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FOOD SYSTEMS INNOVATION HUBS IN LOW-AND-MIDDLE-INCOME COUNTRIES

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INTRODUCTION

Our food systems are under pressure and failing us. This failure includes the inability to (a) produce and deliver high-quality diets to meet nutritional needs, (b) produce equal and equitable benefits, and (c) mitigate negative consequences[1].

The **threats and consequences of such failing food systems** are wide-ranging. Diets are a significant predictor for the nutritional status and overall health of vulnerable groups. In 2019, 21.3 percent (144 million) of children under five were estimated to be stunted, 6.9 percent (47 million) wasted, and 5.6 percent (38.3 million) overweight, while at least 340 million children suffer from micronutrient deficiencies[2]. And although child stunting is declining, global hunger is on the rise again[3]. Simultaneously, over one-third of the global adult population is overweight or obese. Furthermore, sub-optimal diets serve as a major risk factor for non-communicable diseases, driving up morbidity and mortality risks, especially in low-income countries (LMICs)[4,5].

Malnutrition results in an unacceptably high economic burden for individuals, communities and entire economies. Directs costs of poor nutrition relate, for instance, to the treatment of overweight-related conditions, underweight-related conditions, and diet-related non-communicable diseases. All of these contribute to significant and rapidly rising health care costs. In fact, government spending on healthcare increased by 2.5 times in the last 20 years[6]. Such dramatic trends are clearly unsustainable. Indirect costs are also generated in the form of preventable child deaths and impaired cognitive development.

Food systems are, however, driving additional economic losses due to supply chain inefficiencies. Approximately 14% of all food produced globally is lost, or significantly reduced in quality, before reaching the retail stage of the supply chain[7]. Moreover, considering that food systems are the major driver of global greenhouse gas (GHG) emissions, contributing 21-37% of total emissions, there is an urgent need to explore opportunities and innovative approaches to accelerate sustainable transformation[8,9].

Although information on 'how' to transform food systems remains scarce, **innovative approaches and opportunities** exist. These include the innovative use of technology, the reallocation of government expenditure, and the promotion of more nutritious diets. However, scaling

these innovations requires capital and a platform to connect stakeholders and facilitate the transfer of technology and know-how.

Food Systems Innovation Hubs provide an opportunity to address these challenges. They have the potential to stimulate investments in resilient and responsive food systems with the goal of alleviating malnutrition through corporate partnerships, impact investors and government collaboration. These hubs can encourage food companies to expand into LMICs, facilitate investments in local companies, and stimulate supply chain innovations.

This paper aims to draw attention to the role that **Food Systems Innovation Hubs** can play in creating healthy, resilient and inclusive communities in LMICs. First, eight different archetypes of food innovation hubs are described. Future opportunities for these hubs to deliver planet-friendly nutritious and safe foods are then explored. It is argued that the complexity of food systems calls for context-specific transformations, and that innovation hubs have a key role to play here. Three key actions are identified as essential for developing effective Food Systems Innovation Hubs in LMICs: Inspire! Invest! and Innovate!

CURRENT LANDSCAPE

Thus far, most recommended changes in food systems have involved incremental adjustments to existing technologies. Examples include improving egg consumption through backyard farming[10], improving yields through new varieties and alternative farming practices[11,12,13,14,15,16], and reducing micronutrient deficiencies through biofortification[17]. Evidence nevertheless suggests that, even with these changes, it will be challenging to nourish ourselves adequately while observing planetary boundaries[18,19,20,21,22,23,24].

The future of food systems hinges on disruptive new solutions that can help achieve our collective Sustainable Development Goals. We define 'innovation' broadly to include new products, business models, policy practices, technologies, behavioural insights, or ways of delivering products and services that benefit the poor in LMICs — any solution that has potential to address malnutrition more effectively than existing approaches. However, innovations at a systems level are not easy to implement. While solutions are in the pipeline, they vary in their degree of maturity and require patient capital allocation and robust implementation strategies. Moreover, far too many promising innovations fail to scale their impact due to a lack of ability to manage the lengthy and demanding processes they entail[25].

