

The Cold-Chain Conundrum

How do we deliver market connectivity which simultaneously ensures we can feed the world but also economically-empower small farmers ... sustainably?

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Last month, WRI and partners from the World Bank, UNDP and UN Environment launched the 'World Resources Report: Creating a Sustainable Food Future', the result of a research project that looked extensively at the entire food system to answer the question: How do we sustainably feed nearly 10 billion people by 2050?¹ This follows on from the outcome of the EAT-Lancet Commission released earlier this year, led by an international group of leading academics, which considered how we can deliver healthy diets for nearly 10 billion from a sustainable food system.²

In their report WRI estimated that we would need to produce 56% more food in 2050 than we did in 2010. But alongside defining demand (population), supply (production) and diet (nutrition), there is the fourth dimension of economically effective market reach (connectivity). Without efficient physical connectivity, the production cannot and does not translate into supply. A well organised and sustainable food logistics network is absolutely critical to supply the production, with minimum product losses, and feed the 10 billion, and without such a distribution network, the other three dimensions are largely a matter of academic conjecture.

Cold-chain is critical

Cold chain infrastructure is essential to economically effective market reach through efficient connectivity. According to UNFAO, "the lack of sufficient and efficient cold-chain infrastructure is a major contributor to food losses and waste in NENA (Near-East, North Africa), estimated to be 55% of fruits and vegetables, 22% of meats, 30% of fish and seafood, and 20% of dairy".³ As one example, UNFAO estimates that 35% of fish caught is lost, noting that "most of the losses are due to a lack of knowledge or equipment, such as refrigeration or ice-makers, needed to keep fish fresh".⁴

The IFC stated in its report, *Creating Markets for Climate Business* (IFC, 2017), "Given that most food loss and waste in developing countries occurs during production and after it is harvested, the greatest potential for reduction is investment in infrastructure related to storage, transport, cold-chains, and distribution."⁵

Both the WRI and EAT-Lancet studies equally recognise the important role of cold-chains and market connectivity in matching increased supply to increased demand. As one example, both set targets for reducing food loss and food waste by 50% and cold-chains are an essential enabling technology in helping to reach such an outcome. The total food that is lost and wasted across the world today represents a combined 1.3 billion tonnes, or the production of nearly 30% of the world's agricultural land⁶, and hence WRI goes as far as to call for the target to be met by 2030.



Addis Ababa Market, Ethiopia, © Peyton Fleming

¹ https://wrr-food.wri.org/sites/default/files/2019-07/WRR_Food_Full_Report_0.pdf

² [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(18\)31788-4/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)31788-4/fulltext)

³ <http://www.fao.org/3/a-ax746e.pdf>

⁴ <http://www.fao.org/state-of-fisheries-aquaculture/en/>

⁵ <http://documents.worldbank.org/curated/en/470551510737006421/text/121276-WP-IFC-Climate-Investment-Opportunity-Creating-Markets-PUBLIC.txt>

⁶ <http://www.fao.org/3/i3347e/i3347e.pdf>

How much cold-chain?

However, neither piece of work, nor indeed the IFC nor UNFAO, tries to quantify what would actually be required to successfully meet these targets - let alone transport, store and distribute nearly 6 billion tonnes of food by 2050, a substantial portion of which will be fresh and temperature sensitive produce - in terms of the physical numbers and capacity of temperature-controlled road vehicles, cargo ships, multi-modal containers, domestic refrigerators, chilled display cabinets, cold storages, pack houses, ripening chambers, pre-coolers and a plethora of other cold-chain supporting equipment and infrastructure in the energy, transport, retail and food logistics sectors. Furthermore, the mere presence of equipment or infrastructure is not sufficient in itself and appropriate business operating models, cold-chain management systems and training and skills development will be needed too.

