



REPORT – MARCH 2024



■ FOREWORD

In less than four years, we have progressed rapidly from conceptualisation to the realisation of a physical campus in Kigali, the Africa Centre of Excellence for Sustainable Cooling and Cold-chain (ACES). The past six months, in particular, mark a significant milestone as the Government of Rwanda spearheaded the construction of a brand-new Demo Hall and the extensive refurbishment of the campus. New equipment is now arriving on campus and indeed, also into our first spin-out project, SPOKE, in Kenya.

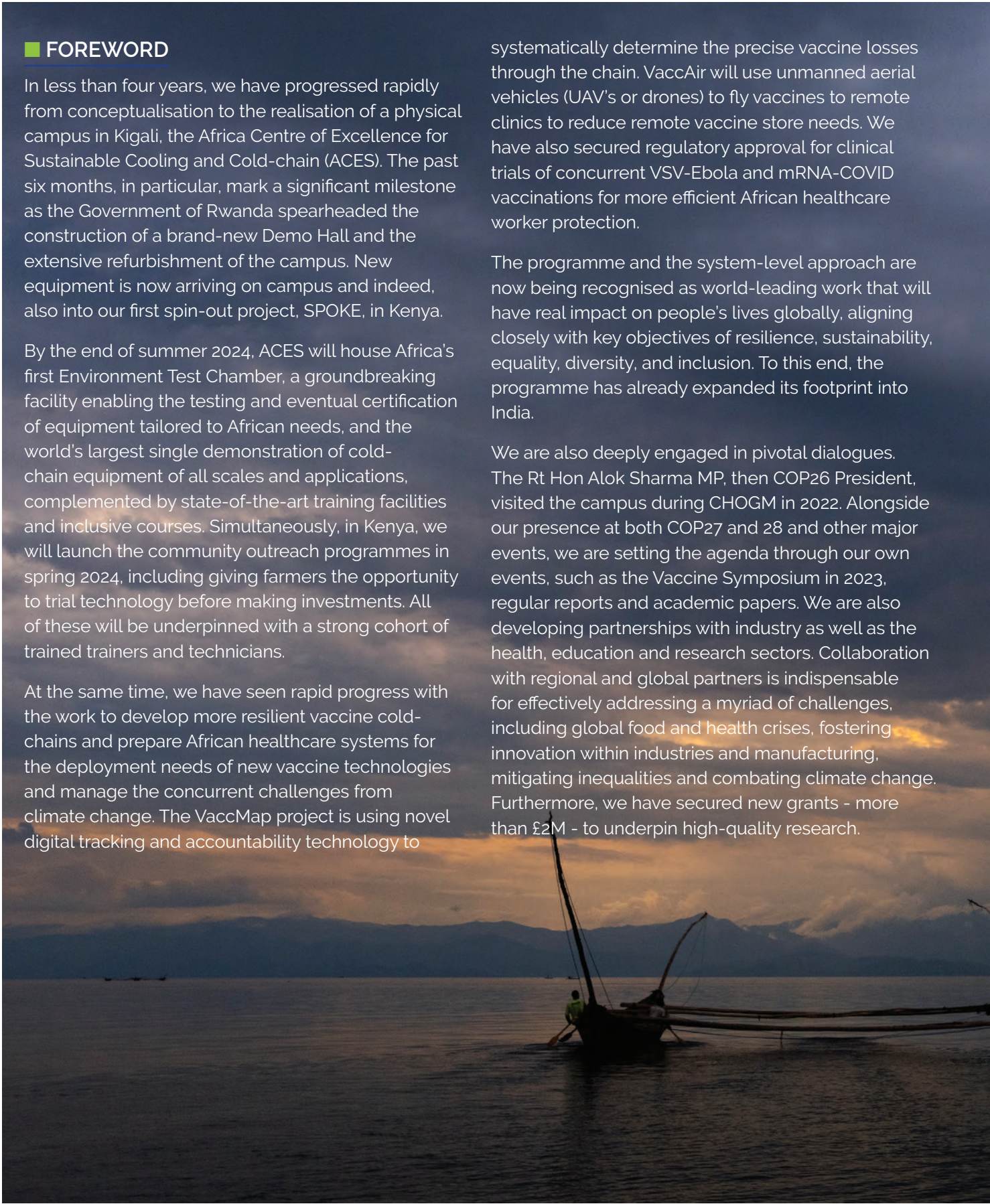
By the end of summer 2024, ACES will house Africa's first Environment Test Chamber, a groundbreaking facility enabling the testing and eventual certification of equipment tailored to African needs, and the world's largest single demonstration of cold-chain equipment of all scales and applications, complemented by state-of-the-art training facilities and inclusive courses. Simultaneously, in Kenya, we will launch the community outreach programmes in spring 2024, including giving farmers the opportunity to trial technology before making investments. All of these will be underpinned with a strong cohort of trained trainers and technicians.

At the same time, we have seen rapid progress with the work to develop more resilient vaccine cold-chains and prepare African healthcare systems for the deployment needs of new vaccine technologies and manage the concurrent challenges from climate change. The VaccMap project is using novel digital tracking and accountability technology to

systematically determine the precise vaccine losses through the chain. VaccAir will use unmanned aerial vehicles (UAV's or drones) to fly vaccines to remote clinics to reduce remote vaccine store needs. We have also secured regulatory approval for clinical trials of concurrent VSV-Ebola and mRNA-COVID vaccinations for more efficient African healthcare worker protection.

The programme and the system-level approach are now being recognised as world-leading work that will have real impact on people's lives globally, aligning closely with key objectives of resilience, sustainability, equality, diversity, and inclusion. To this end, the programme has already expanded its footprint into India.

We are also deeply engaged in pivotal dialogues. The Rt Hon Alok Sharma MP, then COP26 President, visited the campus during CHOGM in 2022. Alongside our presence at both COP27 and 28 and other major events, we are setting the agenda through our own events, such as the Vaccine Symposium in 2023, regular reports and academic papers. We are also developing partnerships with industry as well as the health, education and research sectors. Collaboration with regional and global partners is indispensable for effectively addressing a myriad of challenges, including global food and health crises, fostering innovation within industries and manufacturing, mitigating inequalities and combating climate change. Furthermore, we have secured new grants - more than £2M - to underpin high-quality research.