Food systems innovation hubs can provide transformative solutions to food systems by bringing the right innovations faster to market in a cost-effective manner. We mapped different types of innovation hubs based on their coverage, capacity and capabilities. In our mapping (Figure 1), we identified eight archetypes. The archetype nomenclature is similar to what we see in other peripheral sectors such as education, housing, water and sanitation[26].

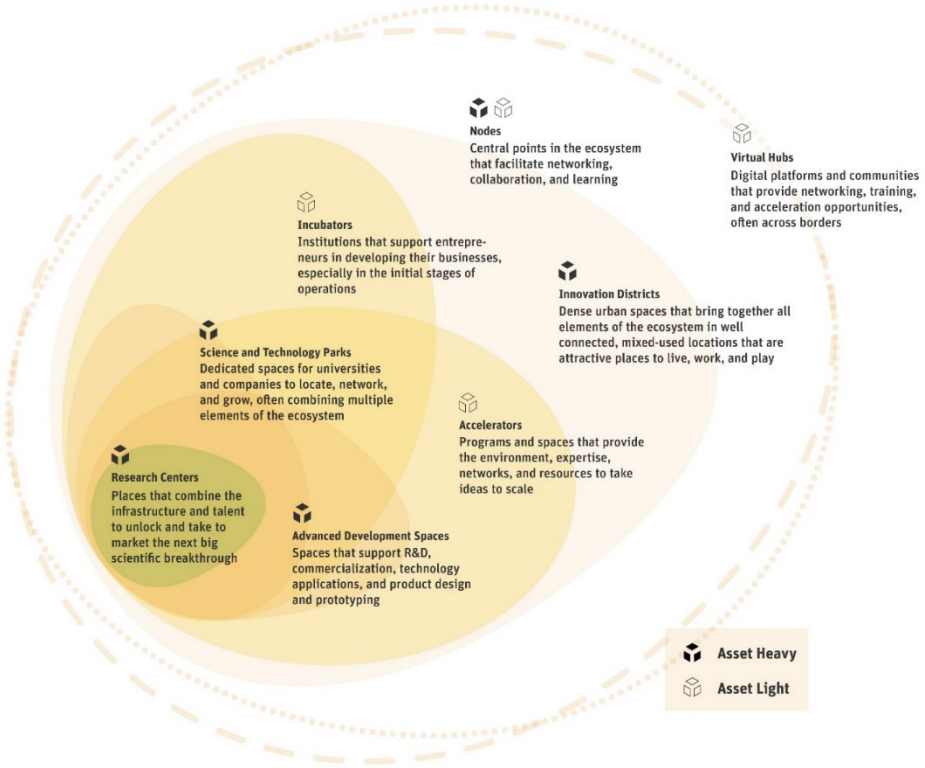

Figure 1. *Schematic representation of the eight archetypes of innovation hubs characterized by their physical infrastructure: asset-light to asset-heavy.*

1) Science and technology parks are usually established by governments in transition economies characterized by market imperfections, limited access to knowledge and finance, high transaction costs due to lack of infrastructure, and weak institutions[27]. They are often seen as developing the innovation ecosystem. Further, they subsidize research and development (R&D) costs for companies and eventually foster collaboration and capital between industry and universities[28]. When there is a strong political will to nurture innovation and facilitate ease of doing business, they can attract international investors.

2) Research centers combine infrastructure and talent to unlock and take to market the next big scientific breakthrough. An example is the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT). ICRISAT adopts integrated genetic and natural resources management as its research strategy with the aim to combine tested methods of crop commodity research with well-established practices in research in natural resources management.

3) Advanced development spaces are typically asset-heavy institutions that support R&D, commercialization, technology applications, testing, product design, and prototyping. With the rise in entrepreneurs in many cities in LMICs, we see an emergent variant of advanced development spaces that have less physical infrastructure and provide informal, unscheduled activity with more open-source knowledge. For example, Fabrication Labs is a small-scale workshop equipped with an array of flexible computer-controlled tools.
Incubators and accelerators are the two most common archetypes found in both high-income countries (HICs) and LMICs.

