

Horizon Scanning for Fresh Markets



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Contents

The Author	2
1 Introduction: The Importance of Fresh Markets.....	1
1.1 National and Local Governments are Maintaining and Enhancing Support for Fresh Markets.....	2
1.2 Fresh Markets in OECD States.....	5
1.3 Trends in Mexico City.....	6
1.4 Fresh Markets Underpin Food Systems, Food Security, Sustainability and Livelihoods	6
2 Challenges and Opportunities for Fresh Markets.....	9
2.1 Institutional and Management Challenges.....	9
2.2 On-site Innovation Opportunities for Fresh Markets	10
2.3 Innovative Services and Fresh Markets.....	13
2.4 Technical Innovation and Smart Fresh Markets	14
2.4.1 Post-harvest loss	14
2.4.2 Cold hub and cold storage solutions:	16
2.4.3 Solar drying.....	19
2.4.4 Reducing food loss – pre consumption at fresh market level. ..	21
2.4.5 Waste management contiguous with commercial activities.....	22
2.4.6 Biogas Digesters.....	28
2.4.7 Water management and water-harvesting solutions.	32
2.5 New business approaches for fresh markets.....	38
2.6 Designing for space in the market	40
2.6.1 Conventional versus New Approaches.....	40
2.6.2 Education and training	42
2.6.3 Market information and financial inclusion zone.....	42
2.6.4 Waste management facilities	43
2.7 Technology solutions for smart market financial management, sales, business models and related governance	43
2.8 Online platform: an example for further digital innovation for fresh markets	45
2.9 Micro business support for fresh markets and their vendors.....	47
3 Public–Private Partnerships (PPPs) Leverage Private Investment in Agricultural Value Chains	48

3.1	Possible PPP Contributions to Food Systems	48
3.2	The Case of Tomato in Ghana: Institutional Support - PPP at Wenchi, Brong Ahafo.	48
3.3	PPPs for Developing Agricultural Market Infrastructure	49
3.4	PPPs and Transport links from Farms to Smart Fresh Market	49
3.5	Structured Contractual Sustainable Public-Private Partnerships....	50
3.6	How Civil Society Stakeholders make Smallholder / Smart Fresh Market Concepts Successful – A Tanzania Case Study	53
3.7	Farmers’ Market Organizations (FMOs) as a key partner for Smart Fresh Markets 3.7	54
4	The Informal Economy and Smart Fresh Markets.....	56
4.1	The “Informal” Economy.....	56
4.2	The Power of Africa’s Informal Economy in a Global Economy	57
4.3	Big brands like Unilever aren't the full answer to helping Africa's farmers.....	58
4.4	Informal Markets, Food Systems and Food Security.....	59
4.5	Informal Markets and a New Policy Agenda	59
4.6	Governance of Informal Food Markets in Africa’s cities - Municipal Support Policies for Operators.....	60
4.7	Managing Illegality at Local Markets: The Cherkizovsky Market Example	62
5	Twin roles for Fresh Markets and Supermarkets	62
5.1	Fresh Markets and Supermarkets as Complementary Entities.....	62
5.2	An Example of Reconciling Smart Fresh Markets with Advanced Supermarketisation in Africa	65
6	Conclusion.....	66
7	References	67

Horizon Scanning for Fresh Markets

1 Introduction: The Importance of Fresh Markets

Globally, tens of thousands of sellers and millions of consumers rely on smart fresh markets (SFMs) and so they are incredibly important for smallholder urban food retailers in developing countries. Fresh markets constitute a considerable market share of fresh produce (Schipmann & Qaim, 2011). For example, in New Delhi the large number of fresh fruit and vegetable (FFVs) markets accounts for approximately 75% of all FFVs sold (Minten et al., 2010). A study by Gomez & Ricketts (2013) found that 90% of all FFVs are purchased through more traditional food value chains in Kenya, Zambia and Nicaragua. In Thailand and Mexico, nations with greater supermarket adoption, traditional food markets share remains high at 63% and 72.5% respectively. Smart fresh markets fulfil another important role as the target location that showcases and sells much of the produce of the world's some 523 million smallholder farmers upon whom some 2 billion people rely for their livelihoods (Fan and Rue, 2020). In Asia and sub-Saharan Africa smallholder farmers produce 80% of the food (Fan & Rue, 2020). Smallholder farmers generally sell their produce through fresh or informal markets and so rely on them for their livelihoods (Gomez & Ricketts, 2013).

Among the reasons for the continued reliance on fresh markets for produce are that consumers view the produce to be fresher, better tasting and healthier than perishable goods sold in supermarkets. It also happens that the network of fresh markets is ubiquitous throughout cities, towns and villages thus providing convenient access to readily available food. Furthermore, there are cultural and social reasons as to why consumers prefer fresh markets (Zhong et al., 2020). This evidence shows the high global reliance on fresh markets for the sale and acquisition of food, and so they hold a key position within the sustainable food transition.

For a food system to be sustainable, it must ensure the health of those dependent on it. 'Protective foods' are foods that protect against the development of negative health implications, i.e., fruits, vegetables, legumes and whole grains (Flor, 2019). As shown, such foods are commonly sold at fresh markets (Kogen et al., 2019). In this regard, they are advantageous over more modern forms of food retail which often sell produce that is high in fats, sugars and preservatives with low nutritional content (Gorton et al., 2011). In theory then, produce from fresh markets can promote nourishing food systems for a growing population (The Rockefeller Foundation, n.d.).

Protective food-based fresh markets can be “sustainable” for environmental and economic reasons. They are often independently run by smallholder vendors, who source their produce from local farmers or wholesalers instead of being reliant on global, GHG intensive supply chains. These shorter value chains can also ensure inclusive economic development (Lutz & Tadesse, 2017). Products do not have to be subjected to rigorous, complex food safety standard regulations, which can require that produce that might otherwise be sellable is wasted (Tait, 2015). All these factors make fresh market produce more affordable to local consumers which is essential for food security within urban and rural socioeconomically challenged environments.

For fresh markets to advance sustainable food systems through the sale of protective foods, issues that negatively impact sustainability must be addressed. For example, a lack of regulatory frameworks can increase the likelihood of undesirable health implications related to compromised food (Yu, 2020). The main barrier to progression is scalability. In many parts of the world, fresh markets are part of the informal sector, i.e. there is no tax placed on the produce they sell and so smallholders do not experience the same government protection or investment that more established retailers receive (Jackson, 2016).

With these issues in mind, public and private investment in infrastructure at and around fresh markets would multiply their benefits. This could happen from the point of production as improved inputs and farm practices would greatly increase yields. The same applies to advances in farming equipment and the provision of storage facilities. In this way smallholder production of commodities with more sustainable qualities in local consumer markets can further supplement supermarket offerings (Grain, 2017). As such, it is in the interest of such governments from a sustainability perspective to uphold complementary smallholder farmer and fresh market economy interests.

Taken from global examples, the following actions could be disseminated to advance the sustainable nature of fresh markets whilst overcoming the issues that hamper their development.

1.1 National and Local Governments are Maintaining and Enhancing Support for Fresh Markets

Smart Fresh Markets are facing new pressures from globalisation and large-scale retail operations. For example, in 2019 the German discount food store, Aldi, and US member-based retail giant, Costco Wholesale, opened their first stores in China. Such enterprises are funded by and therefore operate primarily for the benefit of international shareholders (Manager, 2019).

New bilateral trade agreements between supranational organisations and Asian governments have witnessed the importation of certain goods usually sold at supermarkets. For example, new EU Agri-food trade deals with South Asian countries like Vietnam has seen an increase in imported European goods such as spirits and liqueurs, milk powders, cereal preparations, wine, and dairy products (European Commission, 2020). These products are traded for the purpose of being sold at established supermarkets instead of local fresh markets. Heavy reliance on imports, particularly items that are regularly consumed can raise food security concerns to the potential exclusion of local food producers – which we know to be the background of many Southern Nation economies.

Markets in Central and Eastern Europe (CEE) have already experienced a shift towards supermarket-based food retailers, mostly observed following the fall of the Soviet Union and an influx of direct foreign investment (Dries et al., 2004). The transition to more conventional food systems in CEE has seen traditional market vendors' market share being side-lined. This also has had a direct impact on the smallholder farmers who often struggle to sell their produce to supermarket chains due to scaling, conforming and food safety standard regulations (Dries et al., 2004). Despite this, there is still significant demand and investment in many CEE countries for fresh, local produce sold through traditional farmers markets (Zagata, 2012). In fact, in many Asian and Central and Eastern European countries, governments and municipalities have continued to invest in locally run fresh markets.

CEE governments have placed emphasis on promoting alternative food systems with short, local supply chains as a method of promoting rural development. For example, the Hungarian government set up the Rural Development Programme: “to ensure the viability of farmers through the rise of their potential for increasing profits” (Benedek et al., 2018). In doing so, the programme aims to increase the strength of local farmers markets as an alternative food system to supermarkets. As such these local fresh market systems continue to be favourable for local populations, despite increasing pressures from international governments and food enterprises.

While fresh markets offer a number of advantages as described above, they are not always able to compete with supermarkets in respect of the range of products on offer unless such markets are deliberately designed to offer a range of household items and a greater variety of food products. In the absence of such strategies there is a threat to the livelihoods of smallholder farmers who supply the fresh markets, farmers whose produce – unless so designed - is not easily sold in global supermarkets (Giddings, 2016).

As well as economic reasons, there are social reasons as to why this a problem for governments and municipalities. Cheap high-energy-low-nutrient foods are commonly sold through supermarkets and lead to the perpetuation of dietary health issues such as obesity (Traill, 2006). Furthermore, there is strong consumer demand

in many Asian, South and East Asian and countries for fresh market produce. This is because food it is seen as ‘fresher’ and more fitting to cultural cuisines (Zhong et al., 2020).

Therefore, countries that are reliant on fresh markets for food systems have introduced investment policies to upgrade such markets. Such policies can have the dual benefit of creating better food safety and security, whilst improving the livelihoods of local people. One such example includes subsidies for smallholder farmers. As 90% of all China’s farmers occupy less than 2.5 acres of land and considering that most produce sold in fresh markets is sourced from such farmers, there is a need to protect their livelihoods. Since 2006, the Chinese government has abolished agricultural taxes and introduced agricultural support measures such as subsidies on the procurement of equipment and fertilizers along with a range of other measures to support such farmers as part of the fresh market economy (Bellmann, 2019).

In Nanjing, China, a public-private hybrid model of governance has been found to ensure food security.¹ It allows for informal fresh marketplaces that sell produce from local supply chains to be upheld, whilst introducing food safety policies. There is a mixed ownership and management structure of wholesale and market vendors, which are part funded by public, part funded by private investment. Part of this hybrid provides rent reductions to informal vendors and investment in storage infrastructure. This dynamic ensures that food can be physically provided to citizens at an affordable price while maintaining profitability margins (Zhong et al., 2019). The result is relatively easy and equitable provision of a healthful, local food system (Zhong et al., 2019).

Policies should address demand as well as supply. To ensure that demand remains for fresh foods sold in local markets, and to complement supermarket marketing campaigns, governments need to maintain local consumer awareness. In Mozambique, a nutritious foods vouchers scheme is being introduced, supplied by local small enterprises, and supported by NGOs. The vouchers are distributed through health centres by municipalities or through direct sales from the fresh market smallholder (GAIN, 2015).

In response to rapid urbanisation and the proliferation of international commercial shopping centres, the Singaporean government introduced subsidies to smallholder fresh market vendors (Roughneen, 2018). This is because the government recognised their importance in the selling and acquisition of local foods, their importance to smallholder’s livelihoods and to maintaining Singaporean cultures (Mele et al., 2015).

¹ We devote a section of analysis of public-private structures later in this report.

1.2 Fresh Markets in OECD States

Despite their differences, fresh markets continue to be effective as suppliers of a nation's food systems. In western countries where food culture is a focal point of civic life (e.g., Italy, Spain, and France) fresh markets function alongside retail stores and are a preferred choice for those seeking food healthful lifestyles in their consumption choices. Sourcing food does not have to be a case of either fresh markets or retail outlets. Further to these examples, the functionalities of a supermarket can complement the affordability and freshness of a fresh market with the correct policy instruments:

- Identify food safety policy interventions in fresh marketplaces. This may mean formalising the marketplace to some degree, which would require the involvement of landlords/landowners. This would contribute greater accountability.
- Equally, improved infrastructure in place can assist with this, for example better refrigeration and storage.
- Identify and assist with removing barriers to entry into supermarkets for poorer households. These could be location, costs etc.
- Implement policies that limit the spread of misinformation concerning food safety, for example, high sugar, high fat, high preservative food advertisement.
- Fresh produce from fresh markets can be sold directly to supermarkets. This may or may not come at a higher cost, so would have to be smart about the business methods used. i.e., this produce could be aimed at a wealthier market or alternative business arrangement could be made for smallholders (through institutional aggregation such as cooperatives or farm organisations) to directly supply supermarkets as well as have a free market presence.

In Northern States as elsewhere, the emergence of supermarkets has been described as a “double edged sword” for development. On the one hand, it can lower food prices, create opportunities for farmers and processors to quality differentiated food markets. On the other, it can create challenges for smallholder retailers and farmers who are not equipped to compete and provide similar services to modern supermarkets. However, these challenges are offset by product nutritional and freshness qualities which may not be matched by supermarkets that peddle the western high fat, high sugar, processed food diet.

Furthermore, there are cultural considerations that must be taken into account. There may also be differences as to where a shopper might purchase goods that are a necessity and goods that are hedonic.

1.3 Trends in Mexico City

There has been some movement to shopping malls and away from traditional marketplaces partially due to crowding in street areas in combination with other more conventional westernisation trends. For example, the trend towards regional shopping malls may also be able to offer recreational facilities in a city that is very overcrowded and lacking proper outdoor space.

Still street markets are largely preferred by many shoppers as they exhibit ethnic and cultural attributes that are integrated with fresh, healthy food offerings. While being competitive in their own right, there is a need to consider how fresh markets can physically co-exist or otherwise become more integrated with shopping mall offerings. For many in Europe, fresh markets can be found alongside or at such retail spaces. Another way to think about the relationship to retail centres and stores is to have a designated fresh marketplace and/or to supply produce to retailers.²

1.4 Fresh Markets Underpin Food Systems, Food Security, Sustainability and Livelihoods

Today's food system produces abundant ultra-processed, calorie-dense yet nutrient-poor, cheap foods. High intake of these convenient foods is taking a growing toll on human health (e.g., 821 million undernourished and 1.9 billion overweight or obese worldwide),³ the environment (e.g., 14-29% of global greenhouse gas emissions come from the food system),⁴ and communities (e.g., small-scale farmers and rural communities often experience poverty and food insecurity).⁵

Globally, thousands of sellers and consumers rely on fresh markets and therefore they are incredibly important for smallholder urban food retailers in developing countries. Despite the rise in 'super marketisation' of food systems in urban developing settings, fresh markets retain a considerable market share of fresh produce (Schipmann & Qaim, 2011). For example, in New Delhi the number of fresh fruit and vegetable (FFVs) fresh markets are proportionally lower than that of more modernised outlets, but account for up to 75%⁶ of all FFVs sold (Minten et al., 2010). A study by Gomez & Ricketts (2013) found that 90% of all FFVs are purchased through more traditional food value chains in Kenya, Zambia and

² For a sense of the challenges and opportunities of Mexican fresh markets see:

<https://www.eater.com/2019/12/9/20963654/mexico-city-public-markets-in-trouble-over-tourism-gentrification>

³ FAO, 2018

⁴ CDC, 2018

⁵ [The Lancet Commission – Global Syndemic 2019](#)

⁶ Minten, Bart; Reardon, Thomas; Sutradhar, Rajib (2010). "Food Prices and Modern Retail: The Case of Delhi". *World Development*. 38 (12): 1775–1787

Nicaragua. In Thailand and Mexico, nations with greater supermarket adoption, traditional food markets share remains high at 63% and 72.5% respectively. Smallholder farmers generally sell their produce to fresh or informal markets and so rely on them for their livelihoods (Gomez & Ricketts, 2013).

Continued reliance on fresh markets for produce is in part based upon the consumers view that fresh market produce is fresher, better tasting and healthier than perishable goods sold in supermarkets (Zhong et al., 2020). Furthermore, there are cultural and social sustainability reasons as to why consumers prefer fresh markets (Zhong et al., 2020). This evidence shows the high global reliance on fresh markets for the sale and acquisition of food, and so they hold a key position within a sustainable food transition.

Smart fresh markets dealing in the sale of healthful foods can be considered environmentally sustainable for a number of reasons. Firstly, the produce is sourced from local value chains which are reliant on from smallholder farmers. Regional, national and international food supply chains are reliant on long distance transportation and, therefore, are much more GHG intensive (Rizet et al., 2010). Second, fresh produce in fresh markets is not packaged in single use plastics. It is sold in open market stalls with consumers relying on their own robust, reusable forms of packaging (Buchanan, 2019). Lastly, enormous amounts of food produced is wasted because it does not fill certain cosmetic requirements of supermarkets. This issue is less prevalent within fresh markets which do not have to adhere to such standards. In addition, independent smallholders in fresh markets can sell their unsold fresh produce as other sellable products such as livestock feed, instead of being wasted as per the norm in supermarkets (Global Panel, 2018a).

The convoluted nature of global supply chains means that adapting agricultural practises to improve sustainability is extremely challenging (Giddings, 2016). Relationships between producer-seller-consumer are much closer within fresh markets and so have the advantage of flexibility over modern food systems (Fickling, 2020). They are cultural, built on trust, observations, and experiences. Through NGO or private sector support, these relationships can be utilised to enhance the sustainability of farming practises at a faster rate than global commercial supply chains, either through improved irrigation; natural pesticide use; or any other sustainable farming method. This would result in foods that maintain organic freshness with better overall quality.

Informal fresh markets are relied upon for food security and livelihoods throughout the developing world. Such systems are more focused on inclusivity as they function for the benefit of all those involved. Privately operated international supermarket outlets, focused on benefitting shareholders thus not primarily delivering on the development of the communities who rely on the local food system (IIED, 2016). As an example, the municipal government in Dakar, Senegal has made plans to knock down the Gueule-Tapee market to make way for a four-story shopping mall which would be occupied by a French supermarket chain, Auchan.

