/vertical-farm-2/>>
- Lott, Melissa C. "10 Calories In, 1 Calorie Out - The Energy We Spend on Food." *Plugged In*. Scientific American Blog Network, 11 Aug. 2011. Web. 05 Nov. 2014. <<http://blogs.scientificamerican.com/plugged-in/2011/08/11/10-calories-in-1-calorie-out-the-energy-we-spend-on-food/>>
- Manchon, Marta Gomez. "How Can We Face the Sustainable Food Production Challenge?" *EOI Blogs – Marta Gomez Manchon*. N.p., 28 Feb. 2014. Web. 06 Nov. 2014. <<http://www.eoi.es/blogs/martagomezmanchon/2014/02/28/how-can-we-face-the-sustainable-food-production-challenge/>>
- "Molten Salt Solar Reactor Approved by California." *Curious Cat Science and Engineering Blog*. N.p., 18 Dec. 2010. Web. 05 Nov. 2014. <<http://engineering.curiouscatblog.net/2010/12/18/molten-salt-solar-reactor-approved-by-california/>>
- Nguyen, Tuan. "New Invention Turns Building Rooftops into Wind Farms." *SmartPlanet*. N.p., 16 May 2011. Web. 25 Nov. 2014. <<http://www.smartplanet.com/blog/thinking-tech/new-invention-turns-building-rooftops-into-wind-farms/>>

- Nguyen, Katie. "Burundi, Eritrea, Haiti Top 2012 Global Hunger Index." *Thompson Reuters Foundation*. N.p., 11 Oct. 2012. Web. 05 Nov. 2014. <<http://www.trust.org/item/20121011102000-3yd8l?view=print>>
- "Nutrition Facts and Analysis for Beef, Ground, 80% Lean Meat / 20% Fat, Loaf, Cooked, Baked." *Self Nutrition Data*, N.p., n.d. Web. 05 Nov. 2014. <<http://nutritiondata.self.com/facts/beef-products/6207/2>>
- "Nutrition Facts and Analysis for Chicken, Broilers or Fryers, Breast, Meat Only, Cooked, Roasted." *Self Nutrition Data*, N.p., n.d. Web. 04 Nov. 2014. <<http://nutritiondata.self.com/facts/poultry-products/703/2>>
- "Nutrition Facts and Analysis for Sweet Potato, Cooked, Baked in Skin, without Salt." *Self Nutrition Data*, N.p., n.d. Web. 04 Nov. 2014. <<http://nutritiondata.self.com/facts/vegetables-and-vegetable-products/2667/2>>
- "Piezoelectric Energy Harvesting: Developments, Challenges, Future." *IDTechEx*. N.p., 10 Jan. 2013. Web. 25 Nov. 2014. <<http://www.idtechex.com/research/articles/piezoelectric-energy-harvesting-developments-challenges-future-00005074.asp>>.
- Schneider, Caroline. "Urban Agriculture: The Potential and Challenges of Producing Food in Cities." *American Society of Agronomy*, N.p., 03 Oct. 2013. Web. 05 Nov. 2014. <<https://www.agronomy.org/science-news/urban-agriculture-potential-and-challenges-producing-food-cities>>
- "Scientists Revisit Power from Potatoes." *Alternative Energy News*, N.p., 12 Jul. 2010. Web. 05 Nov. 2014. <<http://www.alternative-energy-news.info/fuel-from-chicken-feathers/>>
- Serant, Vario. "Urban Agriculture in Haiti Facing Lack of Infrastructure." *Caribbean Net News*. N.p., 05 Feb. 2007. Web. 05 Nov. 2014. <<http://www.caribbeannewsnow.com/caribnet/cgi-script/csArticles/articles/000057/005751.htm>>
- Sweany, Rebecca. Telephone Interview with Sweet Potato Expert at Louisiana State University Agricultural Center, Plant Biology Department. 31 Oct. 2014.
- Toth, Michael. Personal Interview with 3D-Printing Expert, 17 Oct. 2014.
- Underwood, Kitty. Personal Interview with Chicken Expert and Local Chicken Farmer, 14 Sep. 2014.
- "Urban Agriculture: What and Why?" *The RUA Foundation*, N.p., n.d. Web. 05 Nov. 2014. <<http://www.ruaf.org/urban-agriculture-what-and-why>>
- Winter, Brian. "Could Chicken Manure Help Curb Climate Change?" *USA Today*, N.p., 11 Feb. 2010. Web. 05 Nov. 2014. <http://usatoday30.usatoday.com/news/nation/environment/2010-02-10-cheap-carbon_N.htm>
- Wood, Daniel. "Space-Based Solar Power." *Energy.gov*. U.S. Department of Energy, 16 Mar. 2014. Web. 25 Nov. 2014. <<http://energy.gov/articles/space-based-solar-power>>.
- Woollaston, Victoria. "Now THAT'S a Power Plant! Indoor Farm Grows 10,000 Heads of Lettuce a DAY Using Lights That Mimic Day and Night." *Mail Online*. Associated Newspapers, 11 July 2014. Web. 25 Nov. 2014. <<http://www.dailymail.co.uk/sciencetech/article-2687674/Now-THATS-power-plant-Indoor-farm-grows-10-000-heads-lettuce-DAY-using-lights-mimic-day-night.html>>.