Whilst Defra ODA funding has played a crucial supporting role in establishing the programme and there is scope to expand further through additional funding next year, the success of the project is, however, equally dependent on people and creating a community with a diverse range of voices and experience at all levels. And to this end the programme goes from strength-to-strength. At the time of writing, we have more than 60 researchers and experts from various countries, with more than half based in Africa and India and a large family of collaborative partners providing equipment, training and other support. It is essential to continue to bolster international cooperation, channel expertise and unlock new partnerships and sources of financing. Reflecting the expansion and vision, a new independent Institute, the Africa Cooling and Cold-chain Institute, has been created to not only manage ACES in Rwanda, but also to lead the programme in Africa

Over the past 12 months, we have highlighted the pivotal role of cold-chain – and indeed cooling - as critical infrastructure. Without cooling and cold-chains, we would not have access to safe and nutritious food; the efficacy of medicines and vaccines would be compromised; homes, workplaces, hospitals and public spaces would be less comfortable for safe living, productive work, effective study, healthcare provision and pleasurable leisure; and the digital systems that underpin every aspect of contemporary life would be unable to operate.

Today, we have a clear imperative for change. In the context of a hotter world, cooling provision will become even more critical. But with the world's first Cold-chain and Cooling Institute, with its own campus and outreach SPOKES being established in Africa, we now have the frontline capability to accelerate a resilient, sustainable, and inclusive transformation on a systemic level.

Professor Toby Peters
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SECTION 1

PROGRAMME REVIEW

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■ BACKGROUND

The “Sustainable Cooling and Cold-chain Solutions” project was conceived in 2019 to increase the adoption and uptake of resilient, efficient, inclusive and climate friendly cooling with the objective of reducing food and vaccine loss while mitigating the potential environmental impact of the cold-chain. In so doing, the aim is to deliver Transformational Systems Change, Economic and Societal Benefits, and Environment and Climate Benefits. Based on comprehensive market studies and needs assessments, in 2020, a framework was designed to address the multifaceted challenges associated with sustainable and resilient cold-chain development and access. Key pillars - Training and capacity building; Finance and Business Model; Enabling Policies; Technologies (testing and demonstration); System Design and Modelling – were developed to form the foundation of ACES and the overall approach to be pursued.

For on the ground delivery, the programme was designed as “Born in Rwanda, pan-Africa in vision” with a physical Centre to be established in Rwanda forming the ‘hub’ - the Africa Centre of Excellence for Sustainable Cooling and Cold-chain (ACES) - followed by the development of physical “SPOKES” (Specialised Outreach and Knowledge Establishments) that would share research, innovation and knowledge in different markets through a ‘hub and spoke’ model. The longer term vision was to replicate in other geographical markets, e.g. India, and to develop a global network of Centres¹. The programme is designed to be underpinned by its own multi-purpose online network and knowledge platform, now in development.

The project has been enabled by approx. £17M (£16,881,898) of funding by the UK Government since

2019 for capital, operation and technical support. A further £2.5M is scheduled to be released this summer (2024) as the final tranche. The United Nations Environment Programme (UNEP) is the lead delivery partner receiving Department for Environment, Food & Rural Affairs (Defra) funding directly and managing the distribution, working in partnership with University of Birmingham through the Centre for Sustainable Cooling (CSC), as the lead academic partner², and University of Rwanda (UR) as the original lead in-country partner. The team of experts and researchers now numbers more than 60, with further recruitment underway. A dedicated 4.25-hectare campus in Rubirizi, Kigali was allocated by the Government of Rwanda exclusively for the ACES project, and a further 200 hectares of farmland assigned for an integrated smart farm. This creates not only the first campus dedicated to cooling and cold-chain, but also the first research and testing site encompassing the integrated food system from seed to plate. The Government of Rwanda has also funded the construction on the campus of a new Demo Hall (\$1M) and more than \$100,000 of refurbishment of existing buildings, including a multi-purpose conference centre (for up to 200 people), a Refrigeration Training Centre, classrooms, offices and general campus facilities.

The UK Official Development Assistance (ODA) funding and the UK technical expertise is enabling the equipping of the Demo Hall with an Environmental Test Chamber postharvest facilities, three Variable Temperature Rooms; Freezer; Cold Store, and a quality and safety control Laboratory as well as fit-out of a state-of-the-art Refrigeration Training Centre. Novel test and demonstration equipment at the campus is being purchased through the ODA funding



¹ Programmes are underway in Haryana and Telangana

² Academic and expert collaboration partners: London South Bank University; Heriot-Watt University; Cranfield University; Wageningen University and Research, VU Amsterdam, Flexible Power Systems.



(including a first of a kind Community Cooling Hub), donations by industry, and through the International Finance Corporation (IFC) TechEmerge programme. It is scheduled that this summer the ACES campus will have the single largest demonstration of sustainable cold-chain technology.

Recognising the expansion and vision of the programme, in 2023, the Government of Rwanda formally created a new independent Institute to lead the in-country work – The Africa Cooling and Cold-chain Institute - with its own Board, staff and governance structure. The Institute will take over the management of the ACES campus and programme delivery as well as the relationship with the SPOKES. The UR remains an in-country partner along with the Integrated Polytechnic Regional College (IPRC) Kigali (for vocational training) and Rwanda Biomedical Centre (RBC, Rwanda's national health implementation agency).

The first SPOKE is being established in Kenya in collaboration with the Africa Centre for Technology Studies (ACTS), a Memorandum of Understanding (MoU) has been signed for SPOKES in Senegal and plans are in advance development with Lesotho. A team funded through the project is working to replicate the programme at two sites in India,

in Haryana State and Telangana State, with the Governments of both funding the programmes and the project team providing technical assistance, supported by ODA funding.

GOVERNANCE AND MANAGEMENT

UNEP is responsible for overall programme governance and financial management and reports back formally to Defra every three months - in turn the project partners report to UNEP with formal progress and expenditure reports. Defra's project manager talks regularly with both the project leader (weekly) and the financial management team (monthly). Funding drawdowns from UNEP by the project partners for agreed programmes are dependent on the reporting and all partners are formally audited on completion with 15% of funding reserved until the final report is submitted and approved.

At an operational level, led by CSC, the programme's senior management team meets weekly, while the academic project team aims to meet fortnightly. Multiple further meetings take place continuously within the team. All parties have their own internal financial management, procurement and recruitment processes while UNEP provides additional training,

support and sign-off where required to the local partners (e.g. larger equipment procurement processes) thereby ensuring they meet UNEP rules and protocols. The UK team provides very hands-on day to day advice and technical support to the local partners and the UNEP team for recruitment and equipment specification and procurement, including sourcing from reputable contractors. The UK and UNEP teams regularly visit Rwanda to support the in-country team and sign-off on major decisions on the ground when necessary.

The Africa Cooling and Cold-chain Institute is a new independent international NGO established to manage the programme and campus as the programme transitions to full operations both in Rwanda and beyond. It has been approved by the Government of Rwanda and the Rwanda Governance Board (RGB) and has its own Terms of Reference, Executive Director and Board (currently five, being expanded with further independent directors to seven/eight). The latter selects the senior management team. Thereafter the Board both supports and provides oversight of the Executive Management team and the wider ACES campus programme and operations, acting in what they reasonably believe to be the best interests of ACES, its community and stakeholders. As a further layer of governance, UNEP has to approve procurement. And as a partner the Institute must report back to UNEP regularly against its objectives, work packages and use of funds. Going forward the Institute must produce annual accounts and submit these and wider, specific reports, including updated planning and cost estimates to the RGB.