This market is the trading place for smallholder informal / semi-informal market vendors, and thus places their livelihoods at risk (Grain, 2018; Bilaterals, 2019).

Instead, formalising the existing markets to a greater degree would ensure inclusive, sustainable growth. This is because it is building on existing cultural norms and networks of suppliers, sellers, and consumers (Zhong et al., 2020). This would reinforce, upgrade, and improve the existing market and lead to more rapid and inclusive proliferation.

For a food system to be sustainable, it must ensure the health of those dependent on it. One aspect of fresh is that they provide a steady supply of protective foods. 'Protective foods' are foods that protect against the development of negative health implications, i.e. fruits, vegetables, fish, legumes, seeds, nuts and whole grains (Flor, 2019). Such foods are commonly sold at fresh markets (Kogen et al., 2019). In this regard, they are advantageous over more modern forms of food retail which often sell produce that is high in fats, sugars, and preservatives with low nutritional content (Gorton et al., 2011). In theory then, produce from fresh markets can promote nourishing food systems for a growing population (The Rockefeller Foundation, 2020).

On another note, fresh markets can be environmentally economic. They are often independently run by smallholder vendors, who source their produce from local farmers or wholesalers instead of being reliant on global, GHG intensive supply chains. These shorter value chains can also ensure inclusive economic development (Lutz & Tadesse, 2017).

Equally, fresh markets can ensure greater food and employment security for local populations because they are not exposed to volatile international financial markets. Smallholder stakeholders in localised food systems are more secure from the business cycle ups and downs experienced by formalised global value chains (IIED, 2016).

In summary, fresh markets are relied upon for food security and sustainable livelihoods throughout the developing world. Such systems are more focused on inclusivity as they function for the benefit of all those involved.

2 Challenges and Opportunities for Fresh Markets

In this sub-section we identify some of the main challenges for fresh markets and their corresponding opportunities.

2.1 Institutional and Management Challenges

- **Fresh market infrastructure:** Fresh markets are normally very conveniently located for consumers, vendors, and other actors, and are therefore important institutions in the retail food supply chain. As such, they would benefit from well-planned technical designs for multifunctional infrastructures and facilities that also support safe handling of food and general hygiene as described in this Handbook. The development of weighing, transport, and storage infrastructures are also important as some markets for staple foods require this infrastructure. Supporting well-planned fresh market infrastructure is also the perfect response to rapidly urbanising populations that are also fresh market customers.
- **Management and organization:** Fresh market user (i.e., normally fresh market vendor) registration processes and simple contractual arrangements managed by experienced staff make such markets efficient and legitimate in the eyes of government and other key private and public stakeholders.
- **Sanitation, waste management and energy systems:** With the right leadership and the cooperation of staff with essential expertise and training capacities, sanitary measures regularly applied and checked will reduce hygiene concerns to a minimum. In countries where tap water is not available, markets can harvest rainwater. Finally, cost effective energy and waste management measures will, if properly designed, create net benefits for the environment.
- **Food quality and safety risks and traceability:** With on-site training of farmers and other producers with the cooperation of cooperatives and other farm organisations, sustainable production of produce, fish and meat will substantially remove product quality and safety concerns. Simple traceability mechanisms can accompany user registration systems.
- **Removing high produce losses:** Well-designed and operated fresh markets should feature cost effective cold storage facilities that can be powered by renewable energy. Low-tech, efficient dry storage facilities should also be built into fresh market infrastructure design and paid for with nominal user fees.

- **Covid-19 related factors:** With the right leadership, virtually all fresh markets can develop and implement policies to address Covid-19 physical distancing measures. The right ‘track and trace’ systems for both fresh market products as well as on-site users should ameliorate these concerns and those that might come with future zoonotic diseases. Contamination or other adverse health events should be more capable of management on this basis— provided that the right relationships exist between fresh market operators and responsible government authorities.
- **Building a relationship around wholesale markets:** Though we address this point in greater detail later, fresh markets have an unrealised potential to expand their market opportunities on both the producer and buyer sides of the commercial equation. With the right regulatory strategy, wholesale market actors can expand the demand for fresh market produce/products and can be physically co-located if not functionally integrated with wholesale food terminals. Wholesale markets attract larger buyers including those that have regional, national and international markets in mind. Improved business education and stakeholder understanding will make this vision possible as it already happens elsewhere.

2.2 On-site Innovation Opportunities for Fresh Markets

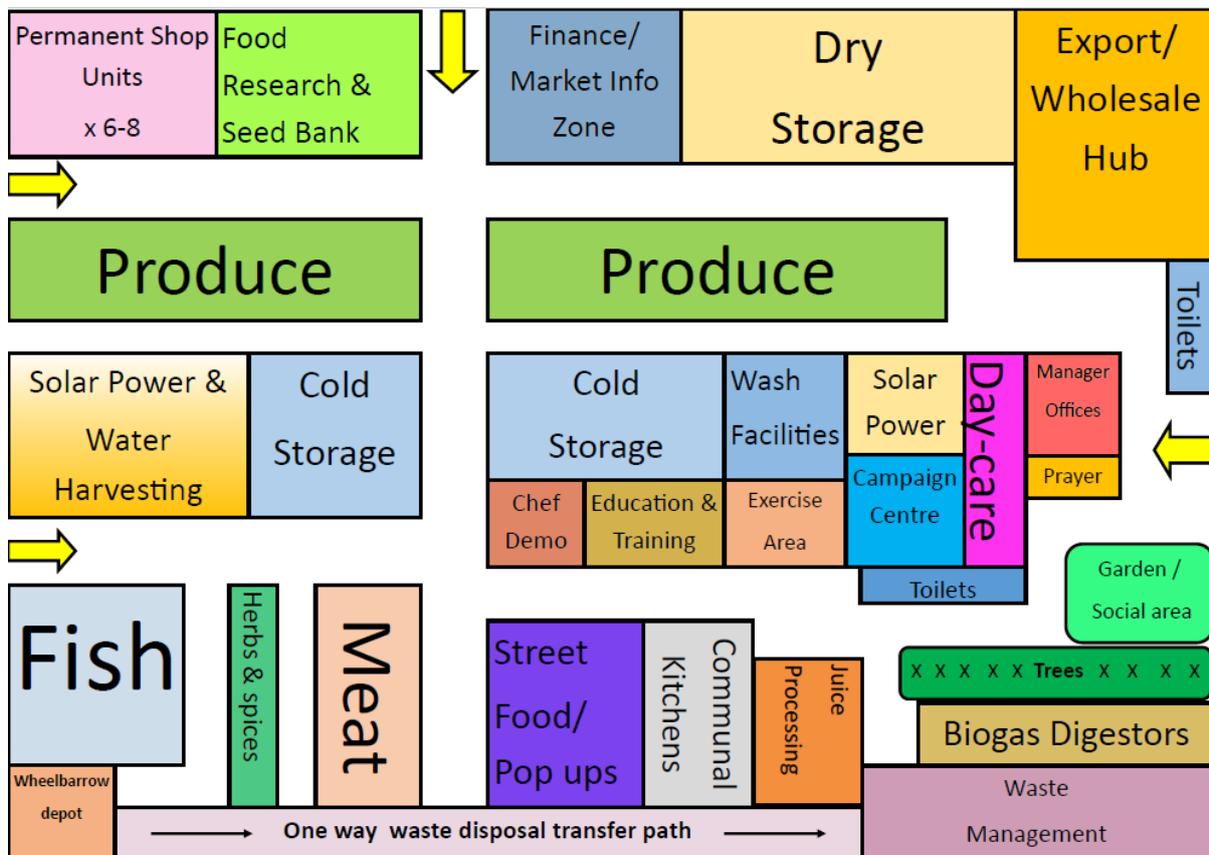
What we have learned from our horizon scanning efforts thus far is that fresh markets would benefit from structural or design-related reform. In our view multi-functionality should be at the core of a well-designed, modern fresh market. Therefore, we are advocating a remodelling of fresh markets along the lines of a new model. Accordingly, in the following diagram we identify the possible functions of a comprehensive 21st century fresh market⁷ immersed in food culture for climate resilient sustainability.⁸

⁷ The diagram is not to scale. Not all functions are required for a given wet market. Function selection is at the discretion of the operator/owner ideally acting in consultation with stakeholders.

⁸ **Additional rationale for location of selected uses:**

South side: The location of the fish and meat markets separated by the herbs and spices is deliberate. The intention is for the herbs and spices stalls to provide a natural odor buffer to avoid the fish and meat smells mixing. Fish and meat stalls will produce the most waste and offal, which needs to be properly disposed of to mitigate against disease and pests. As such, there is a “waste disposal transfer” route directly to the “waste management area” so sellers can properly dispose of their waste throughout the day. There will be wheelbarrows that can be hired to expedite this process. Sellers who fail to properly dispose of their waste will be warned, fined and finally expelled by management. Similarly, the tree line in the east corner is to provide a visual and odour barrier against the “waste management area”.

The possible functions of a comprehensive 21st century fresh market immersed in food culture for climate resilient sustainability.



Finance/market info zone will feature a televisual/social media unit that “markets the fresh market”, calling attention to the market features and advertising on behalf of vendors. This will also enable sellers and buyers to know what prices to expect to sell and buy at. This zone will feature a series of ATMs and credit lenders to help sellers and farmers secure loans that they can use to upgrade their operations. Closely aligned with this function is the Campaign Centre which will be devoted to expanding the interests and influence of fresh markets as well as food health, food culture and related sustainability causes throughout civil society.

Food Research & Seed Bank hub will provide a laboratory and modest seed bank used to research and demonstrate protective foods and related health research opportunities for advancing the roles of fresh market stakeholders. It will be connected to a major university with aligned interests.

Solar power area will be a designated space for on-the-ground solar panels to supply the energy needs of the fresh market, notably cold storage units. They will be fenced off and off-limits to non-authorized personnel.

Water harvesting/ collection area will leverage the best available technology in rainwater and ‘ambient-air’ overnight water harvesting in order to satisfy as much of the freshwater needs for the fresh market. This will also include

technology that recycles the moisture produced in the cold storage units and channels into collection tanks.

Chef demonstration area will bring skilled professionals in to showcase recipe ideas and new cooking techniques to encourage greater participation in the market. Management will work with chefs to ensure they are using produce that is in high supply, to then drive demand and minimise any possible waste for produce with which people are unfamiliar. Key Ingredients on recipe digital/paper sheets will be locationally identified at the numbered stalls in the fresh market for ease of purchase. Aligned with this food concept, Street Food / Pop Ups will provide cooked food dishes representing the produce sold at the fresh market and may have the option to introduce healthful international foods. The ‘Makati Vendors Programme’ (Philippines) is an example where women entrepreneurs that pre-cook and sell meals to schools or at transport hubs can join the fresh market scene. This initiative has also integrated members of the urban poor into the formal economy. The vendors were educated on how to correctly store their produce and encouraged cleanliness to improve food safety. Accordingly, municipality officials supported markets in applying (Global Panel, 2018b) these practices.

In this example, protective local foods produced by traditional local smallholders are being protected through the provision of a simple marketplace. This marketplace has also become the centre for educating smallholders on how to improve food hygiene. Traditional culinary cultures that rely on protective locally sourced produce has been preserved thus ensuring economic, social and environmental sustainability.

The creche/day care centre will provide childcare to empower women to participate in the market activities and therein redress gender inequality present in rural agricultural while enabling social mobility.

Education/ training will provide the fresh market vendors with workshops on various topics from basic financial skills through to recommendations on growing techniques for different produce and how to combat their respective pests and diseases. Farmers and customers can participate in lessons in core skills such as: agricultural inputs, agroecology, business literacy, nutrition, seasonal meal preparation for sustainability and waste minimisation. This hub will also employ people from the existing pool of extension agents, with a view to bring on more practitioners/experts in these fields.

Permanent shop units will provide a small restaurant, café, produce, meat, fish, bakery, corner shop and related essential shopping services to customers on an extended hour basis to maintain ongoing interest in the fresh market and serve as a point for essentials for consumers unable to visit the market at more typical hours.

2.3 Innovative Services and Fresh Markets

In addition to the above-mentioned functions, innovation in services should be a feature of the 21st century fresh market.

Market the Fresh Market – Many of us grew up in the powerful marketing and advertising presence of major food conglomerates. Singing the remarkably effective advertising jingles of leading television commercials was the norm as we integrated fast food, TV dinners and ready meals into our ‘modern’ way of life. These firms and their products are ubiquitous, including in supermarkets, conveying a sense of prestige and normalcy to life in our consumer world since the latter half of the 20th Century. In all that time, can any of us recall similar advertising, marketing and communication drives for protective foods or fresh markets? This Handbook has familiarised the reader with the critical importance of fresh markets to our diets, our health, our livelihoods, our economies, and, indeed, our very existence.

As such, we propose major media campaigns that convey these fundamental messages in relation to the importance of both protective foods and fresh markets as a fundamental part of the health infrastructure of society (WHO,2006 – Strong and Healthy Me Campaign; NHS 2020 5 a Day Campaign; WHO Fruit and Vegetable Promotion) with past examples to be updated and presented with the full array of social media devices and strategies. As such fresh market owners, operators and other stakeholder beneficiaries will be drawn together to create and implement strategic planning, creative services, brand activation, media planning & buying (traditional and digital), internal campaign development and social media activation aimed at promoting their fresh markets and food sales. For reasons of financial aggregation, a national network of fresh markets could generate significant financial and expert resources for this common purpose noting that government support should also be elicited for public health reasons.

Education and Training Campaigns - Further to these efforts, education and training, seminars with health, culinary, sustainability, climate resilient agriculture will be a feature of what fresh market networks do with facilities on site for this purpose. Fresh market management and leadership will work with stakeholders particularly on the supply side to advertise and promote protective foods and related products and services, mirroring the many uses featured at fresh markets. In this regard, public-private strategies to fund and promote protective foods and fresh markets in societal food, health, and sustainability initiatives will feature with on-site media centres and advertising, marketing and related communication resources related to such campaigns.

Cooking Skills and Recipes for Food Health - In order to draw further attention and customers to fresh markets and their vital role in promoting food security, food culture and sustainability, we suggest that fresh market operators draw

upon the knowledge and experience of organisations such as the World Vegetable Centre to develop and promote recipes on-site and on-line (<https://avrdc.org/publications/recipes/>). A simple format would identify a range of culturally representative meals including dishes of the day, with customers being directed to their main ingredients and their locations on-line or in named aisles and stalls at the fresh market itself. Shanghai markets have such an example of on-site cooked and prepared food offerings (<https://culinarybackstreets.com/cities-category/shanghai/2015/ask-cb-14/>) though the proposal made here of on-site chefs preparing dishes and meal programmes appears to be unique.

Mothers and Children - Women play a fundamental role at fresh markets as sellers, staff, managers and customers. Given these novel and important roles why not provide a creche, nursery service? This is of fundamental importance to the fresh market and the communities that it supports. That is why we propose this use at fresh markets. It is already happening in Kenya (<https://allafrica.com/stories/202009080250.html>) and children that grow up in a healthy food cultural environment are likely to develop good eating habits.⁹

Fitness Facilities - as diets become Westernised and urbanisation accelerates, people need a place to stay fit as part of the healthy lifestyles that accompany protective food consumption and fresh market community culture. That is why it makes sense to have fitness facilities on site. That is also what is happening at the Nakuru, Kenya market. (<https://www.youtube.com/watch?v=aAXKineXO6o>)

2.4 Technical Innovation and Smart Fresh Markets¹⁰

In addition to the above suggested multi-functional design and service innovations, other technical innovations are presented in this section. Their relevance to fresh markets and possible solutions are provided for each innovation.

2.4.1 Post-harvest loss

Why is it relevant to Smart Fresh Markets?

Post-harvest loss (PHL) is a problem that plagues and frustrates much of the developing world. For example, in Tanzania, accumulative PHL conservatively

⁹ American Heart Association. "Healthy eating behaviors in childhood may reduce the risk of adult obesity and heart disease." *ScienceDaily*. *ScienceDaily*, 11 May 2020. Available at: www.sciencedaily.com/releases/2020/05/200511092923.htm.

¹⁰ More details can be provided from market suppliers for these innovations as I have their contact information and/or have been in contact with them.

accounts for 45% of food loss (Abass et al., 2014). Worldwide, the FAO estimates that food loss varies from 20-50% of all food grown, depending on the type (FAO, 2015). Most loss results from production, handling, and storage challenges in developing countries, with consumption waste accounting for only 1.3% of all food loss and waste in Sub-Saharan Africa (HPLC, 2014). One common challenge producers in tropical countries especially face are insect pests such as borers and weevils that spoils vast quantities of grain – e.g. 15-25% of PHL in Tanzania (Abass et al., 2014).

What is current practice?

Pesticides are the predominant method of pest control. However, in developing countries, cost, availability, poor regulatory oversight, and toxicity to human health (not exclusive to developing countries) can have detrimental implications (Magolla, 1985). Moreover, there are concerns regarding pesticide resistance which has been rising and threatens the efficacy of all pest controls worldwide (Champ, 1985; Attia et al., 2020). External to dry grain storage, widespread pesticides that typically have low levels of selectivity correlate with the decline in pollinators critical to the biodiversity and habitability of the planet (Walker and Wu, 2017).

What could be done differently?

One method that is represents a solution more affordable, lower impact and lower risk to human health is biological controls (Sampaio et al., 2009). Such methods that have to some extent been practiced since time immemorial, are now gaining increasing traction, with the additional advantages of contemporary knowledge and resources behind it.