As to an indication of the size of the challenge, currently 70% of food in the mature developed markets of the world passes through a cold-chain at some point on route from the point of production to our table.⁷ By comparison, in India barely 10% of the produce that could benefit from using the cold-chain actually does so⁸ – with 1/20 of the population of India, the UK has 10x more refrigerated vehicles alone. India is the world's second largest producer of vegetables and fruit and among the top ten in fish and meat,⁹ but the bulk of these perishable products face risk on the journey to the consumer due to exposure to high temperatures, inadequate handling and logistical support. Reportedly, upwards of 25% of such produce is lost due to a lack of farm-gate preconditioning including precooling, refrigerated vehicles and shipping containers and other supply chain bottlenecks.¹⁰

Importantly, this infrastructure deficit restricts market expansion which in turn dissuades efforts to improve productivity. Any efforts to produce more food, without concurrent logistics enablement, means higher supply at markets in immediate proximity to production points at time of harvest, and a lower product valuation as these markets are in surplus. Conversely,

especially in the case of perishables, the markets located at a distant evidences a disconnect with their supply incurring high food loss and



Lack of cold chain in food markets

causing a demand- supply mismatch. This is not a win-win situation and certainly not sustainable.

The need for sustainability

The addition of what will undoubtedly be a substantial amount of energy consuming equipment and infrastructure to enable the supply of 56% more food produce globally, will also have significant environmental impact if achieved using today's fossil fuel powered technologies. Given the use of refrigerants and insulation in cold-chains, the sector is important not only for its effect on our ability to deliver the Paris Agreement on Climate Change but also for a successful outcome to the Montreal Protocol and Kigali Amendment. In this regard, other than a commitment to achieving zero-carbon cold-chain logistics with no emission of pollutants, neither the WRI nor EAT-Lancet reports consider the potential environmental impact if we do not achieve such a laudable aspiration, let alone the infrastructure investment required to make it happen or the scale of the clean energy resources needed to deliver on it.

The importance of using clean energy in cold-chain deployments was recently underlined by an academic study (Heard and Miller, 2018¹¹) which concluded that the greenhouse gas (GHG) emissions resulting from the operation of a North American-style fossil-fuel dependent cold-chain in Africa would be about 10 percent greater than the food-loss emissions avoided by the use of the technology. It is estimated that total food loss and waste currently accounts for about 8% of global GHG emissions – a significant percentage of which is due to a lack of cold-chains.¹²

However, above and beyond the four dimensions of population, production, nutrition and connectivity there is a single fundamental overarching requirement for **sustainability**. Alongside providing enough nutritious food to feed nearly 10bn people and delivering it using clean energy, we must simultaneously improve the livelihoods of the nearly half a billion small and marginal farmers who are essential to today's global food system and the major stakeholders in its future.

According to the Africa Agriculture Status Report (AASR), 80% of Africa's 51 million farms are smaller than two hectares.¹³ In combination they produce 70% of the continent's total food requirements.

⁷ <https://timestrip.com/the-fresh-cold-chain/>

⁸ NCCD

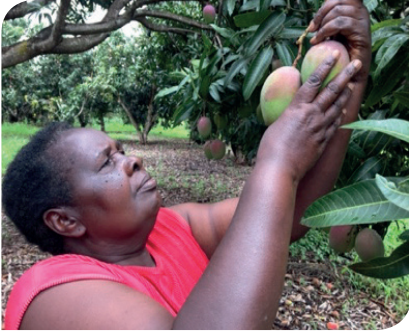
⁹ NCCD

¹⁰ NCCD

¹¹ Environ. Sci. Technol.2019531251-26 0ec19, 2018 <https://doi.org/10.1021/acs.est.8b05322>

¹² <http://www.fao.org/3/a-i8000e.pdf>

¹³ <https://agra.org/wp-content/uploads/2018/10/AASR-2018.pdf>



Cicily Wanjira, a smallholder rural farmer in Kenya checking her mangoes, © Peyton Fleming

Elsewhere, smallholder farmers provide around 80% of the food consumed in Asia and this statistical pattern is repeated

in developing economies around the globe.¹⁴ Overall, the EAT-Lancet study identified that currently, small and medium sized farms provide more than 50% of the essential nutrients in the global food supply. In terms of their importance to employment, as an indicator, 50% of the workforce in India are directly employed by agriculture,¹⁵ 73% in Rwanda¹⁶ and 40% of the total population in Kenya.¹⁷

Rising Incomes

The deployment of cold-chains does not just enhance food security, in terms of increasing reliable access to a sufficient quantity of nutritious food, it also allows farmers to earn more by ensuring the quality of their produce and providing the efficient and effective connectivity needed to sell it further afield - reaching consumption centres in distant cities and urban conurbations.¹⁸ Such capacity is both empowering and galvanising as the farmers can begin to consider growing higher value produce for new markets. It also provides opportunities to produce and sell food better suited to new growing conditions as they emerge, thereby helping them to build capacity for resilience and adapt to a changing climate. Essentially, besides improving economic gains through safe and expanded market connectivity, cold-chains can help improve the resilience of farmers and the rural communities in which they are located.