■ DEFRA INTERNAL PROGRAMME REVIEW

Defra undertook a review of the programme between July and September 2023 with information and analysis provided by University of Birmingham as the lead academic institution. Data was collected throughout the year and by working with those in country to provide up to date information, as well

as by both Defra and delivery partners undertaking multiple site visits to confirm progress.

In 2023, the programme scored an 'A' overall. The review noted that "With the first year of increased funding to the programme, it is unsurprising that there have been some delays, especially to ACES which is now transitioning rapidly to operations through training, equipment procurement and demonstration. However, there has been significant progress and when reassessing the outputs/ outcomes it is clear that ACES is delivering well".

It should be noted that the programme started shortly before COVID in 2019 which resulted in the first field visit as part of ACES being delayed until May 2022. More recently, climate disasters such as flooding and mudslides in May 2023 have been necessary priorities for the Rwandan Government programme leaders who work on ACES, taking them away from the day-to-day leadership of the project. Despite these challenges to delivery, the programme has been able to make significant progress across the different workstreams.

It was noted that there have been delays primarily due to:

- Contracting and funding flow between UNEP and partners as the Programme aims to deliver large scale changes to processes, which takes time.
- The complexities of ordering equipment which is not currently available in Africa, and which requires training of procurement officers and in-country technical advisors, as well as extended tendering processes with contractors.

It is hoped that transitioning to the ACES Institute model will help alleviate some of the challenges faced by UR around complex procurement in new areas for which they had limited experience. Not least the Institute can use the available UK technical experts within the process rather than external non-expert advisors.



HIGHLIGHTS AND KEY AREAS

- The programme has received critical buy-in from supporting countries and partners through co-funding e.g. Rwandan Government providing funding for both the Campus site and a Demo Hall.
- Equipment is being procured / deployed for the Refrigeration Training Centre and Demo Hall.
- A series of training programmes have been developed and launched in Rwanda and Kenya.
- Work has been undertaken to design and develop the ACES Centre for Master's Training (ACES-CMT).
- Five externally funded PhD places on vaccines and one on cold-chain³.
- The project is collaborating with organisations such as SureChill, Pluss, Ecozen, Danfoss, Daikin, Carrier, Duplantis, Netune, Circular, Zipline Inc, Shinogi, Center for Family Health Research, NIHR, NHS and IFC -Tech Emerge, with medical research funding from industry (MSD), NIHR/NHS and charitable bodies (MRC and the JP Moulton Charitable Foundation).
- Secured Rwanda National Ethics Committee (RNEC) regulatory approvals for two ACES medical research projects in collaboration with RBC, the national health implementation agency for Rwanda, and industry partners, and a third study submission is currently under review.
- Secured more than £1M (total) of additional research and education funding for ACES vaccine projects⁴.
- Launched VaccMap project in Rwanda with Circular and RBC tracking 30,000 vaccine doses to individual sub-vial (or dose) level of accountability.
- Statement of Cooperation was signed between IFC, Defra and the Government of Rwanda at COP27 with the IFC Tech Emerge Programme due to support multiple start-up companies on the campus once open.
- Three students have completed an extensive traineeship program that lasted more than 6 months, with one now employed by Danfoss.
- Land (200 hectares) adjacent to the campus has been allocated for the Smart Farm.
- The first SPOKE is at an advanced stage in Kenya with staffing recruited, a dual use site at Konza Technopolis established with farming communities in Lari sub-county in Kiambu County, the first 'Try Before You Buy' (TBYB) equipment arriving in February 2024.⁵
- Further SPOKES are in early-stage development in Senegal (in partnership with the Government of Canada), which will provide a gateway into French speaking Africa, and Lesotho (in partnership with the Millennium Challenge Corporation).
- Activities are also underway in India to replicate the ACES model with two centres being established in Telangana and Haryana (sites are located and due to begin building this year).
- New academic partners have been brought on-board, including from Wageningen University & Research and VU Amsterdam, as well as Flexible Power Systems in the UK.
- Hosted major events in Rwanda – Vaccine Symposium and ACES Forum (October 2023) - and were integral to side events activities taking place at prestige global events such as COP28.
- Hosted University of Birmingham - International Finance Corporation (IFC) Tech Emerge conference.
- Published '3 Degrees' and 'Living in Warming World' reports and three research papers are currently in submission.
- Development of Design toolkits including Cooling Needs Assessments Toolkits, Virtual Design Model, Technology Database and Audit process are on-going.
- Secured intention to create a second research base; a joint ACES/RBC office at Rwamagana District Hospital for the projects planned to take place there in late 2023 and into 2024.
- Developed GESI scoping report.
- Development the Visual Media Training.
- Launch of Kinyarwanda language course for international team members visiting Rwanda.

³ Funds from the NHS and the East Africa Consortium (UR) will fund four full-time PhD scholars.

⁴ includes

- MRC award to develop a point of care lateral flow test for better measles vaccine needs forecasting
- MSD award to conduct a phase 4 clinical trial looking at the safety and immunogenicity of concurrent VSV-Ebola and mRNA-COVID vaccinations for more efficient African healthcare worker protection

(in collaboration with RBC and the Center for Family Health Research).

- Award from the JP Moulton Charitable Foundation to evaluate whether unmanned aerial vehicles (UAVs or drones) used in critical vaccine supply chains can enable zero-emission and off-grid vaccine capability and better equity to mRNA and viral-vectored vaccine technologies.

⁵ In preparation for the roll-out, 40 farmers have been trained on postharvest management and cold-chain.



FINANCES

Defra - Africa Centre of Excellence for Sustainable Cooling and Cold-chain development phases and allocated funding.

Phase 1	July 2020	\$247,661
Phase 2	March 2021	\$3,422,196
Phase 3	November 2021	\$4,016,000
	March 2022	\$654,450
Phase 4	August 2022	\$3,842,485
	March 2023	\$3,309,715
Phase 5	August 2023	\$4,075,550
Phase 6	to be released summer 2024	\$3,000,000 ⁶

Expenditure to date (cost are out to end of 2025, contracted).

Phase 6 not yet allocated – primarily to be spent on equipment and operational costs in Africa and continued project development in India and further development of online platform

Of the total expenditure to date (Phase 1-5), 36% has currently been allocated to be spent directly in-country and of the total phase 1-6, more than 40% is projected to be spent directly in market. Twenty-two people are directly employed in Africa and India through the project currently (more than 40% of their time, majority 100%). This number is projected to increase to more than 30 over the summer with planned recruitment.