Innovations in this vein include ‘botanical pest controls’: – see Trivedi et al., 2018; Guleria and Tiku, 2009 for detailed overviews). Methods being pursued include plant extracts such as: essential oils, flavonoids, alkaloids, glycosides, esters and fatty acids (Hikal et al., 2017). Commercial examples of products include - 1, 2, 3, 4.11

¹¹ As enumerated see: 1. <https://biopurebotanicals.com/> 2. <https://www.puresolutions.com/pure-page/botanical-products/> 3. <https://noosapest.com/pest-control/green-pest-control/> and, 4. <https://www.agrosustain.ch/> . This article offers a balanced appraisal of biological versus chemical pest control agents: <https://owlcation.com/agriculture/Biological-vs-Chemical-Pest-Control>. For a specific example involving cabbage crops produced by smallholder farmers in Africa and comparing botanical to chemical pesticides see the following article: <https://www.sciencedirect.com/science/article/pii/S0261219413002974?via%3Dihub>. It specifically concluded that “the use of locally available plant materials as crop protectants could be less expensive and give financial benefits that are higher or comparable to synthetic insecticides. This justifies further evaluation at a larger scale and over multiple years as well as work on efficacy in a wider range of pest/crop systems.” As such, in a number of instances, botanical pesticides will have a neutral price impact.

Though these are limited to developed and temperate environments. For tropical agriculture the market is currently underserved.¹²

Overall, however, biological pest control offers high efficacy at low cost (Lundstrom et al., 2017). The main constraints to commercialisation are availability of plant material, level of reapplication, standardisation in accordance with international food quality regulations, ease of registrations, concerns over intellectual property protection (Travedi et al., 2017; Gryzwacz et al., 2013). Obstacles to uptake meanwhile are mainly differing level of threat perception: in that this is usually a product of local knowledge and observation, and can diverge from biocontrol experts (Wyckhuys et al., 2018). It is believed some of these obstacles could be overcome through technology-led education programmes. Other forms of biological pest control are ‘bio-stimulants’ and pheromones (Baker et al., 2020; Yakhin et al., 2017).

While nascent currently, such innovations represent a source of optimism and epitomises the benefits of global collaboration. Firstly, with advances in gene sequencing, it may be possible to synthesise the active ingredients in the plant material, eliminating supply concerns (Benelli et al., 2017). Grain storage pests especially, are a global problem, so incentive to invest from big well-funded grain distributors exists. Finally, such collaboration can facilitate the knowledge transfer of any promising break-throughs - especially between geographical regions that occupy similar latitudes and so have comparable climatic conditions – where the farmers would otherwise remain ignorant of methods successful in similar growing conditions (Wyckhuys et al., 2018).

2.4.2 Cold hub and cold storage solutions:

Why is it relevant to Fresh markets?

The challenges are not limited to ambient dry grain storage. Globally, management of perishables is instrumental in preserving perishable foodstuffs. However, inadequate cold chain management across the supply is common in developing countries and remains a critical barrier to reducing food loss, especially in hot countries (Heard and Miller, 2016). As countries develop, cold chain management can expect to expand. For example, it grew 50% from 1998-2008 in India (Yahia, 2009). Why is it a smart solution? As per the table below, cold storage significantly extends the life of fruit and vegetables, making them sellable for long periods of time as follows:¹³

¹² For example, see: <http://projects.nri.org/options/9-about-the-project>.

¹³ Taken from: <https://www.crscoldstorage.co.uk/news/cold-storage-fruit-and-veg.html>

Produce Type	Optimum Temp °C	Optimum humidity %	Storage life
Apples	1-4	90-95	Up to 12 months
Bananas	13-16	80-95	Up to 3 weeks
Berries (incl. Strawberries)	0	90-95	Blackberries/raspberries (3 days) strawberries/cherries (7 days)
Grapes	0	85	Up to 8 weeks
Nectarines, plums and peaches	0	90-95	Up to 5 weeks
Pears	-1-0	90-95	Up to 7 months
Broccoli and cauliflower	0	95-100	Up to 4 weeks
Carrots, mature and immature	0	98-100	Mature, up to 9 months and immature up to 6 weeks
Onion (white and red)	0	65-70	Up to 8 months
Lettuce	0	98-100	Up to 3 weeks

What is current practice?

Current practice relies on refrigeration units that need large and consistent amounts of electricity, which is principally derived from fossil fuels. Thus, there is a concern that an expansion in cold storage to mitigate food loss may be offset by the energy requirements needed to power them. (Ibid.)

What can be done differently?

To limit unintended environmental consequences of expanded cold storage, refrigeration facilities must be renewably powered. Moreover, the low connectivity that characterises areas of low development, supports the case for off-grid solar-powered cold storage solutions (Luerssen et al., 2020; Brookings Institute, 2019). The high levels of natural sunlight make solar-powered solutions the most appropriate choice for developing countries in the tropics.

The following are a sample of some innovative off-grid solar-powered cold storage solutions:

<http://www.coldhubs.com/> - According to a Nigerian market example (Obinze Market, Owerri, IMO State), a three foot by two foot by one-foot crate costs 25 cents (\$0.25 USA) per day to store. One buyer reported a 500% increase in purchases owing to the cold hub storage capability as a result of stress reduction over daily spoilage rates.¹⁴ See also:

<https://energy-base.org/projects/sustainable-energy-in-agriculture-in-colombia/>

<http://www.solarfreeze.co.ke/impact/>

<https://solarcoldbox.com/high-cost-food-waste-cold-storage-solution>

<https://www.brookings.edu/blog/future-development/2019/10/16/how-off-grid-cold-storage-systems-can-help-farmers-reduce-post-harvest-losses/>

Handheld instrument to measure grain moisture – such that farmers can store their grain without risk of mould, pests etc. and then sell it at a higher price when demand rises later in the year. - <https://sesitechnologies.com/>

Off grid solar, Kenya specific - <https://www.treeseamals.org/>

Conventionally-powered cold storage rooms can be purchased from as little as \$3,000 per unit.¹⁵ A 54 m² unit with a storage capacity of 40 crates (each crate being 1 m X 1m X 0.25 m) at \$0.25 per day would yield an income of \$10/day (\$3,650 per year). Accordingly, the payback period for the unit would be just under 1 year. A \$0.50 per day charge per crate would cut the payback period down to less than six months. Energy costs for such a unit have been estimated at \$950 per year. If they are factored in, then we can add 95 days (just over three months) to the payback period at \$0.25 per day then the energy utility bills would have to be factored into crate payments (by increasing them by \$0.06) thereafter.

For a larger scale example, for the price of \$4,000 a conventional cold storage unit of approximately 100m² metres per unit can be purchased.¹⁶ With each square metre of storage space (4 crates) attracting \$1 per day in revenue the payback period would be 40 days (\$1/day X 100 crates X 40 days = \$4,000). This excludes installation and energy use costs.¹⁷ Thus energy costs would add an extra \$0.06 cents per crate (or less) after the payback period.

¹⁴ See the informative video in this regard: <http://www.coldhubs.com/coldhubnews>

¹⁵ See the following unit as an example: <https://dgcoldroom.en.made-in-china.com/product/iKpELMVYaUck/China-Solar-Power-Cold-Room-for-Sale.html>. This is a slightly larger unit for \$8,500: <https://www.indiamart.com/proddetail/solar-cold-storage-22385716073.html>

¹⁶ See for example: <https://coldroomcn.en.made-in-china.com/product/gjbxqfuMCZVt/China-Customized-Cold-Room-for-Food-Storage.html>

¹⁷ According to an Indian study for a 50m² cold storage unit the electricity use cost was \$950 per year. See: <http://odihort.nic.in/sites/default/files/10MT-Cold-Room.pdf>. In another Indian study the electricity cost for a storage room was indicated as \$1,335 per ear <https://www.agrifarming.in/cold-storage-project-report-cost-and-subsidy>

Solar-powered cold storage units come at a higher price but have no real energy costs. Accordingly, a 20 m² “Cold Hub” unit has a purchase price of \$28,000.¹⁸ It can store 150 (30 kg) crates. If such crates attract a cold storage charge of \$0.50 per day, then the total income per day is 150 crates X \$0.50 or \$75. If the price of the unit is internalised in crate charges, then it would take just over one year to pay off the cold storage room. This is because \$75/day crate revenue X 365 days produces revenue of \$27,375. To benefit smallholder farmers and other socioeconomically challenged sellers, a crate storage charge reduction to a very affordable \$0.25 per day would produce a payback period of just over two years. This can occur without any form of government or donor subsidy even though it would be appropriate to have one given the energy infrastructure savings to the state and the greenhouse gas emissions reductions as well. It is worth noting that these units have a product life of 20-25 years (i.e., a minimum of 18 years beyond their payback periods).¹⁹

2.4.3 Solar drying

Why is it relevant to Fresh markets?

Drying crops reduces the moisture content and so slows down decay from insect infestations, enzyme decay, and micro-organism growth – facilitating longer term storage (Muhlbauer, 1998; Tomar et al., 2017). Nutritionally, fibre, protein and energy content are retained after the drying process.

What is current practice?

Traditional sun-drying is quite slow so such loss can occur from decay regardless (Muhlbauer, 1998). This process is prone to high levels of loss due to i) uneven moisture removal due to natural drying conditions variation throughout the diurnal cycle; ii) insects and rodents iii) insufficient drying prohibits reaching safe

¹⁸ For more information on Cold Hubs please see: <https://www.engineeringforchange.org/solutions/product/cold-hubs/>

¹⁹ According to the Cold Hub unit inventor Nnaemeka Ikegwuonu: “One of our hubs is in a large fish market here in Nigeria ...[it means that] more than 300 women will have access to cold storage. And another hub is going to be located in Tanzania next year as a special hub for a refugee market,” says Ikegwuonu. “The goal is to eliminate all previous losses in fruit and veg, increase the income of the farmers, retailers and wholesalers, and create employment for women, as we hire women to work in the hubs themselves.” For more please see: “One of our hubs is in a large fish market here in Nigeria...[it means that] more than 300 women will have access to cold storage. And another hub is going to be located in Tanzania next year as a special hub for a refugee market,” says Ikegwuonu. “The goal is to eliminate all previous losses in fruit and veg, increase the income of the farmers, retailers and wholesalers, and create employment for women, as we hire women to work in the hubs themselves.” For more information see: <https://www.theguardian.com/global-development/2017/dec/28/fighting-food-waste-in-africa>

moisture levels before the crop needs to be moved on (Tomar et al., 2017; Alam and Singh, 2004).

Meanwhile more advanced large-scale drying methods that are common amongst developed countries and large-scale processors in developing are expensive, unreliable, and energy intensive (Tomar et al., 2017).

What can be done differently?

Solar-drying usually involves the enclosure of crops within layers of transparent plastic. With indirect sunlight exposure, it provides a more consistent and efficient drying environment such that: solar drying is comparatively (i) faster, (ii) more efficient (iii) hygienic and (iv) incurs lower crop losses (Tomar et al., 2017; Karim and Hawlader, 2004). This method is simple and affordable, with estimated cost of materials at **\$195USD**. Financial and technical efforts to raise adoption of existing systems is needed (Udomkun et al., 2018). On the bright side, if food loss as a result of solar drying is 40% and food production and the average Kenyan smallholder farming family has an income of \$2,527²⁰ then a 40% food gain would represent \$1,010 of additional food (or five times the price of materials for such a solar dryer).

The design is so simple that there are few commercially available options, since the unit relies on the assembly of just a few basic, widely available materials: the first link provides such instructions. More examples are also included below:

- <https://horticulture.ucdavis.edu/information/solar-drying-adds-value-crop-surplus>
- <https://www.lleaf.com.au/>
- <https://www.solardryingsystem.com/>
- Low-tech drying unit for fruits and vegetables
<https://sparkysocialenterp.wixsite.com/sparkydryer>

In the alternative, a sparky solar dryer (run on biofuel) can be purchased for just \$80. Two kilograms of biofuel (from any woody or garden vegetation waste) is all that is needed to dry and thus preserve 10 kgs of mangos (for example) within 2 hours. This can be accomplished with no greenhouse gas emissions.²¹

²⁰ For this income figure see: <http://www.fao.org/3/a-i5251e.pdf>

²¹ These figures are drawn from a specific example in the following article: <https://www.theguardian.com/global-development/2017/dec/28/fighting-food-waste-in-africa>

2.4.4 Reducing food loss – pre consumption at fresh market level.

Why is it relevant to Fresh markets?

According to YieldWise studies conducted by The Rockefeller Foundation, 10-17% of food loss occurs at fresh markets. Moreover, this means that the food has been grown, processed, packaged, and transported successfully to market by the producer and then is unable to be sold – constituting wasted effort, lower incomes, a known environmental impact.

What is current practice?

- i. The reasons for this are manifold; but essentially, without accurate information, it is difficult for supply to match demand. There is no means for smallholders to coordinate their supplies – both consumers and producers arrive at market, not knowing whether they will arrive at a glut or a deficit in the market – which naturally influences the price producers receive and what consumers may be willing to pay. This discrepancy creates a market imbalance that will invariably lead to food that is unable to be sold and goes to waste.
- ii. At the market level, food spoilage can also occur from insufficient cold storage (see b), and from inadequate packaging solutions. Current packaging and transport are dominated by cheap Styrofoam-based containers; these are inadequate and horribly damaging for the environment – either being burnt or dumped in landfill.

What can be done differently?

- i. Simple pricing information sent through to the mobile phones of smallholders via the mobile internet networks that are expanding across sub-Saharan. This ensures farmers can receive a fair price for their goods and are not subject to market exploitation. It can also better manage both the supply and demand side data so as to reduce waste.
- ii. Mobile banking. The last decade has seen a mobile banking revolution in developing countries. With Smartphones available from \$30USD, this is bypassing the need for expensive telecoms infrastructure – raising the accessibility to low-income farmers with little disposable income.
- iii. The impact of greater digitalisation and financial technology (FinTech), and overall financial inclusion of food producers in the market essentially lowers cost barriers arising from imperfect information and transaction costs. It was found to enhance synergies between environmental and social SDGs (Hinson et al., 2019). Ultimately, these technologies empower producers to participate in markets with more confidence, transparency, and assurances. Digital remote soil profiling that informs farmer how best to use fertilizer and water on respective crops.

Micro-finance for people that do not qualify for bank loans - <https://www.loanbee.co/>

iv. While packaging solutions may be effective, they are nonetheless environmentally impactful.

Some promising alternatives include:

Packaging derived from coconut fibres, a waste product of coconut cultivation, which is normally burnt - <https://www.fortunacools.com/>

v. Finally, cold storage facilities at the marketplace are critical to ensuring the food brought to be sold maintains its quality and that farmers and sellers can receive a good price.

A simple yet brilliant invention has been provided by an 18-year-old recent Kenyan graduate named Gabriella Kiso. It builds in part on the cold storage units concept (see above). However, it is an all in one market stall with an integrated solar panel on the roof that powers a cold storage unit integrated into the stall - <https://africasustainabilitymatters.com/meet-18-year-old-graduate-greening-informal-food-stalls/>. These unique and trendy stalls can be rented for \$3 per day.

2.4.5 Waste management contiguous with commercial activities

Why is it relevant to Fresh markets?

Any solutions posed for Fresh Markets need to ensure there is adequate provisioning of waste management for three main reasons. Firstly, improper waste management leads to organic matter rotting, and unbiodegradable waste build up which can bring disease, pests and overall reduce community wellbeing (Global Dialogue on Waste, 2016). Polluted water course can get blocked and stagnant, creating ideal spawning grounds for malaria carrying mosquitoes. Secondly, waste can leach into water courses, polluting them and threatening water security (Sabiiti, 2011). Thirdly, it represents a loss of resources. Agricultural waste are by-products of the agricultural process that may have material benefit to people but are currently undervalued at less than the cost of collection, transport, and processing (Obi et al., 2016). Good waste management that is aligned with valorisation opportunities supports numerous SDGs on health and circular economy aims especially.

What is current practice?

Current waste management is very underdevelopment and is largely left as an environmental externality – either abandoned or taken to ‘open dumps’. Poor planning, facilities and governance limit proper waste management and the utilisation of waste as a resource (Sabiiti, 2011).

What can be done differently?

Waste management is a problem that pervades globally; few countries have this problem under control. As such, the incentives to provide workable solutions exist at all levels of development. There is no silver bullet but several promising solutions that seek to address this challenge should be explored. Chief among these is the opportunity provided by the humble black soldier fly (BSF).

BSF is an insect with a life cycle of a few weeks that consumes up to 50 times its body weight. Eating food market by-products that are particularly strong smelling and difficult to deal with such as manure, meat and fish offal, kitchen waste. Once grown they can be harvested and provide a nutritious protein-rich feed for aquaculture and livestock, and potentially for human consumption too (Nyakeri et al, 2017). BSF can even have applications as a blended biodiesel found to deliver improved performance at lower emissions (Rehman et al., 2018). For examples see:

<https://agfundernews.com/protenga-roslin-technologies-invests-in-protenga-novel-black-soldier-fly-production.html>

<https://www.eatcrickster.com/blog/black-soldier-fly#:~:text=A%20black%20soldier%20fly%2C%20or%20Hermetia%20illucens%20is,can%20actually%20be%20put%20to%20use%20by%20humans.>

BSF stands to revolutionise solid waste management. At present its implications for a developing world context are somewhat under-researched, however the potential is high. BSF can be employed as means of breaking down all organic waste - and produce feedstock for livestock and aquaculture, or for direct human consumption.

BSF are not fussy: they will consume (a combination of) livestock manure, fruit and vegetable waste, bones, offal, and crucially human waste (Raksasat et al., 2020; Banks et al., 2013). A single larva with an average weight of 7.82mg can consume 25 times its body weight daily – up to 200mg/day (Atiogbe et al.,2019).

Moreover, they will accumulate and indirectly remove toxins, that could otherwise damage soil and water courses, including pesticides and heavy metals, to levels that are within safe parameters (ibid.). This is especially relevant for cattle, who can succumb to diseases from eating feed grown with heavy pesticide use that can gradually build up potency within them, that can be passed on to milk produced (Ahktar and Ahad, 2017; Khaniki, 2007).