The central philosophical challenge to be addressed is that feeding the world is largely perceived today as a large-scale industrial enterprise, with land consolidation into larger, mechanised production units being the default business model for economic efficiency. But for sustainability we need new radically innovative models which economically empower the marginal and small farmer - and create rural employment and resilience, in alignment with existing human backdrop and current on the ground reality. As Dr. Kanayo F. Nwanze, the 2016 Africa Food Prize Laureate and former president of International Fund for Agricultural Development (IFAD) describes it: we need to see an 'inclusive' transformation of the agri-food system to "one that focuses on linking many more smallholders to high-value markets, and adds value and employment along value chains through growth of small and medium enterprises (SMEs)."¹⁹ The cold-chain is at the heart of this. Indeed, India has recognised it as such

the deployment of integrated cold-chains is identified as a key pillar to fulfil Prime Minister Modi's vision of "doubling farmers' incomes" by 2022.²⁰

New business models needed

The reality of business dictates that no matter how appropriate a shift in philosophy might be, cold-chains will only be taken up by small and marginal farmers and associated supply chain players if they are affordable within the local economic context. There are a range of price points within the various options, including shading or simple evaporation cooling. But the investments will likely increase in scope as operations increase in size and complexity. Given the high capital requirement, marginal and small farmers across economies are likely to adopt "pay as you use" type services and funding models will need to be innovative, driven through empowered Farmer Producer Organisations (FPOs), be they as Farmer Producer Companies (FPCs) or co-operatives. Equally key is to enable small and marginal farmers through FPOs and other knowledge transfer channels to understand how to avail services of the integrated components of pre-cooling, storage and transport to gain the economic advantages available from cross-geography access, distance-price arbitrage, time-arbitrage and cross-seasonal trading. This is where new value is created and logistics management is as important as the physical infrastructure required to enable the flow of food from point of production to point of consumption.

For sustainability, we absolutely must ensure a fair and equitable flow of value back to the producers themselves. This is particularly important to safeguard where, in addition to FPCs and co-operatives, we incentivise commercial actors such as local entrepreneurs, medium-



Dek Island fisherman, Bekele Sintie, standing next to fresh tilapia in the fish cooperative's new solar-powered refrigerator, © Peyton Fleming

¹⁴ http://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/Factsheet_SMALLHOLDERS.pdf

¹⁵ Food and Agriculture Organization of the United Nations, Nepal at a glance; India at a glance (<http://www.fao.org/nepal/fao-in-nepal/nepal-at-a-glance/en/>)

¹⁶ <http://www.statistics.gov.rw/publication/rphc4-thematic-report-labour-force-participation>

¹⁷ <http://www.fao.org/kenya/fao-in-kenya/kenya-at-a-glance/en/>

¹⁸ NCCD

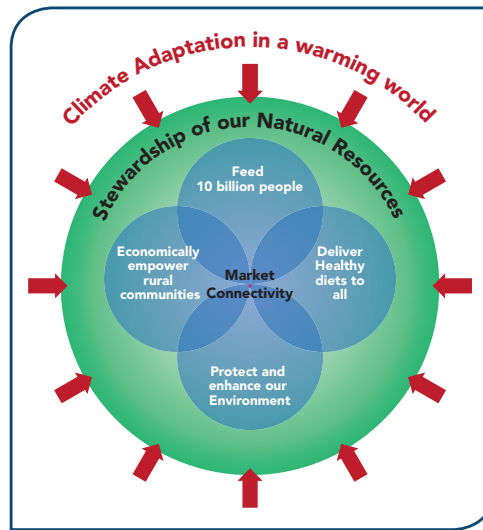
¹⁹ <https://agra.org/wp-content/uploads/2017/09/Final-AASR-2017-Aug-28.pdf>

²⁰ https://niti.gov.in/writereaddata/files/document_publication/DOUBLING%20FARMERS%20INCOME.pdf

sized farmers and third party logistics companies to become the local service providers, deploying and operating cold-chain infrastructure on behalf of smallholder farmers and growers.