UNEP	Programme, operational and project management to include in-country team (five) in Rwanda and the in-country team in India (five). Events, trainings and other costs.	\$4,920,120 – of which \$1,057,200 is in-country staffing in Africa and India
University of Rwanda.	In-country leadership and development of campus, including initial procurement.	\$1,775,000
ACTS	Development of SPOKE programme, staffing and initial procurements and training	\$1,240,700
ACES	In contract (to include outreach for 2nd and 3rd SPOKES)	\$2,918,887
UK/International team of seven research institutes	Programme design and delivery management across Rwanda, other Africa markets and India. Detailed facility, technical design, specifications On-going support to all partners. Recruitment and training. Development of all toolkits and business models, virtual model, GESI framework, etc working with the in-country partners. Engagement with third partners including industry and international agencies like IFC. Government and policy engagement. Grant funding.	\$8,712,250

Additional Contributions

The Government of Rwanda has contributed:

- An operational campus.
- Adjacent farmland for Smart Farm.
- The build of the Demo Hall (in excess of \$1M).
- The campus refurbishment (in excess of \$100,000).
- Additional resources across multiple institutes (Rwanda Environment and Management Authority, RBC, UR, IPRC) including project management, four academics and support to a series of vaccine developing, training and research programmes.

The team has also secured more than \$1M of grant funding, including GCF and FAO while the UK academics have secured more than £1M of additional grant funding.

These exclude industry and in-kind funding secured.

■ OBJECTIVES FOR 2024/25

The programme was designed around:

1. building the capability (physical sites, training programmes, trained in-country delivery teams, industry partners and toolkits, etc) from the ground up and then
2. using the capability to build capacity, and training engineers, technicians, farmers and health care workers, policymakers and other stakeholders as well as find and demonstrate the new and fit for market technologies, and experiment with the right business models, etc. for sustainable cooling and cold-chain in developing countries.

With the facilities, tools and partners in place (or soon to be in place), thereby achieving Objective 1, our goal for the next 12 months is the hands-on building of the capacity to enable change. We will operationalise the programme and the delivery Centres and SPOKES as active training and development centres; publish the outputs from a number of the research programmes and launch the associated toolkits;

establish the Africa Cooling and Cold-chain Institute as the umbrella organisation and, through this, better manage and accelerate the operation and procurement processes across the programme, for rapid roll-out. And we want to win new funding, partnerships and support to ensure the programme is funded for a further three years (through to end 2028). This will all be underpinned with delivery of the agreed set of programmes including training and capacity building, the launch of the online network, knowledge and library services and web platform along with an evidenced based GESI framework.

Specifically, our goal is that:

- The ACES campus, and Smart Farm to be fully operational including the Refrigeration Training Centre, Environmental Test Chamber, storage facilities, and Community Cooling Hub and associated TBYP programme.
- Kenya SPOKE should be fully operational working with farming communities in the Lari sub-county of Kiambu County, which will inform scaling in Kenya.
- Two further SPOKES should be at the procurement and upscaling in-country team stages, following data gathering, design and initial staffing.
- Two further SPOKES to be in early stages of programme development.
- At least one Centre in India at the build stage with both Centres offering initial Foundation and other training programmes.
- Developed plans for at least one further Centre of Excellence in a new market (likely Asia).
- All of the above underpinned with a three - year business plan out to 2028.



Rwanda Minister of the Environment Honourable Minister Jeanne D'Arc Mujawamariya (centre) being shown round the campus during the renovation and build programme.

BUILDING ON PROGRESS TO-DATE

This is a living programme and while existing aspects continue to be implemented and refined, new opportunities and next steps are emerging. These include exciting initiatives addressing discovered gaps in the markets and in so doing creating opportunities - and training – for new local businesses. Examples include high quality ducting, cold room structure building and insulated box assembly as well as potentially in-country assembly for some novel technologies. Additionally with the adjacent farmland we can move to on-site point-of-harvest technology testing and demonstration within the full agri-food system.

Our aim in the period 2025 – 2028 (subject to funding) is to deliver:

- more mobilisers trained for in-country capacity building and knowledge transfer.
- expanding capacity building, including wider stakeholder engagement as well as undergraduate and post-graduate degrees.
- development of a portfolio of specific GESI / Cold-chain training and academic courses, including for policymakers.
- broaden out engineer training including hydrocarbons and CO2 refrigerants.
- developing the integrated system of systems approach.
- accelerating the optimisation, testing and deployment of new sustainable technologies and support their transition to low Global Warming Potential (GWP) refrigerants where necessary.
- establishing the underpinning business models for new technologies and solutions.

- further developing the cold-chain for vaccines work, including mRNA vaccines.
- further roll-out of the SPOKES network to deliver the pan-Africa scope of the programmes.
- bolstering existing activities at the ACES HQ, including:
 - o a full feasibility study for in-country assembly;
 - o a new build full quality and food safety control lab and;
 - o enhanced telemetrics, data and modelling capabilities.
- developing the on-the-ground teams and business plans for further roll-out of the model into other key geographical markets (Asia and Central/South America)
- leveraging key co-funding and partnership opportunities.
- All of the above underpinned with a comprehensive online network and virtual platform to support all stakeholders, and give global access to selected training and academic courses and knowledge.