We envisage Black Soldier Fly being employed at smallholder and market level. Consuming farm and fresh market by-products that are particularly strong smelling and difficult to deal with such as manure, meat fish offal, and kitchen waste; those that are otherwise left to rot, and for which improper management can harbour myriad diseases and endanger human health (Kouamé et al., 2014).²²

Beyond, this benefit to solid waste management, BSF offers a range of commercial opportunities. Once grown they can be harvested and provide a nutritious protein-rich feed for aquaculture and livestock, and potentially for human consumption too (Nyakeri et al, 2017). When they transform into the pupal stage the castings they shed, as well as their bodies when they finally die are very rich in nitrogen and can be mixed with grey water for an effective fertilizer (Beesigamukama, 2019; Green and Popa, 2012). Finally, BSF can even have applications as a blended biodiesel found to deliver improved performance at lower emissions (Rehman et al., 2018).

Economic viability as feedstocks

The clearest opportunity for commercial returns from black soldier fly comes as a substitute to conventional feedstocks for farmed fish (aquaculture) and livestock.

Poultry

A study looking at the potential of Black Soldier Fly Larvae Meal (the end product of harvesting) in Kenyan poultry sector revealed the following findings. Replacing 5%-50% of all conventional feed sources – fish meal, maize, soya – could generate between 69-687 million USD, and the inputs saved there in could feed between 0.47–4.8 million people, with the economic benefit derived lifting 0.32–3.19 million people out of poverty, whilst properly disposing of 2–18 million of biowaste (Abro et al., 2020).

Presently, Kenya imports large quantities of these feedstocks. Thus, substitution would be especially advantageous, as the prices of fish meal, maize and soya are only expected to rise; e.g. over the last two decades they rose by 70%, 65%, and 94% respectively (World Bank, 2018).

See the estimated cost of imported feedstocks for poultry for the period of 2009-2013: quantity ([FAO, 2019](#)) then average price for the same period (World Bank, 2018 cited in Abro et al.,2020).

²² The costs for solid waste management benefits are currently unavailable, since at present there is a very limited waste disposal service industry operating in developing countries.

fish meal: 4968 t x \$1552/t = 7,710,336

soya bean meal: 18,430 t x \$451/t = 8,311,930

maize: 10,500 t x \$337/t = 3,538,500

Therefore, for imported poultry feed alone Kenya spent \$19,560,766 in foreign exchange per year (at 2009-2013) estimates.

Fish Feed

For expanding aquaculture use, which has seen growth globally of 97% over the last decade (see fig.1, [Global Aquaculture Alliance](#)), the argument is especially strong. Popular fish such as salmon, tuna and prawns are carnivores so are presently fed fishmeal - smaller fish crushed - which is both hugely damaging to fish stocks and is economically inefficient. With such demand for fishmeal, and relatively stagnant if not dwindling supply, naturally, prices of fishmeal since 2000, have risen 255% ([Index Mundi](#)) [even accounting for a cumulative price increase due to inflation of 55% ([CPI calculator](#))] With the price standing at \$1,479.92, as of August, 2020. Therefore, a price lower than this figure per ton of BSF meal would present a strong economic argument for this alternative, and for corresponding investment to build the sector's capacity.

Fig.1 Global aquaculture, fishmeal and fish oil use.

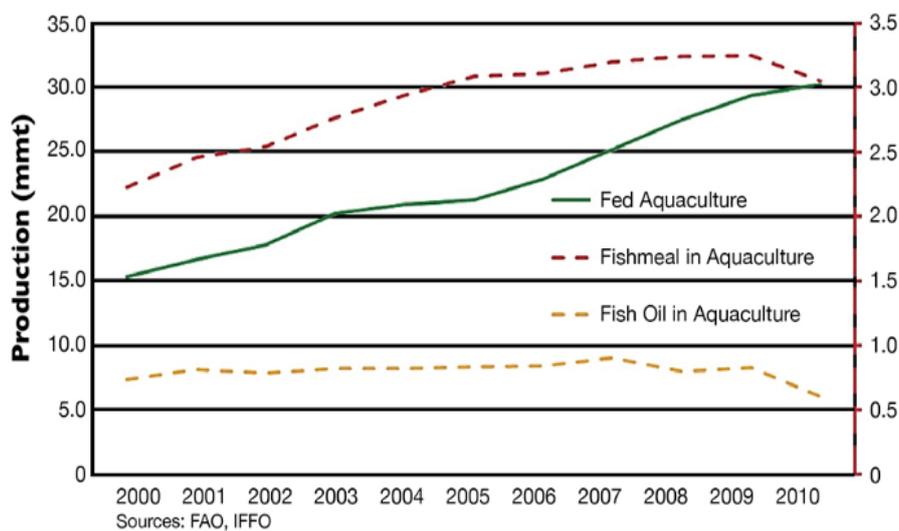


Fig. 1.: Global aquaculture production, fishmeal use and fish oil use.

Moreover, while fish feed for such carnivores can be mixed with plant proteins such as soya, the growth performance declines with percentage included (<https://bit.ly/3ikrsop>). This does not occur with fish meal mixed with BSF. Studies of Atlantic Salmon and Nile River Tilapia – the latter is common in Kenya - showed that feedstock derived from BSF represents a nutritionally suitable alternative with no negative effects on growth performance (Belghit et al., 2018; Toriz-Roldan et al., 2019). Thus, early research suggests that BSF derived meal represents an environmentally and financially better alternative - especially since based off trend rates, the prices of these conventional feeds are predicted to only rise (World Bank, 2018; Index Mundi).

Black Soldier Fly Meal

Due to the nascent nature of BSF derived products, costings are inherently tentative at the moment, and technical feasibility is currently under-researched, especially in the developing country context. However, we can make some early estimations.

In general, a female BSF after mating is capable of laying 500 eggs daily. 1kg of fly eggs will produce 380kg of larvae (maggots) in just 3 days – about 10 bags of 25kg bag of dried feed). In 10 days, they would have hatched, grown into 1cm long maggots for harvest, processing into Maggot feed and ready to feed your livestock (source).

In terms of starting the cultivation of BSF, this is difficult to cost accurately. Commercially, BSFL can be purchased live at \$35/2000 live larvae.

1 live larva -- weighs about 7.82 mg (Gao et al., 2019)

$7.82 \times 2000 = 15640.0$

$\Rightarrow 15.64 \text{ g}$.

The final weight can be 0.25g

Thus, 2000 larvae can produce a live weight of 500g.

If 380kg of live larvae produce a dried weight of 250kg

500g of live BSFL will produce a dried weight of 329g.

However, this is misleading, since Black Soldier Fly exist naturally, and can be attracted from the wild at negligible cost. Indeed, some Kenyan entrepreneurs are doing just this. In Kenya - a kilo is being sold at 35 cents. Thus, if we review this cost in comparison to the prices for conventional feedstocks (Index Mundi): the standings are as follows.

Feedstock	\$Price/ton
Black Soldier Fly	350
Maize	143.71
Soybean Meal	374.95
Fishmeal	1,479.92

At a larger scale, the initial set-up costs were estimated to be higher, however, over time a longer time-frame marginal costs fell with subsequent high level of potential profitability (Pleissner and Smetana, 2020). Here are some relevant figures:

Full process costs: \$93,19028

Operational costs: \$6202.14 per day

Estimated cost of producing 1 ton = \$1703.91

The dried larvae (final product) command a market value of \$2140.70

With a net present value after 20 years of production of \$27,170,908.84

It is important to note that this is without factoring in the commercialisation of other by-products, namely fertilizer. With 53.6 t of fresh food waste yielding an estimated 6.35t of dried fertilizer per day (Pleissner and Smetana, 2020). Urea selling globally at \$249.50 (Index Mundi, August, 2020) which is the most common fertilizer with a high nitrogen content (46%), and would thus be a close substitute for BSF derived fertilizer. At this market value – the process would yield fertilizer (249.50 x 6.35) would yield an additional \$1,584 per diem.

**However, this study was conducted with respect to Germany where purchase power parity would yield higher costs compared to the equivalent factors of production in a Kenyan context.

With rising competition for land, food for human and livestock consumption, the demand for feedstock is only set to increase. Recent developments, especially in aquaculture and agriculture technologies, have helped to maintain relatively stable fish and commodity prices. However, this has come at a great environmental cost. As such, the need for alternatives feedstock is urgent. Black Soldier Fly could revolutionise solid waste management, as well as provide a steady income to millions,

whilst simultaneously reducing the environmental stress being placed on water and on land. The above calculations demonstrate the economic viability of this nascent innovation. Currently, from a purely economic perspective it offers a better alternative than fishmeal – which is necessary for certain applications, namely, aquaculture. Naturally, these costs could be expected to fall as more production occurs and economies of scale are realised. Thus, factoring in the myriad benefits that BSF brings, this is a clear investment opportunity that is ready to be realised immediately.

2.4.6 Biogas Digesters

Biogas Digestors could be a feature at every fresh food market. They provide both high-quality energy and fertilizer, reducing reliance therein on both fossil fuels and charcoal, and expensive chemical fertilizers respectively. Current feedstocks are heavily dependent on a continuous supply of cow and pig manure, meaning the viability of these systems is contingent of successful animal husbandry; this is especially at-risk during drought periods and can lead to abandonment of the system (Kajau and Madyira, 2019). Moreover, scale is key consideration. They still represent a high up-front cost requiring high technical expertise to run (Khan and Martin, 2016). Community owned biogas digestors that use a wide range of organic feedstocks are needed to raise their viability and lower risk barriers to adoption. The viability of fruit waste for biogas conversion has already been proven with encouraging results for biogas production.²³ See the following examples:

<https://www.biogasworld.com/news/small-scale-anaerobic-digestion-using-agricultural-waste-when-technology-and-science-team-up-for-the-environment/>

Larger unit suitable for a farming cooperative or fresh market model - <https://blog.anaerobic-digestion.com/biogas-digester-design-fertilizer-cost-reduced/>

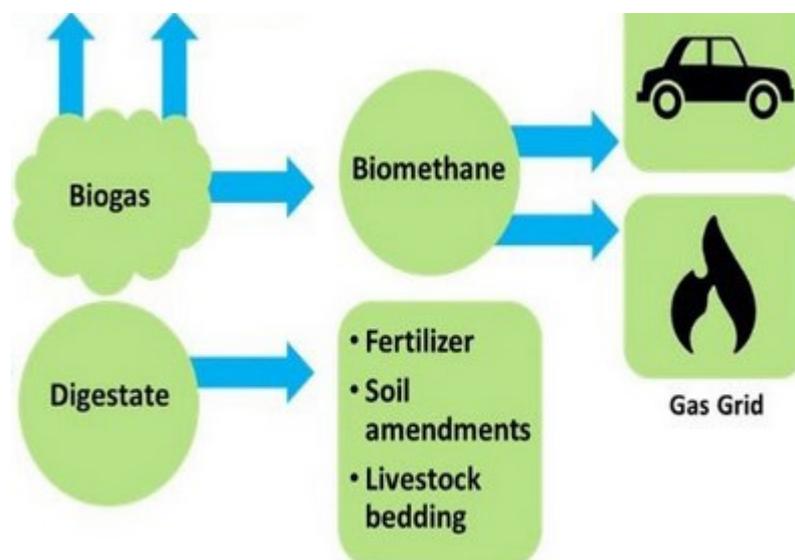
Smaller unit that could be more accessible on an individual level or amongst a handful of market participants - <https://blog.anaerobic-digestion.com/homebiogas-domestic-biogas-plant/>

New approach to waste management in Kenya, developed through the Newton Fund – an offshoot of BEIS - <http://www.newtonfund.ac.uk/news/success-stories/a-radical-new-approach-to-waste-management-in-kenya/>

²³ See the following article which analyses from a scale of 10 tonnes of (Orange, Mango and apple) fruit waste per day: https://www.researchgate.net/publication/322081766_Utilization_of_Fruit_Waste_as_Biogas_Plant_Feed_and_its_Superiority_Compared_to_Landfill

Biogas made from manure and other organic waste - <https://khainzaenergy.com/>

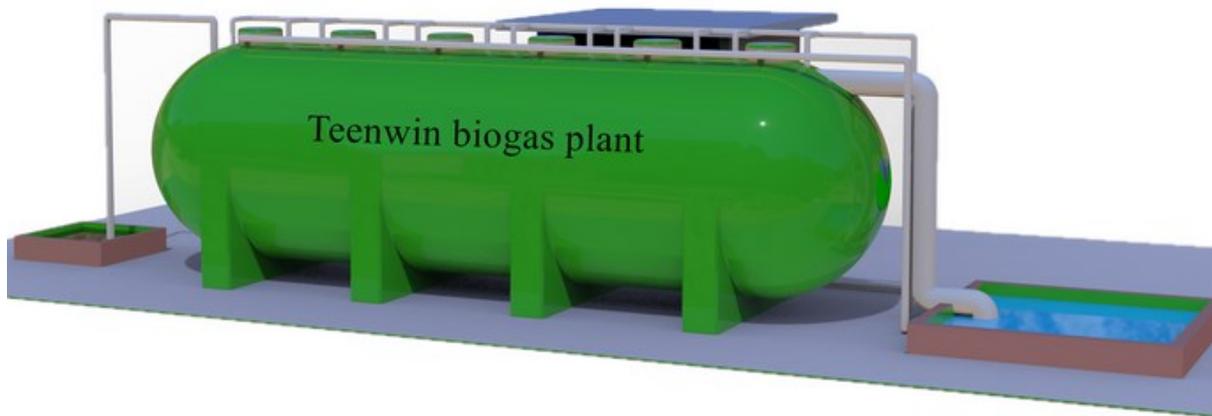
Biogas is a clean and renewable energy that may be substituted to natural gas to cook, to produce vapor, hot water or to generate electricity. It has a lower global warming potential than natural gas which is 99% methane. Biogas is generally comprised of 60% methane and 40% carbon dioxide. As such, biogas is good for the environment: “Methane has a greenhouse gas (GHG) heating factor 21 times higher than CO₂. Combustion of biogas converts methane into CO₂ and reduces the GHG impact by over 20 times. By extracting methane out of waste and using it to produce heat and/or electricity (for combustion engines, turbines) we ensure that the waste will not degrade in an open environment, therefore we are reducing direct methane atmospheric emissions. Moreover, the energy provided by the biogas is likely to displace fossil fuel which is the main contributor to GHG emissions. Biogas energy is considered carbon neutral, since carbon emitted by its combustion comes from carbon fixed by plants (natural carbon cycle).”²⁴ This diagram demonstrates some other potential uses of biogas and its digestate by-product.²⁵



The amount of biogas one can extract from organic waste depends on the waste itself and the design of the digester system. Some digesters can yield 20 m³ of

²⁴ See: <https://www.biogasworld.com/biogas-faq/>

²⁵ Adapted from: Figure 1: Anaerobic digestion process (Graphic by Sara Tanigawa, EESI). Available at: <https://www.eesi.org/papers/view/fact-sheet-biogasconverting-waste-to-energy>.



biogas per tonne of waste while others can yield as much as 800 m³ per tonne.²⁶ It all depends on waste quality, digester design and proper operation of the system.

Biogas plants can be installed and operated for a price of \$15,000.²⁷ The version below from China has a 20-year life span. It can produce 80 m³ per day of biogas and has a capacity of 125 m³. It requires 70m² of space (e.g., 4 metres by 17.5 metres). This makes it an ideal size for a small fresh market. The large green cylinder structures can be added side by side in proportion to the amount of available fruit and vegetable (and other vegetation) feedstock available. It produces a significant waste management solution and clean energy. For large scale fresh markets, it may even make sense to convert biogas to biomethane as an energy source for vehicles. There are various “plug and play” biomethane to biogas conversion systems available in the global marketplace.²⁸ They can produce fuel for vehicles at a price of approximately \$0.45/litre.

Biogas plants can take various shapes and forms. A simple agricultural plant could cost as low as \$3,500 per electrical kW installed. A municipal food waste plant can cost up to \$19,000/kWe installed. A typical payback period on a biogas plant is 7 years (without selling the gas as energy).²⁹

The table below demonstrates the energy return on food waste usage as feedstock:

²⁶ For these and more facts on biogas see: <https://www.biogasworld.com/biogas-faq/>

²⁷ See the following units the first of which is specifically for food waste: https://www.alibaba.com/product-detail/Teenwin-food-waste-treatment-biogas-plant_1600060523142.html?spm=a2700.details.deiletai6.6.3631632awDFnZy; https://www.alibaba.com/product-detail/Teenwin-biogas-plant_1600091169736.html?spm=a2700.7735675.topad_classic.d_title.19b4a573HdmBvz

²⁸ See this report on biogas to biomethane conversion technologies: <https://www.bioenergyconsult.com/biogas-to-biomethane/>

²⁹ <https://www.biogasworld.com/biogas-faq/>

Feedstock	System	Amount fed into digester	Biogas per year	powerQUBE CHP Rating
 Example: Food Waste	 1 x 20ft bioQUBE	183 tonnes per year	32,940 m ³	6 kWe + 8 kWth
	 1 x 40ft bioQUBE	441 tonnes per year	79,380 m ³	15 kWe + 21 kWth
	 2 x 40ft bioQUBE	882 tonnes per year	158,602 m ³	30 kWe + 40 kWth

BioQUBE matrix based on food waste feedstock, including: tonnes per year fed into the digester, annual biogas production and equivalent power and heat in a powerQUBE CHP engine.

Each cubic meter of biogas contains the equivalent of 6 kWh of heat energy. The same volume of biogas converted to electrical power yields 2 kWh; the rest of the energy is dispersed as heat that can be reclaimed and applied to other uses. By way of an example the 2kWh generated by a cubic meter of biogas can light a 40W light bulb for 50 hours. If a market producing half a tonne of waste as feedstock per day in turn generates 32,940 m³ of biogas per year, then the energy produced will cover all of the energy needs of the market and the remainder can be provided as cooking gas or electricity or even engine fuel for neighbouring uses. If we monetise the value of biogas, each m³ of biogas (with 60% methane content) provide 6.7 kWh of energy while one litre of petrol produces 9.0 kWh of energy.³⁰ 32,940 m³ of biogas has the same energy content as 24,582 litres of petrol. If we can produce converted biogas (to biomethane) for \$0.45 per litre and the prevailing price of petrol in Kenya is currently \$0.98 per litre (more than double the production price in our example) then this price differential represents some \$13,082 (24,582 litres x \$0.53). This is based upon using 183 tonnes of food, vegetables, and related vegetation as feedstock (see the BioQUBE table above). This is almost the purchase price of the Teenwin biogas plant (referred to in our diagram). It is not assumed that the purpose of such a biogas plant at a fresh market is to provide the equivalent of a gas station business. The illustration and calculation do however give an indication of the financial (not to mention environmental and other socioeconomic) benefits of biogas plant technology at a smart fresh market. This could well reduce the biogas payback period to a matter of a few years.