4) Incubators are institutions that support entrepreneurs in developing their businesses, especially in the initial stages. An example of this is the *WeInnovation* Hub in Nigeria[29], which focuses on education, agriculture, healthcare, and infrastructure. The *WeInnovation* Hub has supported more than 300 start-up teams and more than 6,000 youth entrepreneurs.

5) Accelerators are programs and spaces that provide the environment, expertise, networks, and resources to take ideas to scale. They are probably the most common archetype. Here we describe four noteworthy examples.

Rockefeller's SME Accelerator: The investment thesis of this accelerator covers three areas. Firstly, it brings together actors to finance small and medium enterprises (SMEs). Secondly, it facilitates stand-alone investments in making nutritious foods accessible and affordable. Thirdly, it functions as an accelerator for start-ups that have been in operation for a minimum of two years.

Word Economic Forum's Food Innovation Hubs: World Economic Forum (WEF) plans to launch four food innovation hubs to support food system transformation. These hubs will be locally driven and owned, both multi-stakeholder and inclusive, creating a community of practice to share learnings and build capacity. [30]

World Food Programme's (WFP) Innovation Accelerator: Based in Munich, Germany, this accelerator provides WFP employees, entrepreneurs, and start-ups with funding, hands-on support, and access to WFP's global operations. In just five years, 80 projects worldwide have received support, with 14 innovations scaling up to reach 3.7 million people. [31]
LAUNCH was constructed ten years ago in partnership with NASA, Nike, USAID, and the US State Department. The platform sources and accelerates solutions to the challenges faced by rice farmers and the institutions, governments, and companies surrounding them. LAUNCH fosters new models such as network-centered innovation and collaborative equilibrium[32].

6) Innovation districts are "geographic areas where leading-edge anchor institutions and companies cluster and connect with start-ups, business incubators, and accelerators. They are also physically compact, transit-accessible, and technically wired, and offer mixed-use housing, office, and retail.[33]" Found primarily in HICs, Michigan state (USA) is a prominent example, where a state-wide policy encouraged to source 20 percent of Michigan's food from Michigan markets. This has stimulated the creation of 13 more food innovation districts throughout the state. Some examples of food design interventions are community gardens or fruit-bearing street trees. A well-planned innovation district can reduce transport and storage requirements and create an enabling environment for the demand and supply of safe and nutritious foods. One such example is *Sight and Life*'s Nutrition Kiosk, which was conceived as a solution to the problem of delivering last-mile nutrition in the urban landscape of India. The Nutrition Kiosk uses a pushcart format which is compact and in line with the strong street-vending culture of India.[34]

7) Virtual hubs are digital platforms and communities that provide networking, training, and acceleration opportunities, transcending borders. They are constantly absorbing new information and capacities that

can be accessed by other connected 'users' anywhere in the network. Virtual hubs consequently open up the possibility of leaner and more agile local ecosystems. A minor variant of virtual hubs is aggregation on a platform approach for advancing innovations in rural areas. Aggregation is a popular way to achieve the critical mass of consumers or producers needed for any innovation to succeed.

8) Nodes are central points in the ecosystem. Nodes typically have a regional presence but aim for global collaboration and impact. One example is the Foodvalley in the Netherlands, which has built an active relationship strategy with regions and countries worldwide to collaborate and accelerate innovation in agri-food. The Foodvalley caters to the full range of businesses. Research programs are supported via research and academic partners.

THE FUTURE OPPORTUNITY FOR FOOD SYSTEMS INNOVATION HUBS AND THEIR IMPACT ON SOCIETY, ECONOMY AND ENVIRONMENT

In our review, we find that innovation hubs are not a new phenomenon. Most are technology-focused. Some are yet to launch. A thorough assessment of their capacity to deliver planet-friendly, nutritious and safe foods will guide us to coordinate, collaborate and invest in building capacity in LMICs.