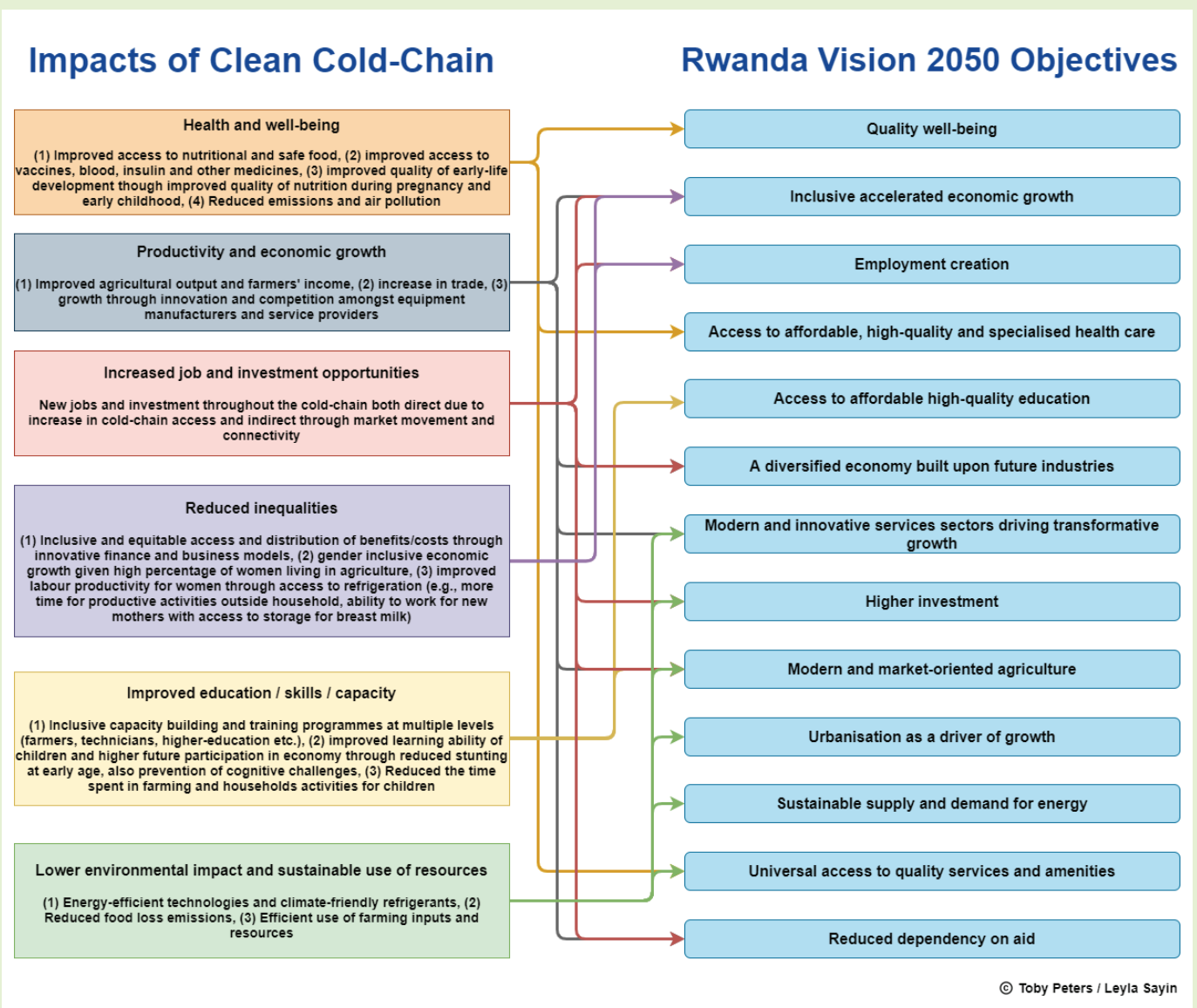
In so doing, this next stage will play a pivotal role in ensuring the continued success and growth of the programme, allowing it to address emerging opportunities and challenges worldwide. It will specifically globalise the programme establishing an integrated network of physical Centres and SPOKES and a full online platform and network, including virtual training and courses. The broader plan includes the proposed establishment of new Centres in South America and Asia, with consideration for possible inclusion in Small Island Developing States where access to sustainable cooling solutions is a significant barrier.

■ COLD-CHAIN IS CRITICAL INFRASTRUCTURE

Cold-chain is not an optional extra or a lifestyle luxury! It is a critical service for a well-functioning, well-adapted, resilient, healthy society and economy, enabling access to the basic essentials of life, food and health.

As an example, Rwanda's Vision 2050 sets ambitious

goals for addressing multiple developmental challenges from food security, malnutrition, poverty reduction and health to education and equality; all essential within a well-functioning society. Achieving these goals will, however, require the development of an end-to-end, sustainable, resilient, inclusive and equitable cold-chain for food and pharma.



SECTION 2

PROGRAMME DETAILS

■ WHY WAS THIS PROGRAMME NEEDED?

Cold-chains are critical infrastructure, vital for a well-functioning society and economy (see page 9). They underpin our access to safe and nutritious food and health, as well as our ability to spur economic growth, and deliver socioeconomic development. Furthermore, cold-chain infrastructure, and the lack of it, have implications for global climate change and the environment.

As one example, in Rwanda 40% of food production in the country is lost or wasted along the supply chain, mainly due to lack of a robust cold-chain. This equates to 21% of its total land use, 16% of greenhouse gas (GHG) emissions, and 12% loss to its annual Gross Domestic Product (GDP). According to the National Land-Use and Development Master Plan 2020-2050, yields will have to be improved 15 times compared to 2019 levels to ensure food security for all Rwandans by 2050. If the food loss were to be fully eliminated, yields would only need to be improved 9 times to achieve food security in 2050.

Cold-chains are however complex - multi-dimensional, temperature-controlled networks that must maintain perishable and temperature-sensitive products at their optimum temperature and environment from point of harvest to destination, preventing qualitative and quantitative product losses and ensuring their safety. In so doing they include multiple stakeholders from farmer to retailer, vaccine manufacturer to district nurse not always properly connected. While the global cold-chain capacity has been growing in recent decades, the growth has not been equitable in terms of access.

As a result, the existing and planned cold-chain infrastructure for the agrifood and pharma vaccine

value chains in many emerging markets is insufficient, of low quality, lacks connectivity between stages, and is carbon and resource intensive. This is resulting in a huge loss of agri/food and pharma/vaccine products, imposing higher market risks and lower profits for all actors in the value chain, and lowered product value for consumers, with accompanying impacts such as deteriorating food and vaccine security, wastage of input resources, increasing GHG emissions and environmental impacts, hunger, malnutrition, morbidity and mortality, with more disproportionate impacts for vulnerable groups.

At the same time, many actors in the value chain compensate for the lack of cold-chain infrastructure and accompanying market risks through business practices that undermine the health and safety of end consumers. Underlying these problems is the lack of integrated and holistic planning; lack of an enabling policy, regulatory, fiscal and financing frameworks; insufficient capacity for planning and implementing sustainable, resilient and inclusive cold-chains; and lack of targeted support for transitioning, especially by the smaller actors in the value chain.

These are also linked to long term structural issues facing local market economy such as: inequality and regional and urban-rural disparities in accessing physical and digital infrastructure and the financial system; predominance of the informal sector in terms of labour participation; less ease of doing business, including due to bureaucratic hurdles and corruption; and an education system that is out of sync with current and future requirements. These challenges are further amplified by the sheer scale and complexity of national, regional and global cold-chains into which farmers need to trade.