³⁰ For these conversion rates see: <http://www.sgc.se/ckfinder/userfiles/files/BasicDataonBiogas2012.pdf>

Biomass utilisation

- Biomass waste to fertilizer convertor – Converts rice husks and cassava peels into quality organic fertilizer - <https://safiorganics.co.ke/>

2.4.7 Water management and water-harvesting solutions.

Why is it relevant to Fresh markets?

Most developing countries are areas of high-water insecurity. This is likely to only worsen with climate change. Particularly in developing countries characterised by high seasonal variation in precipitation, rain harvesting, and water storage solutions are especially vital to ensure adequate year-round supply. Efficient management of sparse water resources that balances productivity and environmental impact is a key challenge for developing country agriculture, and is subsequently critical to the success of the Smart Fresh Markets initiative and wider initiatives such as UN SDGs and WASH.

What is current practice?

Most of the developing world agriculture is still rain-fed and means that farmers are beholden to the vagaries of annual precipitation variation. Inadequate rain harvesting facilities results in foregone water resources for potable and agricultural usage. Typical strategies involve makeshift collectors on roofs and sheds that channel rainwater down gutters into collection vessels. Outside of the rainy seasons, farmers are typically reliant on well and boreholes, which can be over-exhausted and lead to a depletion of the water table for the area. Meanwhile, management solutions such large scale dams, basins, drain infrastructure are beyond the reach of rural farmers. Moreover, a lack of data hinders deploying schemes in areas of greatest impact.

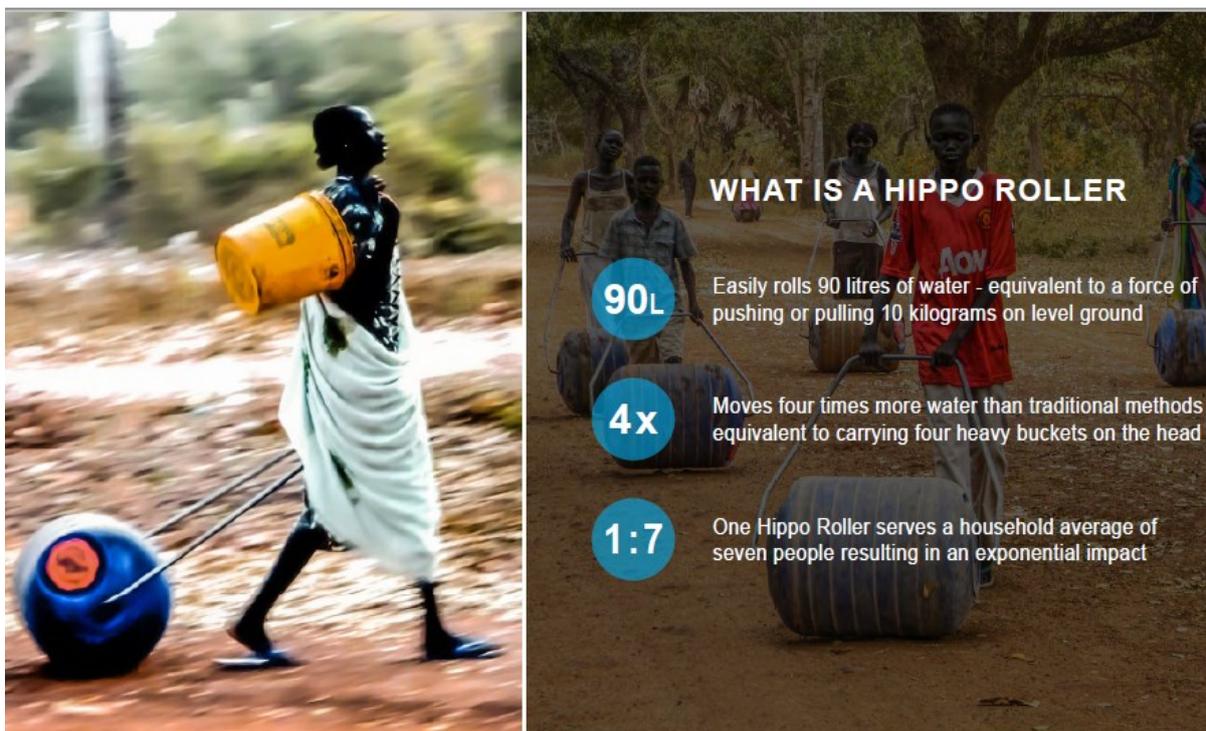
Traditionally however, there are other means that are successful. A ‘Zai’ or ‘Tassa’ consists of digging a hole on the land and partially filling with compost to attract plant matter and fauna that help retain the water and yield rich organic matter for mulch and fertilizer. Other low-tech solutions include large containers made of plastic or glass that collect the water as it falls.

What can be done differently?

While these are positive. To safeguard developing country water and food security, a more comprehensive approach to water management and water harvesting needs to be employed. Here are some examples:

- Water collection can be difficult and physically demanding. This solution aims to make that process easier - <https://hipporoller.org/>
- More sophisticated medium-scale rain harvestment for community buildings such as a cooperative - <http://ecosoftt.org/water-wastewater/rain-water-harvesting-2/>
- Low water usage mushroom cultivation units that empower women especially - <https://www.agrilinks.org/post/fungiculture-and-success-malawi>
- Despite access to piped water rising from 36 to 46% in Kenya, there is no monitoring and so the utilities companies can get away with underdelivering on the quality of service. An IOT powered start up is trying to change this -
- Technology oriented to help governments better manage water at the catchment year via satellite data and machine learning - <https://satsure.co/>

A nifty and effective solution for most smallholder farmers and householders is the Hippo Roller. Here is why it is a valuable, et simple technology. Farm scale rollers are \$125 each. The technology reduces human effort by 400% when moving around water for crop irrigation or consumption purposes. The farmer effectively saves 75% of the time that would otherwise be spent on crop irrigation. In addition, this product can serve a household of seven in relation to water provision.



In relation to rainwater, economic feasibility studies for Rainwater Harvesting (RWH) systems for developing countries and for agricultural are sparse and incomplete (Amos et al., 2016; Valasco-Munoz et al., 2019). Many broader studies believe however, that the potential is significant and currently remains untapped (ibid.); with recent signs in of progress on this front [11]. In theory, the most influential factor that determines the relative cost-benefit of RWH implementation is the price of water saved. However, his is hard to calculate as precipitation varies across regions, seasons and sources; and pertinently to our work on Smart Fresh Markets, there is low availability of municipal supplies in rural areas. Indeed, as of 2015, only 2% of the Kenyan’s water supply was from RWH sources. Thus while, this cost-benefit analysis will look at the finances of the technology, it is important to consider more holistic implications too.

Technology

Systems can vary in level of sophistication. Set ups tailored for Western markets typically include filters, and pumps, both of which require energy and would reduce its feasibility in a developing world context. Moreover, costs will vary depending on whether the water is potable or is suitable as “grey water” for agriculture only, after the water sits in the storage receptacle and becomes less safe to drink.

For our purposes, we shall include the following criteria:

- Outdoor use only; negating the cost of expensive plumbing that can make it less viable (Preece, 2006).
- Gravity-only; avoiding pumps which raise capital and maintenance costs (Hall, 2013)
- Non-potable water only, removing the need for filters [physically or chemically], given the nature of the ‘agriculture/food system’ focus of the SFM project.



Costings

Start-up capital costs:

Materials:

Water Tank of 10m³ = 68,000 KSh [2] / 624 USD; or 65,700 KSh / 603 USD [4]

- Mean price (3s.f) = 66, 850 KSh / **613 USD**
- The piping of the RWH system that directs the water (see image below) is like that of a conventional gutter and can be constructed using cheap PVC piping.
- Labour costs.
- Estimated based off one days' unskilled labour - Ksh282.90 or 2.60 USD.
- But the farmer and/or collective could install so this cost will be considered negligible.

Running costs

Mean Annual Precipitation (MAP) in Kenya – 1068mm

Tank size (Ts): Will vary with precipitation, as well as expected consumption patterns.

Roof Area (RA) is the height x width of the roof, or available water catching surface, and directly predicts the runoff produced.

Runoff: f(MAP, RA).

Using estimations from a 'nomograph' (see below) (Gathenya and Kinyari, 2010) as our reference. This would account for the run-off coefficient, since not all the water that lands will successfully enter the pipes of the RWH system. With the following values of:

$$RA = 80m^2$$

$$Ts = 10m^3$$

Runoff available to collect: 200 lpd (assuming rainfall of 1068mm/per annum).

Reliability (R) is: f(MAP, Ts, RA)

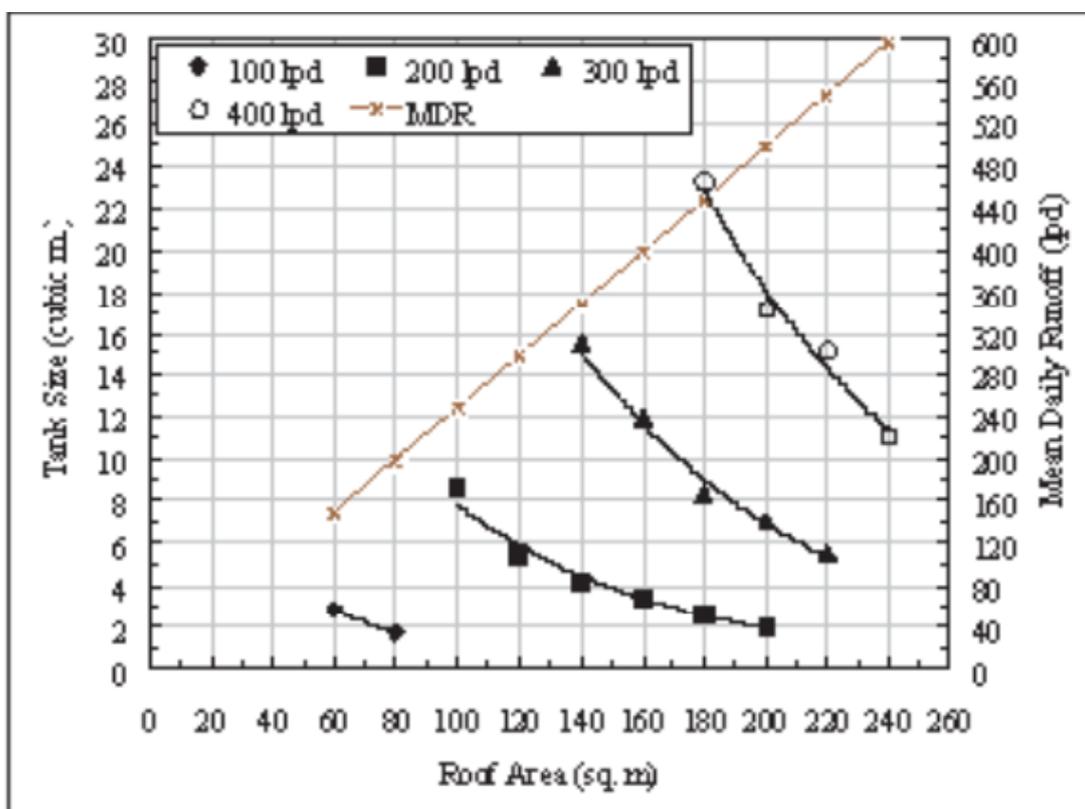
NB: The reliability will also be determined by usage, and thus how quickly the storage tank is drained. A 200 Lpd rate with a 10m³ (10,000L) – would fill the tank in 50 days of mean rainfall. However, in the tropics rainfall is very seasonal, so it is important to have the large buffer, so to over wastage during the rainy season.

This is an imperfect calculation since outside of Nairobi or other urban centres, there is low access to public water supplies. So, farmers are reliant on precipitation. However, based on the price of water from sold by "Nairobi City

Water and Sewerage Company” [3], who charge 53KSh/m³ to quantities between 7 and 60 m³, the cost of water saved is 530 KSh or 4.9 USD every 50 days. This represents an annual saving of: (4.9 x 7.3) 35.8 USD.

Payback rate: 613/ 35.8= 17.1 years.

However, we must consider that in rural areas, municipal water supply is largely unavailable in rural areas where most of the agricultural takes place. Moreover, it is possible for the supplementary water is the difference between a successful crop and failure – leading to almost total loss of yearly income. So, with these factors in mind, RWH facilities are almost priceless.



Source: Gathenya and Kinyari, 2010. Figure 4: A 67% reliability nomograph for Nairobi Dagoretti Meteorological Station (annual rainfall).

Barriers

The following barriers arise in relation to water management and water harvesting solutions:

- High initial capital cost of RWH is pushing them beyond the reach of average people in developing countries. This could be rectified with policy shifts and subsidies. Recognising that it is unrealistic to expect full capital recovery in development projects (Banerjee et al., 2010).
- Antiquated laws either discourage installation or are actively prohibitive of RWH systems in residential areas – policy needs to review this immediately.
- Some evidence suggests a review of policy to include RWH, alongside solar power facilities in new builds, is in progress – but this remains circumspect (UNEP, 2013; Berger, 2011).
- There are signs this is shifting [\[5\]](#)
- Lessons from philanthropic projects involved in ‘community hand pumps’, such as “[WASH](#)” suggest there is insufficient attention being given to training, maintenance and the long-term sustainability of water management grassroots projects (Amos et al., 2016).
- In Kenya, it is perception rather than practicalities that are stymying increased grey water usage – education is likely to be most effect to overcome this (Ngumbah, 2014).
- Farmer’s capacity to install RWH systems also depends on conditions of their land tenancy – as shorter terms will limit the incentive to invest in this technology (Kiggundu et al., 2018).

Rainwater harvesting represents untapped potential. Given the arid nature of Kenya’s climate, that is likely to become drier in the coming decades, the high dependence on agriculture, and the low level of access to municipal water supplies to rural farmers, this is certainly an easy win. While the costs may not look like a huge saving in more urban areas, such as Nairobi, when the price of water is moot, in rural areas the arguments are strong. The high capital cost relative to smallholder income make this technology beyond the reach for most. Thus, in lieu of the state spending on more expensive conventional plumbing systems, policy should be reshaped to incentivise installation of RWH systems. These could be done at the cooperative level to bring down marginal costs for the individual. Finally, while the ROI is poor monetarily and payback rate is long, the low absolute cost of implementation compared to the benefits yielded over the long-term should justify intervention from international philanthropic agencies to collaborate with municipalities and communities to scale up the use of this technology.

2.5 New business approaches for fresh markets

Integrating Fresh Markets into Wholesale Markets – In many nations, older regulations can impede the ability of markets to transform food systems and food security. They have also stood in the way of wholesale markets. Further to our analysis (above) on challenges and opportunities for fresh markets, it is fundamental to build a relationship with wholesale markets. Developing these actors will scale up sales from fresh markets and help to support and aggregate agricultural producers into a sophisticated business-smart force of entrepreneurs. For example, in London, wholesale and fresh market functionality has existed side-by-side with major markets at Billingsgate, Smithfields, and Spitalfields. These markets (which specialise individually in fish, meat, or produce) are planning to come together on one site to act as the major wholesaler and retailer for these products <https://wholesalemarkets.co.uk/>.

Fresh market advocates should look to the potential of this functional integration as a means of understanding a way to open sellers up to regional, national and international buyers and the associated business opportunities. In the London version, most ‘tenants’ are small businesses. Functional integration of these market opportunities will provide vendors with a digital platform with 5G connectivity, electronic ordering and other high-tech options. This includes new waste and energy strategies as well as new solutions for transport and logistics. This example could be easily within the reach of fresh markets an aligned with the cost-efficient technology options we have proposed here.

As an example of this original and innovative proposition, by coincidence, the Kigali Wholesale Market for Fresh Produce Market (KWMFP) is a major new project that has the potential to completely transform Rwanda’s horticulture value chain, generate new employment, strengthen access to the domestic and export markets for smallholder farmers, improve health and safety standards, traceability and food security, and ensure better and transparent farmgate prices for producers (Ugandan National Agricultural Export Development Board - UNAEDB). According to the UNEADB, the KWMFP will play a role in consolidation of produce, value addition, transport, logistics and information services. It promises to serve farmers, cooperatives, traders, transporters and consumers of all types, as well as processors.

Diversified customer opportunities for fresh markets - In addition to being the go-to location for local residents, fresh market vendors should also be supported in expanding their customer bases. This expansion can be driven by fresh market finance information and education. Trainings for these vendors can provide business market strategy, standard form contracts, and access to citizens/business legal advice. The development and presence of wholesale markets either near major cities and/or key produce, fish, meat production hubs will provide opportunities to

access supermarkets, restaurants, and many other institutions as new customers. This vision can in turn be replicated at the regional, national and international scales.

Vouchers for Fresh Markets – Though the range of possible public policy measures that could support protective food provision at fresh markets is potentially infinite, policies should address local customer demand for healthful foods as well. To ensure that demand remains for protective foods sold in fresh markets, and to compete with supermarket marketing campaigns, governments need to maintain consumer awareness. In Mozambique, a nutritious foods vouchers scheme is being introduced, supplied by local small enterprises and supported by NGOs. The vouchers are distributed through health centres by municipalities or through direct sales involving the fresh market smallholder (GAIN, 2015).

A Public-Private Governance Initiative - In Nanjing, China, a public-private hybrid model of governance has been found to ensure food security. It allows for fresh markets that sell produce from local supply chains, whilst introducing food safety policies. This model provided rent reductions to informal vendors and investment in storage infrastructure. The result is relatively easy and equitable provision in a healthy, local food system (Zhong et al., 2019).