Food Systems Innovation Hubs are social, private or government owned enterprises that support local entrepreneurs and practitioners to advance productivity and sustainability enhancing innovations, access capital and knowledge through collaborations, train and build their technical and business capacity and create an enabling ecosystem together with local government. They present a tremendous opportunity to reimagine our food systems by connecting various ecosystem actors to enable co-creation, develop linkages and alignment, and generate innovative and inclusive governance models that enable collaboration and unlock barriers to scale[35]. In doing so, the hubs aim to unlock investments and leverage innovations to create healthy, inclusive and resilient communities in LMICs (Figure 2). Most of the local hubs are owned by actors within the country, while those with a multi-country reach or a global reach are often owned by more than one stakeholder. Furthermore, government has a crucial role to play in creating an enabling environment for food system innovations.

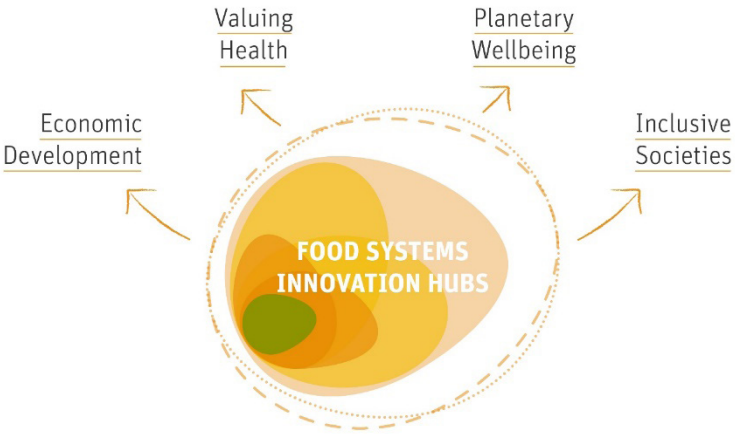

Figure 2. *Food Systems Innovation Hubs stimulate economic growth, ensure health benefits for all, protect the environment, and create sustainable societies.*

Economic development

Innovation has profound effects on macro-economic environments. It accelerates economic growth and is the reason why some economies are more robust in the long term than others[11]. However, capacity to innovate rests almost exclusively in HICs and with large companies endowed with capital, expertise, networks and resource-intensive R&D departments[36,37]. Shifting the locus of innovation from internal R&D teams to communities (Figure 3) could facilitate the rapid transformation of food systems.

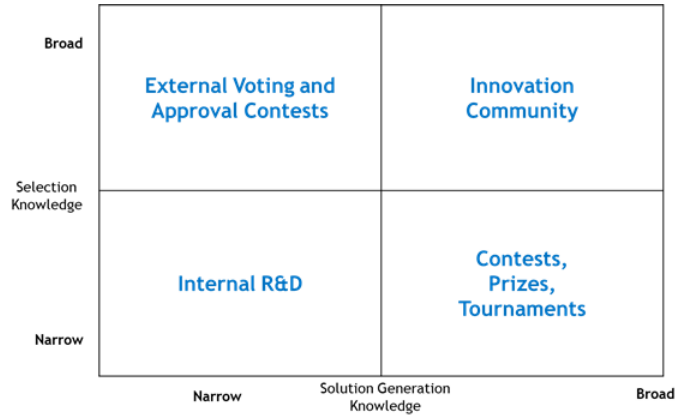

Figure 3: *Engineering serendipity: the future of Innovation Platforms*[38]

Moving the locus of innovation: Stimulating innovation calls for two knowledge-based activities: (i) generating a range of solutions to an innovation problem and (ii) selecting the appropriate solution(s) from alternatives generated (Figure 3). Innovation platforms can bring together communities of problem-solvers and expand the locus of innovation from internal to external. 'Thought for Food' and *Sight and Life*'s 'Elevator Pitch Contest' are creating such innovation platforms. Hubs can intensify such efforts.