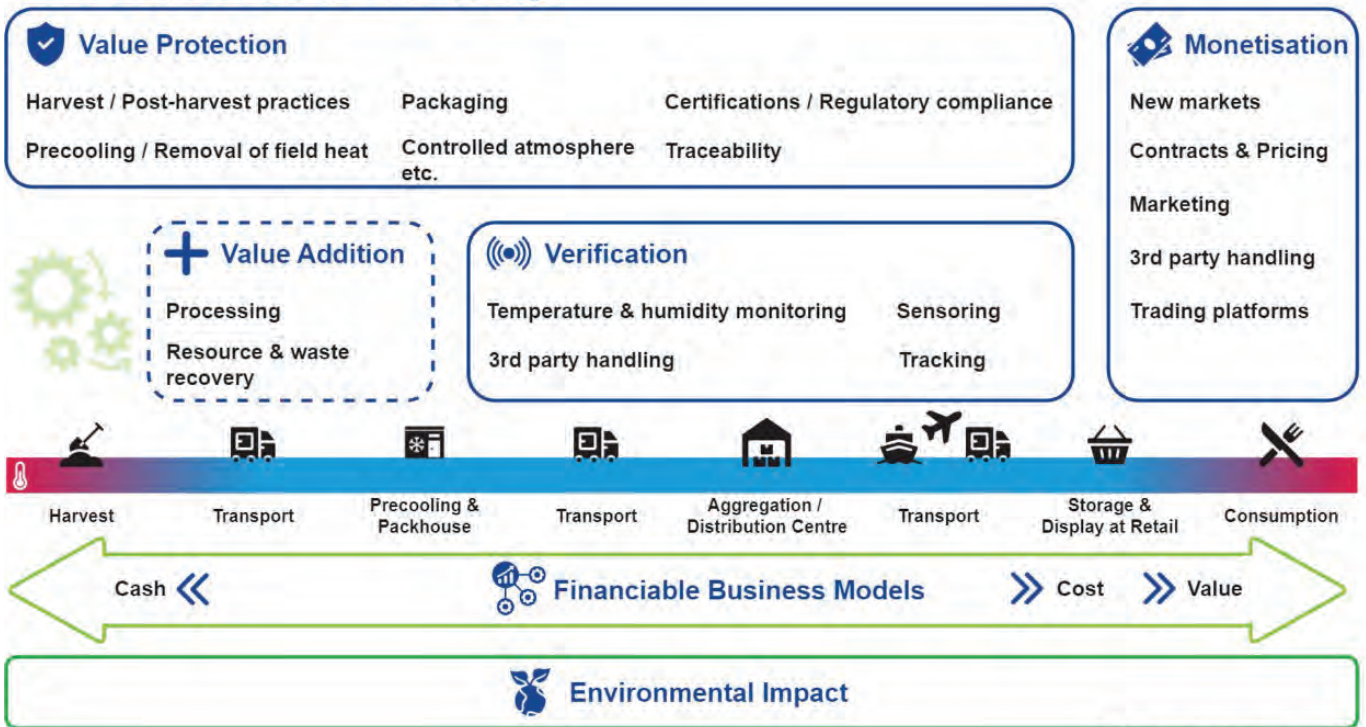
■ WHAT DOES ACES SET OUT TO DO?

As cold-chains continue to gain attention as one of the key pillars of socio-economic development, it becomes increasingly important to understand how to deliver them (1) sustainably with minimum environmental impact; (2) equitably, providing access for all, including poor, disadvantaged, and marginalised farmers and their communities, as well as women and youth; and (3) while ensuring that they are future-proofed and resilient against changes to the system as well as future risks, shocks and disruptions.

To date, where there has been intervention it has been mainly reductionist, testing individual technologies or interventions in silos. A cold-chain system is, however, highly complex – for food as an example (see diagram page 12) it necessarily includes pre-cooling and postharvest management, including processing, distribution and consumption. It includes both static and mobile elements that must work seamlessly together, and which are a primary source of different energy demands, including from logistics and transport. These systems are, however, fragmented, data sharing and collaboration is sporadic and there is no top-down holistic view of how the system is performing.

Equally the focus is often on optimising the chain's sub systems, which neglects the interdependencies that exist amongst the economic environments, energy resources, technology choices, mitigation and adaptation strategies, social and political systems and results in a sub optimal system of systems. And they vary by country as well as being dependent on local produce, economic, environmental, social, cultural and political circumstances.

Cold-chain is not cold storage



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While there is a need for equitable and sustainable cold-chains, there also needs to be a paradigm shift towards a different way of thinking that goes beyond simply taking business-as-usual action. We need to recognise that developing a sustainable and equitable cold-chain is about more than procuring and installing solar-powered cold rooms at the farm gate or chiller cabinets with lower GWP refrigerants in supermarkets. Developing a sustainable food and pharma cold-chains in fact presents a wicked problem with diverse drivers and barriers, all interconnected and with multiple feedback loops. At a systems level, cold-chain sustainability is impacted by, among others, postharvest inventory management and food behaviour understanding, packaging

and handling materials, waste management, heat reclaim, and the operational models and procedures employed. Key challenges revolve around access to reliable and affordable energy, behavioural issues, skillsets, and the business and financing models that underpin the overall investment. It requires cooperation from multiple stakeholders and contains many interdependencies.

It is these issues that ACES sets out to address through the Centre's programme which takes a first of a kind comprehensive, needs-driven, system of systems approach to the planning, development, deployment and operation of food and pharma cold-chains.



MoU signed with Government of Haryana



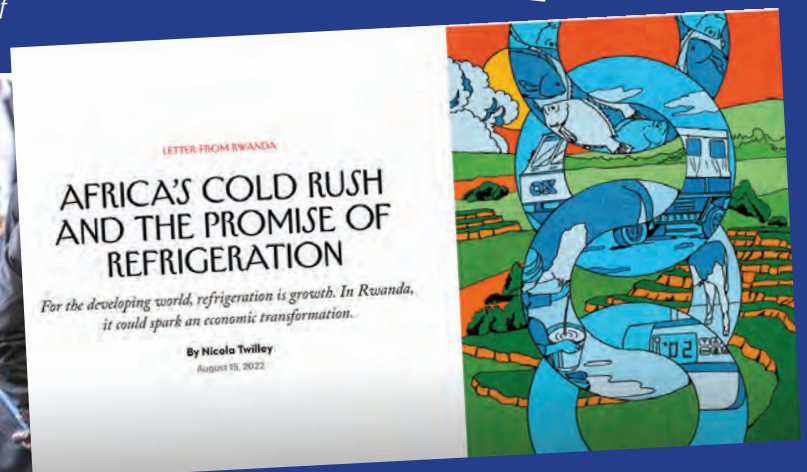
Minister of State The Rt. Hon. Lord Richard Benyon from the UK's Department for Environment, Food and Rural Affairs (Defra), Rwanda's Minister of Environment Dr. Jeanne d'Arc Mujawamariya, and Emmanuel Nyirinkindi, Vice-President, IFC after the signing of Statement of Cooperation



Publication of reports and generation of media coverage to promote cooling as critical infrastructure and ACES system-based solutions.