Innovative Public-Private Partnership Contracts – Land ownership can be prohibitively expensive around the world. Therefore, novel contractual arrangements between municipal governments and private sector fresh market operators should be considered for public lands. In addition to lease agreements for the use of land for a prescribed period, ‘concession contracts’ can be formed. These would allow for the design and building of the market and its use for a prescribed concessionary period (e.g., 25-30 years) and offer the opportunity of a return on investments. Finally, a variation on the concession contract the [“Build-Operate-Transfer (BOT) contract”] allows the operator ownership of the fresh market for the duration of the contract. This arrangement dispenses with the need for constant consultation with the municipal government on site-related operational decisions. The Mandaluyong City Market is an example of such a BOT contract.

This model could be applied to the development of existing markets. Commercial activities in marketplaces could then reimburse the capital investment made by the private sector.

For example, private sector investment could go into ensuring adequate facilities of storage, better access to water as well as implementing our framework model of multifunctionality for a smart fresh market. Investment financing could be paid back to private sector investors through a percentage of sales, for example as well as bank interest.

(<https://ppp.worldbank.org/public-private-partnership/library/summary-mandaluyong-city-market-rebuilding-bot-basis-undp>)

2.6 Designing for space in the market

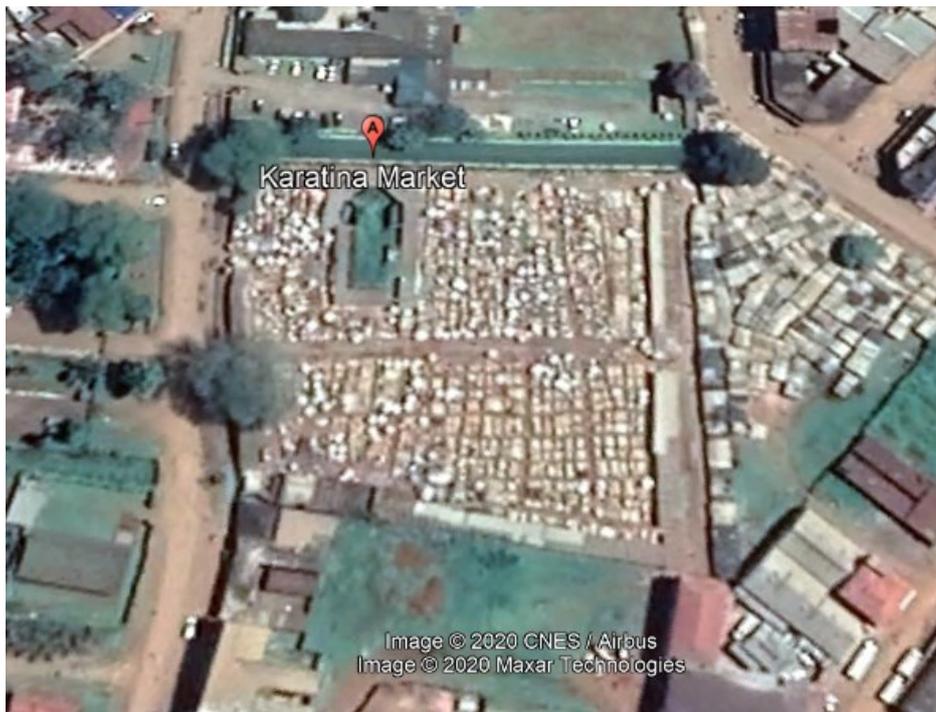
2.6.1 Conventional versus New Approaches

Why is it relevant to Smart Fresh Markets?

The design of the market space is critical to the realisation of Smart Fresh Markets. They will serve as a centralised hub for market related activity. On-site services will be numerous and varied to maximise the functionality of the space, especially considering they will be in areas where transport is poor and practical logistics can otherwise curtail choice, participation, and efficiency. They will also incorporate all the technologies previously discussed such as cold storage and waste management facilities. Centralised production for SFMs is likely to bring a myriad of benefits. In a similar project in Bangladesh, such market innovation improved production, household income, and food security (Roozen, 2018). With the larger aim supported by strong evidence that increased market participation brings many development benefits to the rural poor (Rapsomanikis, 2015; Omiti et al., 2009).

What is current practice?

Current practice is large but disparate and sprawling markets that are chaotic and dirty (see below). Karatina, in Nairobi, the largest open-air market in East Africa is emblematic of the problems facing current designs. Customers and vendors alike are concerned about disease and overall poor sanitary conditions caused by a lack of drainage, toilets and waste management facilities (Muchiri, 2019). There is minimal zoning and planning regulations to structure the market layout (ibid.). This results in an environment of confusion where traders are regularly overlooked and areas closest to the entrance or most trafficked areas are highly prized, with peripheral sellers routinely disadvantaged due to their unfortunate poor location (ibid.). For example, there are three floors, but customers rarely go upstairs as everything they demand is available on the first floor, and the upper floors lack access ramps and ventilation – both of which hurt trade and the latter of which is especially concerning in light of COVID-19. This inefficient layout engenders corruption and weak competition, which in turn hurts consumer value and social equality, with premium sites going to the highest bidder, not necessarily local producers (ibid.). In Karatina, such chaos and unfairness have precipitated an exodus of trade as customers and traders abandon the site and look for opportunities elsewhere. Indeed, a bustling hub of enterprise and commerce has since been reduced to a shell of its initial promise (ibid.).



What could be done differently?

The design of the SFM will seek to address the above failings through coherent, transparent, and consistent zoning policy. This will enable similar produce types to be located near each other in a logical way, both helping consumers navigate the space and creating choice and healthy competition. There is potential for colour coding and signage to help distinguish different produce zones, as was implemented in the Bangladesh “Village Super Market” (Roozen, 2018).

The SFM design will go beyond conventional fresh markets or farmers market, with designated zones to accommodate additional services such as: education and training centres, a ‘financial zone’, waste management facilities, and opportunities for ancillary commercial activity e.g. street food sellers and on-site ‘juicing’ of lower quality produce. Moreover, the SFM will serve as wholesale hub such that farmers can sell directly to consumers, buyers, restaurants, public institutions such as schools, hospitals, and eventually supermarkets themselves; together with the opportunity to distribute regionally and internationally. The following will detail further the different zones.

2.6.2 Education and training

These spaces will act as learning hubs where farmers and customers can participate in lessons in core skills such as: agricultural inputs, business literacy, nutrition, meal preparation – seasonal to ensure produce in glut is used at appropriate times to minimise waste.

Chg	%Chg	Vol B	Bid	Offer	Vol O
0.00	0.00%	20,709,800	5.45	5.50	42,815,900
+0.05	+0.29%	1,267,100	9.25	9.30	1,242,100
+0.00	+0.36%	354,100	6.35	6.40	168,400
+0.01	+0.08%	2,144,400	1.14	1.15	7,206,100
0.00	0.00%	4,302,745,000	0.04	0.05	5,448,146,400
+0.03	+2.83%	1,647,600	1.09	1.10	12,735,100
-0.02	-0.77%	23,545,800	2.56	2.58	8,524,100
+0.13	+7.88%	1,206,000	1.78	1.79	459,700
0.00	0.00%	12,178,200	10.30	10.40	4,427,000
+0.00	+4.55%	1,719,300	13.80	13.90	1,415,700

Vol/Value(K)	High/Low	Ceil/Floor
28,233,400	1.62	2.04
45,083	1.57	1.11

2.6.3 Market information and financial inclusion zone

Here, a system of digital payments could record market sales volumes from the market transactions. This would enable producers to receive up-to-date inventory information via an online platform. Since most people in Kenya have mobile phones ownership (see b.3), such facilities are within reach. This zone could also include a digital message boards, using solar powered efficient LEDs, for bulletins relevant to traders and customers - e.g. Sale on mangos, go to “zone 12”.³¹ This could then link up with the education hub, such that easy to follow instructions were given to advise people how to make the most use of produce that is in season and in glut. This board could even display accurate market prices for produce such that the parameters of sale are better defined, and producers and consumers can make more informed transactions (see above). A secondary function would be a place for farmers to obtain financial credit to support investment of new innovations. Farmers could come with a card or digital signature that corresponds to them and their cooperative. This way lenders have greater assurance that the farmer is part of a cooperative that can sponsor the risk they take on. In that, cooperatives grant better collateral (Carter et al., 2014) and enable agglomeration payments with lower interest rates (Onyegbulam et al., 2019).

³¹ A digital reference board is essentially a display monitor with information provided from a personal computer or laptop. A state of the art 65 inch monitor costs \$750 https://www.alibaba.com/product-detail/Hot-selling-65-inch-4K-wall_62456628223.html?spm=a2700.galleryofferlist.normal_offer.d_title.5ddd3482FtGL3w. Personal computers and laptops can be purchased for as little as \$500. So the overall investment is marginal.

2.6.4 Waste management facilities

Here we are aiming for no water toilets. Currently, the general low-level hygiene is compounded by inadequate toilet provisioning. In Katarina, there are just four toilets to serve thousands of people (Muchiri, 2018). However, The Gates Foundation has produced toilets that do not require



water, and instead use a series of chemicals to convert human waste into usable fertilizer – these should be explored in favour of conventional ‘Western toilets’.³² The toilet is actually quite like a mini sewage treatment technology. The nano membrane waterless toilet design runs for 5 cents (USA) per day and is being piloted in Ghana.³³ It will serve 50 users per day with a 10-year life. As it is being developed for the Gates Foundation for providing clean sanitation services to millions of poor people in the developing world.³⁴

2.7 Technology solutions for smart market financial management, sales, business models and related governance

Why is it relevant to Smart Fresh Markets?

Technology solutions to empower greater financial inclusion and independence are widely viewed as critical to sustainable poverty reduction and social mobility (Adenle et al., 2018; Rapsomanikis, 2015). Smart market financial management would look to build on the progress that has already been made thanks to the existing trend of high mobile phone adoption that has been transforming lives across the socio-economic spectrum in Africa (Asongu and Boateng, 2018), and with it, greater democratisation of basic financial services (Owusu-Agyei et al., 2020). With 640 million subscribers in 2012 (Triki and Faye, 2013; see b.3), leveraging this

³² For more information on this technology see:

<https://www.popularmechanics.com/science/health/a24747871/bill-gates-life-saving-toilet/>

³³ For more information see: <https://www.designindaba.com/articles/creative-work/new-waterless-toilet-design-costs-five-cents-run>

³⁴ The toilet dissemination programme runs alongside a \$42 million initiative for new sanitation grants

<https://www.gatesfoundation.org/Media-Center/Press-Releases/2011/07/Gates-Foundation-Launches-Effort-to-Reinvent-the-Toilet>

mobile phone revolution promotes financial inclusion, shorter supply chains, and greater transparency, and is key to unlocking the potential of SFMs.

What is existing practice?

Prior to mobile phones, existing horticulture supply chain involved many intermediaries which typically eroded revenue received by the producer, and engendered exploitation and corruption. Farmers would also journey to the market without any indication of the price they would get and would often be compelled to settle for a low price, since their goods would soon spoil and be worthless. Insufficient market information removes the price signal that is critical to well-functioning markets, promoting health competition, and ensuring farmers receive a fair price for their goods (Frick & Groenewald 1998;). Moreover, farmers having sold their goods, would carrying cash on them and may be robbed on their return (Furuholt and Matotay, 2011). All of this meant high risks to farmers and discouraged market participation.

What could be done differently?

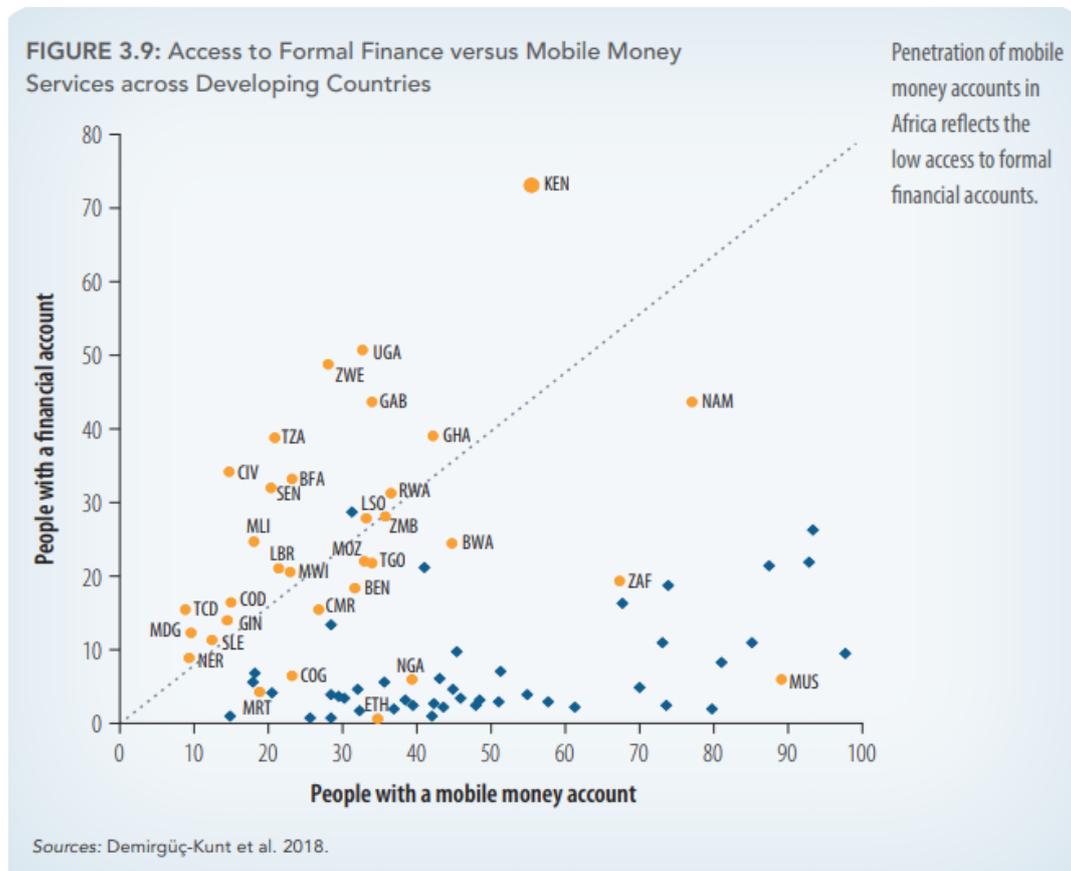
In Kenya, financial inclusion through mobile banking has been spearheaded by “M-PESA”, a popular mobile banking company (Ngugi et al., 2010), and building on this success would be central to our new model for Smart Fresh Markets. Moreover, while



cash usage remains dominant, the number of ATMs in Africa is still low (Triki and Faye, 20130), so incorporating cash-less payment into SFMs will be a significant means of bypassing this otherwise limiting factor. Further, the market for innovation is ripe; more than 50% of mobile money services globally are in Africa (World Bank, 2019). Hopefully, the integration of mobile banking into more structured market participation could create a next phase for this financial empowerment and represent a model for other developing nations to follow.

Additionally, acting as part of a cooperative can facilitate enhanced financial inclusion. Membership can enable farmers to receive credit at lower interest rates since (Onyegbulam et al., 2019), since they can act as each other’s collateral (Carter et al., 2014). As such, the idea would be to position cooperatives as sub-networks of financial nodes, such that they can secure credit on more favourable terms and use

that to invest in communal innovation that benefits the members collectively, such as grain storage facilities.



Source: Demirguc-Kunt, Asli; Klapper, Leora; Singer, Dorothe; Ansar, Saniya; Hess, Jake. 2018. Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution. Washington, DC: World Bank. © World Bank.
<https://openknowledge.worldbank.org/handle/10986/29510> License: CC BY 3.0 IGO

2.8 Online platform: an example for further digital innovation for fresh markets

We intend for fresh markets to satisfy the purchasing needs of consumers in their totality. An online platform would have two-way functionality and as such would serve to inform and signal to both producers and buyers in a variety of ways. It will serve as a central hub for individual customers, as well as a wholesale outlet that can then supply the larger volumes required of restaurants, schools, hospitals – both regionally and internationally. The platform would show a stock of the available inventory, which then would allow all types of consumers to view, purchase and

arrange delivery of their chosen goods in a timely, safe, and cost-effective manner. Such a platform can be maintained on a computer or laptop reinforced with a server. Such equipment can be purchased or rented at a nominal cost.³⁵

An online platform would help farmers market directly to consumers, cutting out the middlemen, and providing customers with an alternative to supermarkets (O'Hara and Low, 2020). Such a platform could provide additional employment for delivery services, the cost of which could be viable if conducted as part of a cooperative. Aggregating the data from all their members, the platform would be able to flag up specific produce that is either in high or low demand – allowing farmers in cooperatives to best time their sales and receive better prices. Over the years, such a platform would be able to provide annual estimates of produce demand, and so in the case of a local drought or disease, they could coordinate with other regional platforms to better balance supply and demand. Moreover, farmers could share updates about external shocks in certain regions (e.g. locust plagues or other well-known chronic pests specific to certain crops) and exchange suggestions for remedies to build up the participants' collective knowledge base.

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The platform would help farmers market their produce collectively as part of a cooperative – something that grants them increase bargaining power and better prices therein (Fischer and Qaim, 2013). This in turn could help them secure contracts, that can then be fulfilled by cooperative members. This could occur at a regional and international scale – enabling supply chain links that are more conducive to working with larger commercial buyers.

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³⁵ See the following URLs which outline server purchase and rental factors for small businesses <https://www.servermania.com/kb/articles/how-much-does-it-cost-to-build-a-server/> and <https://www.servermania.com/kb/articles/how-much-does-a-server-cost-for-a-small-business/>. Typically, one can purchase a server for approximately \$1,000 or can rent one for \$100/month. Backing up data on a cloud server can cost as little as \$5 per month. A \$1 annual subscription paid for by wholesalers, international buyers, traders and farmers would pay for ownership of this server within a month of service provision with a modest income to be made by a data entry staffer for any membership exceeding 1,000 members. In the alternative, there is no shortage of Overseas Development Assistance funders that would pay for such a service noting its relevance to civil society food systems/food security goals for a given locale or region.

cooperative. Aggregating the data from all their members, the platform would be able to flag up specific produce that is either in high or low demand – allowing farmers as part of cooperatives to best time their sales and receive a better price. Over the years, such a platform would be able to provide annual estimates of produce demand, and so in the case of a local drought or disease, they could coordinate with other regional platforms to better balance our supply and demand. Moreover, farmers could share updates about external shocks in certain regions e.g. locust plagues; or well-known chronic pests specific to certain crops, and exchange suggestions for remedies to build up the participants collective knowledge base.