Purposive Financing: Hubs must unlock innovative funding mechanisms in order to attract governments and investment funds. A few novel ones are described below.

Governments: Health spending is rapidly increasing, with 60% of the current budget coming from governments. In LMICs, this spending grew by 2.2 times and increased 0.6 percentage points as a share of GDP[39]. Such dramatic increases are clearly unsustainable without reforms[40]. Interventions aimed at disease prevention and health improvement can cut healthcare costs dramatically while improving health outcomes. For example, healthy lifestyle including healthy eating in the USA can result in healthcare savings of USD 2.7 trillion per year reducing healthcare expenditure from 20% to 7% of GDP[41]. This makes a compelling case for the US government, other nations and funding agencies to invest in innovative food solutions.

Investment Funds: As private sector investors and sovereign wealth funds look to create sustainable lending portfolios[42], financing healthy, resilient, and carbon-neutral solutions is a compelling proposition. Moreover, creating asset classes to fund innovations in food systems can help governments to reduce spending on healthcare and help companies to adhere to their carbon commitments.

We present below three examples of investment-worthy cases:

- Vertical farming is a sustainable alternative that uses up to 90% less water and land, and 60% less fertilizer, than traditional agriculture[43]. The farm can be located at the city's edge, reducing transportation costs and time from farm to fork, thus lowering food loss or waste. Vertical farming can also release arable land for the cultivation of cereals and legumes.
- Farmland investment*:* Compared to conventional asset classes, investing in farmland has generated excess returns[44], is relatively less volatile[45], is uncorrelated[46], is resilient to economic cycles[30], and represents a good hedge against inflation[47]. This is likely to encourage more investment in farmland as a yielding asset and to provide fresh capital for nutritious foods.
- Insect farming is a promising and sustainable alternative to conventional protein sources. It is resource-light and planet-friendly and can recycle nutrients from food loss and waste at improved feed conversion efficiencies[48,49].

Funding and investing in nutritious food is a necessity and no longer a privilege for the few. Developing nutritious foods will reduce health care expenses, provide a sustainable alternative to achieve carbon reduction goals, and provide an asset class that ticks all boxes for institutional investors while generating inclusive economic growth.

Valuing health

Increased availability and affordability of nutritious foods will not by itself generate change on the scale necessary to meet national and global commitments related to hunger and malnutrition. Moreover, the role of advertising in driving people towards unhealthy foods cannot be underestimated. Nudging consumers to value nutrition is therefore critical. Consumers in LMICs are ready to pay more for nutritious products if they deem these to be valuable. Nutritious foods will need to be positioned as foods that add value to the consumer's life. Creating such demand appears to depend on both tangible and intangible factors. Tangible factors focus on the intervention or product, for instance: (i) availability, affordability; (ii) nutrient content, energy value, serving size; (iii) taste, appearance, aroma, mouthfeel, convenience. Intangible factors consider the consumer context: (i) consumer aspirations, anxieties, expectations; (ii) culture, values, belief systems, social norms; (iii) knowledge, perceptions, behaviors around health/nutrition. Social marketing should ensure that the consumer is at the center of the campaign. Food Systems Innovation Hubs can focus on amplifying the values and priorities of the communities they serve, encouraging consumers to choose healthy, nutritious diets.

Planetary wellbeing

Global warming is a formidable challenge. The way we produce, process, and package food contributes to more than one-third of global GHG emissions[50]. Innovations are needed to rapidly lower GHGs, such as unlocking barriers to scaling the (bio)fortification of staple foods, reducing food loss and waste, better management of marine fisheries, aggregating smallholder livestock farmers to improve productivity, and supply chain efficiencies.

The effects of global warming are most keenly felt in LMICs. These regions have also seen less widespread fortification of their local food staples than HICs. (Bio) fortification could therefore be an effective intervention against both micronutrient deficiencies and the climate change shocks experienced by food systems. Closer to the consumer, solar-energy-based innovative techniques such as solar dryer or solar storage for perishables can preserve food quality and prevent waste[45]. These techniques can alleviate global warming because solar energy generates up to 90% fewer GHG emissions than natural gas and coal[51].