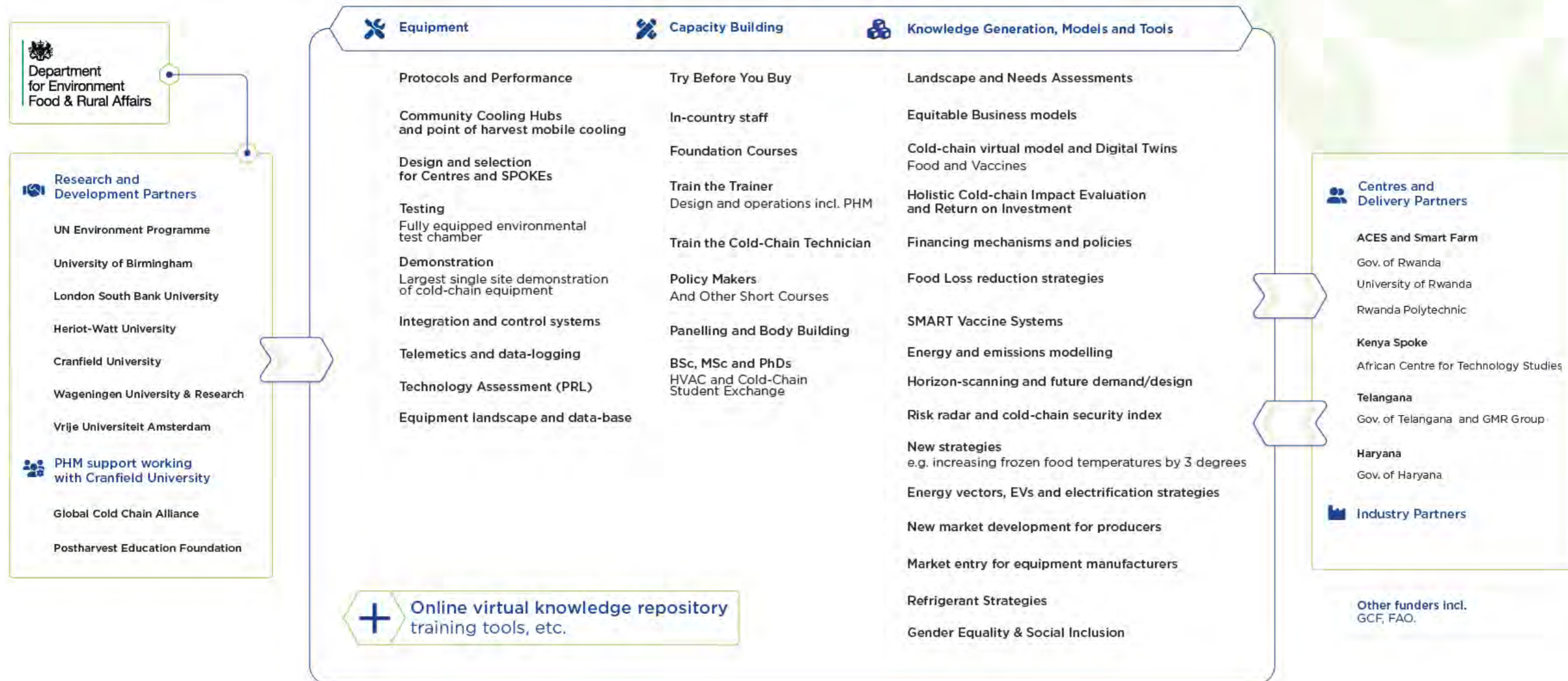


COP President, the Rt. Hon. Alok Sharma MP, visited ACES during his attendance at the Commonwealth Heads of Government Meeting (CHOGM) in Rwanda



Centre of Excellence Programme

The accelerated deployment of **sustainable** (environmentally, economically and socially), **resilient** and **equitable temperature-controlled, end-to-end connectivity for food and health** which simultaneously **protects the quality and safety, minimises loss and provides value to all stakeholders.**





To have impact on the key challenges identified, all of these issues have to be solved concurrently.

- Lack of knowledge in cold-chain design and its key elements and the associated costs, challenges and risks.
- Unorganised and uncontrolled cropping/ sowing pattern being followed by farmers which is leading to either glut or deficit in availability of fruits/ vegetables in the market.
- Substantial traces of pesticide residues in fruits and vegetables due to their indiscriminate use, imposing serious health risks to consumers and presenting a barrier to formal markets.
- Lack of awareness among farmers on the immediate measures to take after harvesting at field level to control postharvest losses.
- Removal of field heat through precooling is not practiced by the majority of farmers.
- Measures such as sorting, grading, etc., are not being done by farmers before packing produce.
- Poor packing processes.
- Insufficient availability of Postharvest Infrastructure such as farm level pack-houses, pre-cooling units, cold storage units etc.
- Vegetables contaminated postharvest by polluted water and artificial colours. These factors increase the risk of microbial and other contamination at all points from farmer to consumer.
- The poor quality of vehicles coupled with inadequate conditions of roads and poor packing practices are one of the major causes of postharvest losses to most fruits and vegetables.
- Involvement of multiple players in the supply chain mechanism from farmer to consumers leading to 150 to 200% price hikes and 20-30% postharvest losses.
- Lack of financeable business models for community based pack houses and cold hubs.
- Fruits and vegetables experience a much higher degree of price volatility than other produce for the reason that there is a high level of mismatch between demand and supply and farmers do not have access to market intelligence on the prevailing prices or market choices - in different - markets (including using storage to delay time of sale).
- Lack of awareness of government subsidy schemes.
- Inconsistent governmental policies to enable inclusive cold-chain sector development, including limited cross-ministerial collaboration. Additionally, the lack of addressing the informal sector, which delivers 95% of the food in low- and middle-income countries.
- Limited availability of affordable financing mechanisms for sustainable cooling and questionable use of grant money in flawed business models, leading to underutilised cold-chain facilities (i.e. white elephants).

■ KEY PILLARS

Training and capacity building

- Training for farmers and co-operatives
- Training for community mobilisers
- Training for cold-chain engineers
- Training for policy makers and financial institutes
- Development of the SPOKES network and Centre of Excellence programme in India
- Cold-chains through the GESI lens
- Undergraduate and postgraduate degrees

Finance and Business Models

- Financeable Business Models
- Inclusive Financing Mechanisms, including blended finance solutions.
- Return on Investment Model to underpin Governments' investments

Technologies – testing and demonstration

- Build and demonstrate off-grid Community Cooling Hubs
- Testing new technologies
 - On-farm pre-cooling
 - Off-grid, low GWP solutions through the cold-chain
 - Development of protocols for testing food safety and energy efficiency

- Demonstrating new technologies (including through the SPOKES and TBYB)
- In-country assembly (Phase 2)

System Design and Modelling

- Peer-reviewed data collection tools
- Virtual modelling
- Telemetrics and data collection
- Next-generation's vaccine cold-chain infrastructure and systems
- Energy Transition and Access (including electrification of transport strategies)
- Agrifood system testing from soil to fork (SMART FARM plus Cold-chain campus)

Policy

- Promotion and adoption of a holistic, systems-based approach for cold-chain sector development. Promoting interdepartmental collaboration.
- Risk radar and cold-chain security index
- Public, private community partnership financing
- Cooling as critical infrastructure
- Expansion of the Global Vision
- New strategies for energy savings and energy efficiency e.g. increasing set point for frozen food by three degrees



SECTION 3

WHAT IS ACES?