There are signs of nascent operations in this vein emerging, however, they are quite nebulous and encounter classic network effects: in that, they will improve progressively as their user base rises. A report produced by the World Bank, identified establishing a “Single Digital Market” as critical to achieving better regional and inter-Africa market integration (World Bank, 2018). They concluded that this would need a “single online market”, where governments, private companies, and citizens could all trade and exchange with transparency and accountability across the regional expanse (ibid).

Government can help get there. An empirical study found that customer adoption rates were impeded by a reticence to submit credit card information; and a government watch dog that would regulate the online marketplace sites and prohibit fraudulent sales would mollify these concerns (Olotewo, 2017). The World Bank report (supra) also endorsed a singular ‘digital identification’ mechanism could facilitate greater accountability. This was employed at a small scale in a Bangladesh “Village Super Market” with good effect (Roozen, 2018).

2.9 Micro business support for fresh markets and their vendors

In Brazil (as elsewhere) micro-business formation has pulled many people out of poverty. Small businesses have joined taxation initiatives set out by the government, voluntarily. In return, they receive access to social protection and business development services. This could apply to fresh markets. Smallholder farmers and other small businesses can sign up directly to municipalities in return for a small tax and in return they get access to a market space (ILO, 2014). Whilst formalisation may be beneficial for governments and corporations, great care must be taken to ensure they remain in line with green growth strategies. This is where institutions and NGOs can provide support and advice.

3 Public–Private Partnerships (PPPs) Leverage Private Investment in Agricultural Value Chains³⁶

3.1 Possible PPP Contributions to Food Systems

PPPs can be one way of increasing investment into smart fresh market food supply chains. PPPs have been employed in Africa to address state and market failures. As such PPPs can address the following:

- Pre harvest services rather than output marketing as a focus for Private sector investment.
- Investment in crop storage thus reducing spoilage.
- Progressive state intervention for smart fresh markets as produce supply chains liberalise.
- Low public investment in basic infrastructure.
- Private sector financial risk reduction strategies.

With the apparent benefit that PPPs can provide, simultaneously to smallholders and private companies, we need to promote well-structured PPPs.³⁷

3.2 The Case of Tomato in Ghana: Institutional Support - PPP at Wenchi, Brong Ahafo.

Under the platform of a “Public-Private Partnership,” four organizations, the German Technical Cooperation (GTZ), Brong Ahafo Regional Directorate of Ministry of Food and Agriculture (MoFA), Unilever Ghana Limited (Unilever) and Afrique Link Limited (ALL) promoted a pilot project to explore the commercial viability and sustainability of establishing a formal value-chain relationship in the tomato industry in Ghana. The project concept was for the public enterprises to assist the farmers to grow fresh tomatoes; for ALL to process into tomato paste and tomato pulp; and for Unilever to market and sell the tomato paste and assist ALL to

³⁶ We need to decide together whether the Public Private Partnership analysis belongs here or in the Economics of Smart Fresh Markets report. Thanks for the help on this decision.

³⁷ For more information please see:

<https://www-sciencedirectcom.iclibezp1.cc.ic.ac.uk/science/article/pii/S0305750X11001471>

sell and market the tomato pulp through its distribution system. This provides a positive example of a PPP working for smallholder farmers in a rebuild context.³⁸

3.3 PPPs for Developing Agricultural Market Infrastructure

PPP MI, or Public Private Partnerships for Market Infrastructure should be framed as having the following overall objectives:

- Enhance food security and safety, thereby improving rural and urban development and quality of life.
- Smart Fresh Market construction, redevelopment, and enhancement project finance.
- Increase access of sellers to markets or even formal markets.
- PPP MIs do not necessarily require new infrastructure. You can build on what is already there by modernisation and upgrades.

These types of projects facilitate access to markets. Both for the seller and possible investors. For example, by improving marketing abilities to sellers. It can also assist with economies of scale, for example increase possibilities for fertilizer, farm technologies and training and other agricultural inputs from private sector businesses. This can assist work on advancing smart fresh markets because this could be a method for marketplace development. See <http://www.fao.org/3/a-i5699e.pdf>

3.4 PPPs and Transport links from Farms to Smart Fresh Market

A little further away from the smart fresh market itself but no less important is the means by which sellers can get their produce to smart fresh (if not all) markets. The economic case for developing road infrastructure to link elements in the agricultural value chain – suppliers, farmers, extension services, collection points, wholesalers, agro-processors, end-user smart fresh markets – is strong. This includes:

³⁸ The main sources for this case study is the following:

https://www.researchgate.net/profile/Elizabeth_Robinson9/publication/265011908_The_Case_of_Tomato_in_Ghana_Institutional_Support/links/548ed225cf225bf66a6a952.pdf

- Increased access to the fields during the fresh season, leading to better farm management.
- Importance of farmers accessing rural wholesale markets, avoiding the loss of margins from dependency on local transportation agents.
- Growing importance of urban retail markets, and the need for efficient and rapid transportation to distribute products, especially perishable produce.
- Improved reliability of agricultural inputs, leading to higher yields and reduced post-harvest losses.
- Diffusion of improved farming methods, including irrigation and other land management methods.
- Increased flow of information between farmers, agricultural traders and extension service workers.

The chapter in this document highlights the benefits for farmers, supply chains, distributors and sellers for increased road infrastructure. There are five case studies where PPP models for agri-orientated road development, for example:

In Tanzania, the Road Act 2007 promotes involvement of the private sector in development, maintenance and management of roads. Local Government Act No. 7 1982 is supportive of private sector involvement in transportation.

PPP investment in road infrastructure between farms and fresh market stalls may be a barrier to development if the seller is struggling to get enough produce to market. The seller may also incur damages to produce on route, and if it is a great distance then produce may spoil (if the location of a market is in a high temperature climate for example).

Is there a way in that a PPP could be set up with public sector, whereby private sector investment could go into allowing easier access of produce to markets? Repayment could come from tolls or taxes on road vehicles.³⁹

3.5 Structured Contractual Sustainable Public-Private Partnerships

This sub-section explains various innovative contract structures that can accommodate a range of smart fresh market ownership and leasing arrangements. In this regard, there is no one type of contract that suits all smart fresh market stakeholder control arrangements. As such, this bundle of contractual types will suit virtually all such arrangements.

³⁹ For more information on the vital importance of transport infrastructure to food systems please see: <https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/2131.pdf>

Service Contract: Government hires a private firm to provide a service for a short period of time (1-3 years normally). Firm is normally selected through competitive bidding process. Through this, government remains main provider of services and private sector plays a minor role and does not directly interact with the partner. Private sector provides most the funding but not the project revenue, however, does not bare any liability financially or otherwise. These contracts can have significant effect on productivity and is especially useful for private sector introduction of technology to marketplaces. These contracts have low barriers to entry.

Drawbacks include: not being suitable for capital investment from private sector, not being able to have an impact to the broader system of management, gov maintains ownership and therefore politically vulnerable.

Generally, this kind of contract is used in maintenance, emergency repairs, public information.

This kind of contract could be useful within fresh markets that wish to introduce standard maintenance, where public sector is strong, and markets are not in need of serious improvement.

Management contract: Extend the role of the private partner to provide some or all the service compared to service contract. Still does not finance capital investments. Tariff is set by government and charged to consumer of specified service. Gov decides how much the contractor is to be paid for labour and other operational costs.

Main advantage: gains in efficiency through private sector without gov selling assets, relatively simple to set up, incentives to improve efficiency can be included.

Main disadvantages: it is difficult to separate the operation of the public service and the finance and expansion of the service. The private party to the partnership is responsible for operating the public service while arrangements will need to be made for financing and expanding the service. Precautions need to be taken into consideration to ensure that private sector are not misleading with their achievements to increase revenue.

Management contracts can be employed into fresh market situations where private sector wish to introduce their services quickly, or private sector want to get a steppingstone into marketplaces. Drawback is local or regional government need to be aware of potential false claims of service and also are in control of assets.

Lease agreement: The private contractor is responsible for the complete operation and management of the public service. The private operator has the leverage to charge the users and most cases bear the commercial risk. However, the private partner is not responsible for making any new or replacement investments. The quality of service and the tariff to be levied on the consumer is regulated by the government. Under a lease contract, the government owns the asset and is

responsible for capital expenditures for new projects, replacement of vehicles, debt service, tariff and cost recovery policies. The government also bears capital investment risk which is generally recovered from the tariff charged by the private operator. In addition to this, the government also receives lease payments.

Advantages: In lease contracts the profits of the contractor depend on the sale of utilities. Since by lowering the cost of production, the contractor can increase profits, there is an incentive to become efficient.

Disadvantages: The incentive to increase efficiency may lead to poor maintenance of assets because this can lead to increased profits. This is likely to happen particularly in the end of the contract. Also, in this type of contract the government must set the tariff which is a sensitive issue and may involve complex arrangements. Moreover, this type of contract is not appropriate for attracting private finance.

Different countries have successfully leased out port terminal, railway line, optic fibre cable to private sector. Therefore, this type of contract could work by governments and municipalities leasing marketplaces out to the private sector, if the private sector can provide evidence that leasing to them will assist with development. The downside is that private sector still can't fully invest in the market area.

Concession Contract: The contractor is responsible for the complete delivery of service in a particular region. This contractor is responsible for providing working capital and all capital investments. (However, the public sector may extend finance in the form of Viability Gap Funding) These contracts are usually long term (25-30 years) so that an acceptable return on investment can be made by the private partner. The concessionaire collects tariff from the consumer directly, as per the contract. The government's role is mainly restricted to regulating the price and quality of service. The ownership of all assets remains with the government.

Advantage: can be a means of attracting private finance. In addition to this, greater risk can be transferred to the private sector. These contracts also have strong incentives in place to increase efficiency since lower costs will lead to higher profits for the contractor.

Disadvantage: They involve a complex contract which requires the government to have the means to regulate tariffs and performance standards. Because of their long-term nature, the bidding process and contract design is further complicated. There is also a danger that the contractor may not make new investments if costs cannot be recuperated during the term of the concession. Furthermore, concessions may provide only limited competition because of their complex nature and because of the large investments required which could lead to inefficiencies.

This type of PPP may not be suitable to informal fresh markets in developing countries because of their complex nature and long-term contracts. With

marketplaces that need more rapid development, in countries without proper government representation, this PPP may be ineffective.

BOT: BOT (Build-Operate-Transfer) type contracts are special forms of concession contracts. In BOT contracts, the private partner maintains ownership of the asset throughout the term of the contract. In a BOT project, the private sector finances, builds, and operates a specific new facility and is responsible for operation, maintenance management of the system and also bears substantial project risk.

In addition to BOT contracts, there are a large number of variations such as BOOT (Build-Own-Operate-Transfer), BOO (Build-Own-Operate), BLT (Built-Lease-Transfer), SOT (Supply-Operate-Transfer), ROT (Rehabilitate-Operate-Transfer). Since BOT and similar arrangements are a form of concession, they possess some of the same advantages and disadvantages. The advantages and disadvantages of the particular contract depend upon its specification. In such contracts, preparing the tender and the contract takes time due to its complex nature.

<https://poseidon01.ssrn.com/delivery.php?ID=898031068069020012083103092004120113024008049068035042027073092093009087104108126102101009029001009024018094065031120091116023098004058073081094067064086127071072073065014043110025007107091123093100113003090096019118072000005070113075094026020026081120&EXT=pdf>

Divestiture or Privatisation: This would apply when a government stakeholder (national, municipal, crown or shell company) wants to pass on its fresh markets to a private or other entity.

3.6 How Civil Society Stakeholders make Smallholder / Smart Fresh Market Concepts Successful – A Tanzania Case Study

This important question provides some essential answers as to how to frame and empower stakeholders vis-à-vis fresh markets. What we have learned in Tanzania is that it is essential to improve buyers' pro-smallholder purchasing ability. This can be done through improvement of road, railways, bridges etc. It can also be accomplished through improvement of market infrastructure itself. The accessibility of markets is also key. Improved infrastructure to allow buyers to access towns, villages etc is relevant for the purpose of accessing fresh produce.

There is also a need for innovation. Agricultural and business officers have trained smallholder farmers and market vendors in how to run their business, increase their farm yields and improve overall development. Many smallholder farmers and market vendors are responsible for the entirety of their business, including the procurement of correct materials and farming infrastructure. Business success in relation to servicing fresh markets is not likely to occur without technological or educational innovation reaching these smallholders in remote areas.

In a more ambitious light inclusion of a fresh market vendors produce into more formal markets can provide steadier income. Access through innovations such as fruit preservation can address oversupply/undersupply issues.

These points are illustrated through a case study on the potential for organic agriculture to sustain livelihoods in Tanzania. Accordingly, it is noted that

- Organic agriculture in Tanzania is predominately export focused.
- There is a basis for and evidence of enhancing organic agriculture contributions to sustainable livelihoods and food security amongst smallholder farmers.
- International trade and private sector donors have helped to commercialise smallholder organic agriculture with benefits for local, national and international markets.
- As such both top down approaches (involving investment from large institutional entities) and bottom up approaches (small holders pulling themselves up through commercial and farm training) can work together.⁴⁰

3.7 Farmers' Market Organizations (FMOs) as a key partner for Smart Fresh Markets 3.7

Grassroots, community lead organisations have been argued to aid rural development through supply local public goods or services (Bernard et al., 2008). A Farmers Market Organisation (FMOs) are cooperative organisations that can support income generation. They offer the possibility of community focused development through tentative inclusion in competitive markets. Smallholders are extremely resource constrained, so FMOs can create strategic resources needed to compete with privatised traders.

Issues arise when such organisations wish to become more entrepreneurial, as often a choice must be made between inclusion vs. competitiveness. Inclusivity can hinder overall development and general upgrade of fresh marketplaces, whereas FMOs that focus on competitiveness can drive development and innovation. Entrepreneurial FMOs are also more attractive to investment and can facilitate entry to a formal market. (Lutz & Tadesse, 2017).

⁴⁰ These resources form a partial basis for this case study:

https://www.bmz.de/en/publications/type_of_publication/information_flyer/information_brochures/Materialie280_green_innovation_centres.pdf; https://www.rural21.com/fileadmin/downloads/2019/en-03/Rural21_3_2019.pdf;
https://www.tandfonline.com/doi/pdf/10.3763/ijas.2007.0266?casa_token=sp1X0U6dFRQAAAAA:TaJZ3mCRFdIfGDm14f04bVrCY4r0RQ05J_dcvB9z8d6LYNXw0C0fKrKMUb2bq0dP9CZb0Bd-MLk;and
<https://docs.wfp.org/api/documents/WFP-0000110345/download/>

Competitiveness vs inclusiveness

With FMOs in Africa there can be conflict between efficiency and equity. This issue is generally not reported on in academic literature (World Bank, 2007). For an FMO to be inclusive, there generally must be low entry fees, open membership and community services focused. However, this generally can give rise to ‘freeriding’, i.e., members who do not contribute sufficiently, either deliberately or through no fault of their own, to the overall revenue of the FMO. When this happens, it can stifle innovation, development and investment.

Competitive FMOs must be more flexible and efficient in their output if they are to compete with established private businesses. Such FMOs require substantial investment, which requires a degree of investor-investee trust. FMOs that cannot perform to the standard required will not receive as substantial, if at all, funding. It should be noted that investment does not just always mean capital. Investors may then want a stake in management which in some cases can be a cultural roadblock (Barham & Chitemi, 2009).

Crucially, if an inclusive FMO is to be successful, there are some key issues that need to be addressed. For FMOs with large membership bases, strategic governance is required. More resources are collected the larger the group, yet, this can create governance difficulties, such as regulation of members. This can lead to troubles such as the free rider issue, control issues and influence costs. In many cases that require smaller investment, these problems can be addressed, however, with larger there needs to be more targeted governance (Lutz & Tadesse, 2017).

Example: FMO in Ethiopia

Ethiopian government provides support for development of FMOs. In Oromia, NGOs promote competitive FMOs, mainly for food crops. They build, trade and mentor FMOs by strengthening unions. A report by Lutz and Tadesse (2017) looked at 16 FMOs operating in the area and drew these issues as conclusions:

- Commitment to provide financial resources and collateral
 - o Smallholders asked to invest only small amount to be a member so barrier to entry is low. However, total revenue from membership fees are too low to finance the FMO operations needed and loan access is low. Smallholders do not gain the benefit of being involved in the FMO
- Commitment to sell
 - o Smallholders not generating enough finance through the FMO so informal sales are also going on to finance smallholders.

- Commitment to contribute to the management.
 - Leadership is not based on capabilities but on social status. Possible need for a committee instead? There needs to be some kind of auditing committee to prevent corruption.
- Targeting
 - More entrepreneurial activities do not develop. FMOs behave in line with the countervailing power model, but do not become a sustainable competitor in the market as this requires an entrepreneurial strategy.

Overall, these conclusions were drawn: lack of transparency; freeriding; lack of selection and; lack of participant investment were cited as the main issues.

Generic requirements for FMOs:

- There needs to be a clear distinction between community and market-oriented organisations.
- Investors are a major influence on FMOs (either gov or private)
- If NGOs or government are to be involved then lack of infrastructure can be supplied, however, when this is transitioned to the governing entity of the FMO this can fall apart. There needs to be greater influence from NGOs /government for a longer period to ensure the FMO does not drop off.⁴¹

4 The Informal Economy and Smart Fresh Markets

4.1 The “Informal” Economy

The informal economy refers to the plethora of fresh market stalls, kiosks and hawkers that play a vital role in farm to fork food provision across developing countries. The main transition mechanism as informal economy actors join the formal economy over time is likely to be digital technologies. As discussed, digital technologies and platforms are likely to modernise smallholder agriculture and the supply chains it serves. Digital data sharing will in turn facilitate Government support and assistance to improve the infrastructure in and around fresh markets

⁴¹ These institutional dynamics are discussed in greater detail in the following report: <https://www.tandfonline.com/doi/full/10.1080/00346764.2017.1300317>

while promoting the direct participation of the important smallholder agricultural sector in food retail systems.