In summary

Cold-chains can be an essential contributor to the United Nations Sustainable Development Goals - not least SDG 1 (End Poverty); SDG 2 (Zero Hunger); SDG 3 (Good Health and Well Being; SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action), the Paris Agreement on Climate Change and the Kigali Amendment to the Montreal Protocol. Application of clean efficient cooling in cold-chains delivers on three core pillars for sustainable food:



(i) enhance the income, economic wealth and financial security of farmers, growers and fishers; (ii) improve food quality, safety, nutritional content and value to consumers; and (iii) achieve this sustainably with minimum environmental and natural resource impact.

The key question we need to answer is: "How do you create the local and global, temperature controlled "field to fork" connectivity to feed 10bn people sustainably from hundreds of millions of small-scale farmers whose livelihoods and well-being are often dependent on only 1-2 hectares, as well as ensure they are climate change adaptation ready and resilient all without using fossil fuels?"

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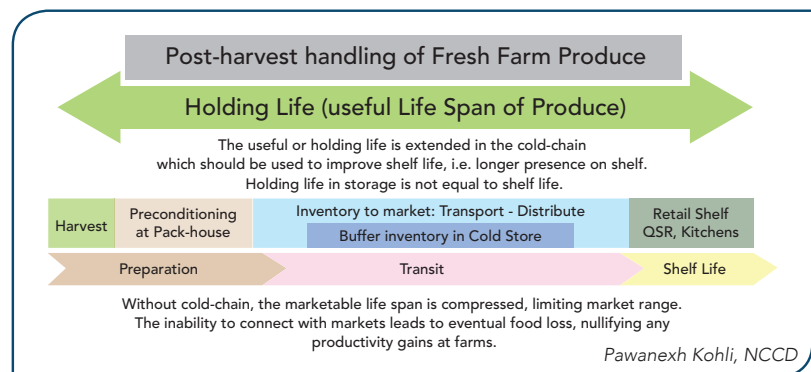
COLD-CHAIN

A cold-chain is not, as many perceive it, the provision of cold storage alone. It is in fact an integrated, optimised and managed network of temperature-environment controlled pack houses with pre-cooling, vehicles, cold stores, and distribution hubs which seamlessly operates to maintain custody of the food under care, to assure the safety, quality and quantity of food, and to deliver it swiftly from farm, harbour or beach to consumption centres across geographies and over time.

Designed properly, using clean cold-chain technologies such as solar or wind powered refrigeration systems, and cryogenic cooling, we can also pre-empt undesirable pollution and degrading energy exploitation in pre-cooling, cold warehousing, transport and/or quick freezing.

There are five key pillars that need to be addressed simultaneously:

- connect producers to markets to supply a growing population;
- improve nutrition quality, food safety and value to consumers;
- enhance income, economic well-being and financial security of small and marginal farmers, growers and fishers, their families and their communities;
- meet obligations under Kigali Amendment / Montreal Protocol and Paris Agreement on Climate Change as well as improved air quality in urban and transport corridor environments;



- build adaptive capacity and resilience to climate change impacts on resources, productivity, etc.

As an indirect consequence clean cold chain development can:

- assist in making better use of natural resources by reducing loss of food between field and fork - 1.3bn tonnes of food is lost or wasted annually and this represents the production from nearly 30% of the world's agricultural land, as well as a waste of 38% of agriculture energy and water consumption.
- create jobs and economic growth, especially within rural communities, including secondary agriculture where farm-linked economic activities such as food processing arise at village level, which can help stem rural-urban migration.
- have a multiplier effect on various supporting economic activities such as transportation and international trade, by opening new markets for allied sectors and endorse efforts for higher productivity at farm levels over an extended period.