Targeted investment and technology transfer from HICs to LMICs will be crucial in advancing and adapting prod-

uct innovations such as new food enzymes and insect protein, business model innovations for solar technologies and improved livestock management. To that end, Food Systems Innovation Hubs in Africa and Asia can accelerate this process. These hubs will share both capital goods and knowledge resources with partners in LMICs, allowing them to access innovations vital to (bio)fortifying local diets and strengthening fragile food systems.

Inclusive societies

Innovation can help alleviate social exclusion and inequalities in the food system by providing more personal, predictive and preventive nutritious products and services that improve human health. Additionally, inclusive innovations help reduce inequalities by making existing goods and services cheaper and more accessible. A food system transformation would ensure social inclusion for all food system actors, especially women, smallholders and young people. The WEF describes three key actions: link smallholders and SMEs to finance and markets; empower women; and engage youth.

Link smallholders & SMEs to finance and markets: This involves elevating the position of smallholders and SMEs in value chains through access to financial services, market and asset information. We need to see more companies across many sectors developing new business models with the potential to help close the rural and agricultural finance gap affecting smallholder farmers and agri-SMEs.

Empower women: Women make up 43%[52] of the agricultural workforce in LMICs, yet less than 20%[53] of the landowners are women. With more equitable agricultural policies towards women, more than 100–150 million[52] people could be lifted out of poverty.

For any innovation to truly have an impact on women's empowerment, it needs to have a gender-transformative approach from its very inception. This refers to an approach that explicitly engages women and men to examine, question, and change institutions and norms that reinforce gender inequalities and, through that process, to achieve both economic growth and gender equality[54].

Engage youth: The average age of farmers exceeds 60 years in most geographies, and farming is unattractive to most young people.[55] The younger generation has the potential to combine the introduction of new technologies with learning from traditional methods to solve the food system's biggest challenges. Many organizations, such as the CGIAR also believe that innovation will help make agriculture more attractive to young people.

To spark social change, hubs can design food systems in a more deliberate manner, with innovations targeted at each of the levers of social change. This can be done through a combination of an inclusive design lens and purposive financing.

CONCLUDING REMARKS

Not only are food systems complex; each is also unique to the geography and culture it is supposed to nourish. Therefore, a one-size-fits-all solution does not exist, and the approaches used by HICs cannot be expected to work in the same way for LMICs. Our aspiration is that the transformation of underperforming food systems lies in innovation hubs.

As next steps, with country ownership, diverse actors in the food system will collaborate and connect with existing models in a few LMICs such as India, Rwanda, Nigeria and then build a cohesive food systems innovation hub for scale and sustainability. Driven by the government, activities are already underway through Food Systems Summit Dialogues in Rwanda to design one such hub. Operating in a variety of different locations, these hubs will be able to mold themselves to the needs of their specific nations and communities by engaging directly with their people, culture, entrepreneurial talent, and unique climate. This will be achieved by focusing on three key actions: Inspire! Invest! and Innovate!

INSPIRE! Hubs can encourage outstanding food and technology companies to expand into LMICs, with the goal of growing market interest, aligning with a range of investors, and developing and testing new products.

INVEST! Hubs can facilitate investment in local companies that have the potential to scale, as well as in technology transfer, nutrition, food safety, and consumer studies to prove market viability and identify latent demand for nutritious foods.

INNOVATE! Hubs stimulate innovation throughout the value chain in a manner tailored to LMIC markets and draw additional investment into scaling up and innovating new technologies. This will be especially impactful to the SMEs and start-ups that dominate food production in these markets today. These SMEs also face unique constraints compared to their developed-nation peers.

Food Systems Innovation Hubs are bold initiatives that will accelerate innovation, streamline processes, support nature-positive, biodiverse agriculture, build sustainable supply chains, and create a consumer pull for healthy foods to better nourish the nations and communities they serve.

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