4.2 The Power of Africa's Informal Economy in a Global Economy⁴²

The informal market in SSA represents 41% of GDP and 72% of total employment.⁴³ It is vital to the livelihoods of citizens and its structure complex. Previous engagement with the informal sector in some parts of SSA have been met with violence and confrontation. Development institutions must be weary of the complexities at play within the informal sector and not look to antagonise, or disproportionately impact smallholders.

There are good arguments to be made by development institutes for formalising economies. Informal settings are much more likely to carry with it issues of exploitation. For example, the informal market includes the use of child labour, below living wage wages, low job security and high incidence of HIV. Therefore, and as to harness the positive influences on informal fresh markets whilst addressing exploitation, overseas development institutes (ODIs) should pay close attention to the operational elements. Targeted approaches to each individual market should be employed. ODIs should engage with donors and investors, so that there can be proper communication between both parties as to the conditions of investment (Floodman Becker, 2004).

Currently, informal fresh markets are often overlooked by policy makers because government want to focus on large enterprises. However, there is a lot the formal economy could learn from the informal about fast and inclusive development. Fresh informal markets are predominately managed by women in SSA, therefore, have the benefit of providing women with agency if the marketplaces are managed correctly. Political leaders may have to start listening to entrepreneurs, managers and staff working in the informal economy to formulate more inclusive policies that may prove more relevant to Africa's development. In addition, policy makers can understand a lot by observing the hierarchy in informal fresh markets. Hierarchy is often determined by social-political status rather than formal appointment. Better understanding this could assist with turning informal fresh markets into the formal economy (Jackson, 2016).

⁴² For a primer on the role of informal economy actors in Africa please see the following source: <https://qz.com/africa/599483/dont-underestimate-the-power-of-africas-informal-sector-in-a-global-economy/>

⁴³ Ibid.

4.3 Big brands like Unilever are not the full answer to helping Africa's farmers⁴⁴

Formalising markets and food supply chains seems, on the surface, like an efficient method of providing smallholders with agency to move out of poverty. Theoretically, the profit that middle-operators receive are removed and instead goes directly to smallholders.

Since the 1960s, food and agriculture in Africa has shifted away from largely exports to feeding its increasingly urban population. Exports of agricultural produce has shifted from 50% to just 12% (OECD, 2016). This has expanded the informal food market, as increasingly smallholders can directly sell foods in markets close in proximity to their farms. With this has come increased competition between smallholders.

There have been examples where attempts to integrate smallholders into formalised markets have appeared successful on the surface. A contract farming initiative in Uganda appeared to successfully integrate smallholders into a food manufacturer called Mukawno, however, on further investigation it was found that smallholders were continuing to sell their produce informally because their produce received greater upfront value (Vorley et al., 2015). In another instance, Unilever had to abandon an initiative with onion farmers in Tanzania for similar reasons. It is not just financially more viable for smallholders to continue with engaging with informal markets, produce does not have to be subjected to the same rigorous food safety standards. These standards can mean that smallholders lose a lot of their produce that might otherwise be sellable (Tait, 2015).

Trying to apply a global corporate model within informal markets may achieve economic advancements in some respects but fails to recognise that other issues of social and environmental sustainability that may be of greater importance to a smallholder. Big business approaching this issue may become dogmatic. Instead, it would be helpful for big businesses to listen to the wishes of smallholders instead of forcing their agenda. Overall, greater sustainability can be achieved if the conversation is dynamic and involves the smallholder (Vorley, 2015).

⁴⁴ The analysis in this subsection is drawn from the following source: <https://www.theguardian.com/sustainable-business/2016/aug/31/unilever-africa-farmers-inclusive-business-agrifood-development>

4.4 Informal Markets, Food Systems and Food Security⁴⁵

Food markets are the biggest employer in West Africa (WA) with 66% of total employment (Allen et al., 2018). The rapid growth in population coupled with increasing urbanisation means that this sector is continuing to grow outside of farming. As discussed, food markets are dominated by informal market settings, especially in poor urban areas (Proctor and Berdegué, 2016).

The difference between income and food prices are particularly stark in in WA. This reduces the purchasing power of households to obtain enough food and food that is of sound quality/safety. Monitoring pricing systems is a normative method of preventing fluctuations, however, this is more challenging within markets which are dominated by informal fresh markets. This can be addressed by improving local supply chains, increasing the productivity and agricultural output of smallholder farmers or promoting local trade systems (Allen, 2017).

4.5 Informal Markets and a New Policy Agenda⁴⁶

“Green Growth means fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies.” (OECD, n.d.)

With the informal market making up a considerable percentage of the economy in SSA, informal food markets are often overlooked within green growth strategies. Despite this, there are considerable lessons that can be taken from the way in which informal markets operate that can inform social, environmental and economic sustainability. Firstly, they are often focused on inclusivity. Fresh, informal markets work for the benefit of all those involved, instead of primarily for the benefit of shareholders. As discussed, these shareholders are often international, thus not delivering on development of smallholders. Secondly, informal fresh markets rely on local value chains, sourcing produce from local farmers. This is a far less fossil fuel intensive and relies more on natural fertilisers or pesticides. Lastly, these markets can be more economically stable if they are not subjected to volatile international markets. There are other economic draw backs, such as hindering scale up, however, with the correct policies in place to assist with yields, economic growth that benefits smallholders first can be achieved (IIED, 2016).

⁴⁵ The relevance of informal markets to feeding West African populations ins discussed in the following piece from the OECD: http://oecdinsights.org/2016/07/11/economic-activity-west-africa-feeding-population/?utm_source=newsletter&utm_medium=email&utm_campaign=whatsnew

⁴⁶ The relevance of informal markets to green growth strategies is addressed in this research source: <https://www.iied.org/informal-economy-green-growth-conference-pinpoints-need-for-new-policy-agenda>

Conversely, informal markets can be detrimental to social and economic sustainability because they are unregulated, untaxed and therefore exposed. So, formalisation of markets can address this, but must be done in a targeted way that does not do more harm than good to informal workforces (). There are a few success stories that can provide a blueprint:

Formalisation of micro-businesses in Brazil- This has pulled many people out of poverty in a country that has large wealth, but large inequality. Small businesses have joined taxation initiatives set out by the government, voluntarily. In return, they receive access to social protection and business development services. This could apply to fresh marketplaces in SSA. Smallholders can sign up directly to municipalities in return for small tax and in return they get access to a market space (ILO, 2014).

Whilst formalisation may be beneficial for governments and corporations, great care must be taken to ensure they remain in line with green growth strategies. This is where institutions and NGOs can provide support and advice.⁴⁷

4.6 Governance of Informal Food Markets in Africa's cities - Municipal Support Policies for Operators

In Informal markets, street vending and informal trade are especially important sources of livelihoods and financial independence to women, who are primarily the street sellers of perishable goods. The table below explains challenges and how they can be overcome by policy and interventions.

⁴⁷ See: <https://research.wur.nl/en/publications/sustainable-food-consumption-in-urban-thailand-an-emerging-market>

Challenges	Intervention
<p>Urbanisation is increasing rapidly in SSA with major implications to food security and other governance challenges.</p>	<p>Regular government engagement with smallholders through institutions. Monitoring pricing systems is a normative method of preventing fluctuations, however, this is more challenging within markets which are dominated by informal fresh markets. This can be addressed by improving local supply chains, increasing the productivity and agricultural output of smallholder farmers or promoting local trade systems (Allen, 2017).</p>
<p>Food security policies in urban Africa face institutional, administrative and political challenges which include:</p> <ul style="list-style-type: none"> ●Lack of local mandate for food security under decentralisation policies. ●Lack of cross sectional, cross ministerial policy integration ●Political contest over cities that occasionally leads to violence (FAO, 2003) 	<p>There is a need for vertical and horizontal cooperation across sectors and ministries.</p> <p>Food security can be increased by supplying better storage, wholesale and market infrastructure.</p>
<p>Government regulation has been heavy handed in trying to eliminate urban informal food economy, even violent.</p>	<p>Informal markets need to be actively included into government discussions about urban food security. Again, assistance from institutions would help.</p>
<p>Overproduction of foods in the informal sector can lead to issues of supply.</p>	<p>Better storage, better communication between stakeholders set up.⁴⁸</p>

⁴⁸ For more information see the following sources: <https://www.ifpri.org/publication/governance-informal-food-markets-africas-cities>; <http://www.fao.org/3/a-y4312e.pdf>

4.7 Managing Illegality at Local Markets: The Cherkizovsky Market Example

The informal economy can take a breadth of different forms, from small independent hawkers to large criminal operations. Criminality can vary; low scale tax avoidance, illicit transactions, imperfections of customs regulations and corruption all perpetuate from the engagement of the informal economy. The policy issue that faces government is that it provides immediate jobs and contributions to the national economy and therefore, governments do not want to risk losing this. Tackling crime and corruption in fresh markets can therefore have a detrimental effect on those who are most vulnerable. If the market is dealing with contraband items, government might want to consider making it legal or semi legal to avoid it being a target for organised crime. This would have to be analysed and considered in great detail to ensure that the contraband item is not harmful or leads to negative outcomes.

Connections with state institutions (mainly the customs office) and private businesses (banks, transportation companies, travel agencies) are extremely useful to increase the profitability and sustainability of operations. Given the potential of the informal economy in generating income, providing employment, and boosting economic development, it is appropriate that policy frameworks and strategies aimed at formalising these practices are found without hampering its benefits (Zabyelina, 2012).⁴⁹

5 Twin roles for Fresh Markets and Supermarkets

5.1 Fresh Markets and Supermarkets as Complementary Entities

Supermarkets play an important role in the development and delivery of food systems and offer a convenient business model for governments and municipalities. Public and private investment often goes to supermarket chains that have less risk associated with them than fresh markets. This often means that smallholders cannot afford to purchase infrastructure to increase yields such as more advanced farming equipment or storage facilities. However, supermarkets that compete with smallholder fresh market vendors through price often do not offer protective foods with the same sustainable qualities (GRAIN, 2018). As such, it is in the interest of such governments from a sustainability perspective to uphold fresh markets alongside supermarkets. Consumers will also appreciate diversity in their food purchasing options.

⁴⁹ The costs and benefits of informal trading arrangements are addressed in this source: file:///C:/Users/Invate/Downloads/Zabyelina2012_CostsandBenefitsofInformalTrade.pdf

In this table we consider the benefits of fresh markets and supermarkets. This suggests that their offerings can work alongside one another:

Fresh Markets	Supermarkets
Food safety is established through local trust. Local knowledge of market vendors directs purchasing choices.	Produce must follow strict food safety guidelines and there is greater accountability.
Fresh markets are often perceived to have fresher foods with greater nutritional value, especially with fruits and vegetables.	Supermarkets normally have better storage infrastructure, which is particularly important for produce that can make individuals unwell if it spoils. Example: meat, fish and dairy products.
Shorter food supply chains make produce that is essential to a healthy diet - such as vegetables and fruit - more affordable. This is especially important to the urban poor.	Longer food supply chains increase the range of food offered, thus can provide nutrition from food groups that otherwise might not be in regular supply.
Shorter supply chains where vendors are close to the market make it easier to check for sustainable farm practices.	Supermarket buying power can be used to positively influence the environmental sustainability of supply chain actors.
Fresh markets generally offer an alternative to processed and high-energy-low-nutrition foods.	Processed food can be prepared quicker in accordance with consumer tastes and time constraints.
Informal system at fresh markets are better for smallholder sellers as a hedge against larger scale institutional corruption or other barriers to upscaling.	The supermarket economic system is more attuned to the formal, highly regulated economy, and therefore more beneficial to the national macroeconomic model and development.
If citizens are using fresh markets primarily to gain their produce, then they are less likely to be faced with misleading marketing information on the nutritional benefits of food.	Additional benefits to the economy such as employment of staff including those working suppliers that are providing goods to supermarkets.

In view of the benefits and disbenefits of both commercial offerings a sensible strategy integrates fresh markets alongside supermarkets. Indeed, this is what customers already do to diversify the food cultural experience for positive health reasons. In many Western nations (for example Spain and Italy), fresh markets function alongside supermarkets and are a preferred choice for those seeking healthful foods.⁵⁰ It does not have to be a case of either/or.

In fact, it is even possible that fresh markets and supermarkets can work together. This can be accomplished through a supplier (i.e., fresh market) and retailer (i.e., supermarket) relationship. Many of us have experienced examples in which supermarkets provide locally grown produce to show their commitment to local growers/businesses or to otherwise resonate with local (and sometimes even national) food customs and traditions (Schwartz, 2009). What this requires is aggregation of smaller suppliers of produce. For example, in Chile, we have seen farmers cooperatives and the largest supermarket suppliers of fresh fruit and vegetables in the City of Temuco providing this local supplier arrangement to supermarkets (Reardon, 2002).

Aggregation of fresh market vendors provides a similar supplier opportunity while expanding the range of customers for growers. If fresh markets are run alongside wholesale markets or are physically part of them then in addition to offering a vending opportunity on site at the fresh market, they can organise this supplier relationship with supermarkets as a contractual undertaking. The ultimate key to the success of this fresh market role will be in organising grading sorting, packaging and delivery to supermarkets as this is the “make or break” proposition of such a supplier/retailer relationship. Such functionality can be offered to aggregated vendors at or near the fresh market.

The emergence of supermarkets has been described as a “double edged sword” for development. On the one hand, supermarkets can lower food prices and provide opportunities for fresh market managers and their vendors and other farmers and processors to access differentiated food markets. They can also contribute to influencing consumer behaviour through strategic display of fruits and vegetables. On the other, the emergence of supermarkets creates challenges for smallholder retailers and farmers who are not equipped to compete and provide similar services to modern supermarkets. The promotion of fresh, protective foods can also be difficult as supermarket customers continue to demand the Western dietary menu with accompanying ill health effects. Treating fresh markets and supermarkets as an integrated food system offering can blunt the sword with the shield of protective foods as we transfer to a more peaceful, nutritious relationship with what we eat.

⁵⁰ Achón, M.; Serrano, M.; García-González, Á.; Alonso-Aperte, E.; Varela-Moreiras, G. Present Food Shopping Habits in the Spanish Adult Population: A Cross-Sectional Study. *Nutrients* 2017, *9*, 508. CBI Ministry of Foreign Affairs, Which trends offer opportunities or pose threats on the European fresh fruit and vegetables market?, 2019 <https://www.cbi.eu/market-information/fresh-fruit-vegetables/trends>.

5.2 An Example of Reconciling Smart Fresh Markets with Advanced Supermarketisation in Africa

Largely, supermarkets have not been able to get a foothold in Africa with 85-90% of all food sales through open air, informal fresh markets (ATKearney, 2015). Those who do shop at supermarkets, tend to do so infrequently and in bulk for pre-packaged non-fresh items. This is because clientele who wish to buy fresh produce will go to markets regularly, at least a few days a week (AFSUN, n.d.).

People in the country of South Africa have been traditionally reliant on independent smallholder vendors and farmers. South Africa has seen supermarkets take a greater market share in sales of fresh food produce in the last 20 years. This has been followed by a change in food supply networks which has seen a greater integration of retail companies. Retailers demand certain standards and requirements from suppliers, which creates issues for smallholder farmers who may not have the ability to meet these standards. For example, lack of preferred pesticides, lack of capital for upfront investment and issues with land use. Wholesale market operators also pay suppliers monthly, which may not work for smallholder farmers without capital saved. In addition, lack of adequate storage facilities means smallholders can struggle to sell to wholesale in bulk. These farmers way then have no choice but to sell to independent fresh market vendors, thus trapping them out of larger retail supply chains. With 3 million small farmers and food vendors in South Africa, there is a great political and social need to include this demographic in new food retail outlets (Dannenberg, 2013).

As a response to these developments, NGOs and private sector ventures were set up to support local farmers achieve supermarket level yields and standards, such as AgriBEE for black economic empowerment in SA. However, when the business was transferred for smallholders to maintain it failed due to mismanagement and lack of reinvestment. Since then, there have been further, more successful initiatives, for example in Komatipoort, where emerging farmers have collaborated in with established to bring them into the supermarket supply chain (Louw et al., 2006).

South Africa has already experienced a transition into supermarket focused food outlets. This research demonstrates that agricultural policy is needed to ensure that those who are reliant on informal food markets, such as smallholder farmers, are included in the transition. It requires government initiatives that allows for NGO and business collaboration with small farmers to ensure they have the correct training infrastructure and investment to be able to compete with larger commercial farmers.

Extended to the fresh marketplace, in areas that are fast-developing, and supermarkets are becoming more common, fresh markets must be able to compete. This may require formalising markets where applicable. A possible strategy to this

could be similar to that of agricultural policy in South Africa, through market supply chain collaboration with emerging smallholder vendors.

6 Conclusion

Section 1 of this report began by explaining the critical role that fresh markets play with respect to Food Systems, Food Security, Sustainability and Livelihoods across many countries in the world. In Section 2 we highlighted the challenges and opportunities for these markets. In respect of opportunities, we placed special emphasis upon our new design concept for a 21st Century Smart Fresh Market. Central to that analysis is the introduction of multi-functionality, multiple services and a range of major innovations that will bring fresh markets into the modern world in part through an emphasis on digital technologies. The section brings new concepts to the world which support the cause of drawing the world's smallholder farmers into modernised food supply chains which offer them and their families the opportunity for sustainable livelihoods which reflect the true value of their labour and entrepreneurship.

In section 3 we advocated for the role of structures and procedures around Private Public Partnerships which followed on to an emphasis (in Section 4) about the continuing importance of informal markets – market stall and kiosk operators and hawkers as significant stakeholder contributors to nations' food systems and food security. We rounded out our analysis by explaining the essential complementarity of fresh markets and retail stores including supermarkets to the provision of food on our daily tables and meal gatherings. The key message of our horizon scanning efforts surrounds the continuing critical role of smallholder farmers, fresh markets and the significant potential of modern multifunctional structural concepts to maintain and enhance the world's food systems.

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