FACILITIES

ACES is the only Centre of Excellence of its kind globally with a focus on holistic and sustainable system of systems cold-chain solutions. It is a uniquely situated 4-hectare headquarters campus (operated by the ACES Institute) in Kigali, and will be equipped with:

- a state of the art in-market technology test and demonstration centre;
- working with IFC and industry, the largest single demonstration centre of sustainable cold-chain equipment;
- a fully equipped refrigeration (including refrigerants) and data telematics training centre to provide the technical skills, including train the trainer programmes;
- a quality, safety, and postharvest management laboratory to conduct tests to evaluate and monitor quality, safety and storability potential of local crops, guaranteeing that they meet international and established standards;
- a business hub to provide the ecosystem⁷ and tailored incubation, training and acceleration support for early-stage technology companies to accelerate to market and scale up their businesses;
- renovated conference hall and classrooms;
- an adjacent nearly 200-hectare model Smart Farm that will allow research of cooling in the Water-Energy-Food Nexus and wider climate adaptation challenges including diversifying crop cultivation for increased farmers' income and more resilient sustainable food systems, which will inform scaling of approaches to broader farming communities and food systems;
- collaborative undergraduate and teaching facilities established at IPRC Kigali.

For the health research programmes, ACES works in close collaboration with the RBC, across a wide range

of projects and is in the process of establishing a second facility and joint ACES/RBC research office at Rwamagana District Hospital.

HUB AND SPOKE MODEL

Alongside the main campus in Kigali, ACES is also establishing SPOKES throughout Africa to showcase: 1) how solutions can be deployed in practical, real-world applications and 2) provide the on-site and outreach learning, training and knowledge transfer as well as centres of technical assistance accompanied by implementation of research to support local community uptake. The first SPOKE model is being developed in Kenya with the African Centre for Technology Studies (ACTS). Further SPOKES are being planned in other countries within Africa (MoU with Senegal recently signed, Lesotho in train).

SPOKES will support fit-for-market localisation and deployment of solutions throughout Africa, considering differing local needs, priorities, dynamics, challenges, and opportunities. They will offer technical assistance and training to ensure that the required capacities and skills are transferred to the in-country partners for successfully establishing, operating and managing solutions and delivery of the expected benefits. SPOKES will also run a novel "Try Before You Buy" initiative (see page 19) to engage the farmer communities and co-operatives, enabling them to experience the value of cold-chain (through improved quality and market connectivity) before they invest in purchasing equipment and helping them develop robust business models. Additionally, SPOKES will enable a bottom-up robust research and knowledge generation agenda to drive innovation and draw insights and evidence on impacts of sustainable and resilient cooling and cold-chains in developing countries.

⁷ The innovation ecosystem necessarily includes a complex network of support: R&D labs and incubators; physical infrastructure to pilot test and properly evaluate technologies underpinned by government-supported programs; verification and validation capability; supply chain and manufacturer development; accelerators and local venture funds that provide innovators with advisory and financial support; the training that produces qualified talent; agencies that promote and support IP filing; policy engagement to create the right environment for disruptive technology deployment, etc.

■ TRY BEFORE YOU BUY

The TBYY programme will involve each SPOKE having (initially) two sets of basic, moveable, off-grid equipment cooling and cold store. 1 tonne pre-cooler/5 tonne cold store, plus temperature controlled vehicles and packing crates, etc), which can be deployed for around three months in a community, complete with training (including postharvest management), remote monitoring and support. During this period – normally aligned to a harvest – the farmers can experience at first hand the impact of a cold-chain on their businesses, while in parallel be supported to develop market connectivity along with a financeable business model to purchase their own ‘fit for purpose’ equipment. During the process the ACES team work closely with the community leaders to undertake robust needs assessments, develop

their business model, and engage the community as well as potential new customers.

Through the programme, we aim to help communities understand the value that a cold-chain brings not just in reducing postharvest losses but also in terms of delivering them value capture/ uplift. The activity is supported by a well-defined monitoring, evaluation and learning framework to provide systematic evidence on technical, business and broader socio-economic aspects.

TBYB will be free of charge aside from necessary in-kind time and effort from local collaborators. For this reason (i.e. the fact that it is free), key to the success of the programme is to ensure the communities are committed and invested through their time.

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■ POSTHARVEST MANAGEMENT

In the agri-food sector, cold-chains are about protecting and maintaining quantity and quality of food (i.e. value) from farm to customer. Alongside temperature control, effective postharvest management systems ensure the optimisation of storage conditions, adequate handling processes, and the use of suitable packaging methods. ACES adopts a holistic approach to postharvest management, incorporating all these systems to mitigate food loss and waste, extend the postharvest of perishable goods, and ensure produce remains fresh and safe throughout the supply chain. This comprehensive approach not only maintains the quality and integrity of the food products but also enhances their market value, resulting in significant monetary gains for stakeholders, including smallholder producers and job creation in rural areas. Moreover, it significantly contributes to the overall efficiency and sustainability of the food supply chain.

ACES, through its specialised training programmes promotes knowledge in postharvest management,

food quality, and safety. These initiatives provide participants with insights into the biological responses of fresh produce to storage and processing, as well as the technologies available to extend shelf life while maintaining nutritional and physiological quality. The training programmes prioritise best practices and adherence to international standards by incorporating comprehensive guidance on proper handling, storage conditions, and transportation protocols to mitigate risks of contamination and deterioration. By equipping stakeholders with the necessary knowledge and skills, ACES ensures that they understand not only the “what” and “why” but also the “how” of postharvest handling practices essential for maintaining quality and safety standards. Access to such information and training empowers farmers and growers to maintain the nutritional content of their produce, ensuring it remains free from diseases and disorders. This enables them to access broader national and international markets while guaranteeing product safety and meeting market requirements at various levels.

■ FUNDING AND FINANCE MODELS

ACES is implementing a comprehensive set of programmes to develop the business models, funding routes, and finance mechanisms necessary for accelerating the deployment of inclusive cold-chains. These include:

Moving the funding needle - Over the past few decades, funding in agriculture and food has predominantly been targeted at improving yield, primary production, and irrigation resulting in a misbalance between the investment in the production and distribution stages. The hypothesis is that this is partly caused by the lack of understanding of contributions about the role of well-functioning supply chains and cold-chains in achieving social, economic, and environmental goals. There is a need to assess the balance in finance between production and the (cold) chain, including its relative impact on societal goals (social, economic, environmental). The work undertaken by ACES is envisioned to be a first test and proof of the hypothesis and a foundation for recommendations towards policy makers as well as for further research.

Financing mechanisms - ACES work in this area aims to comprehensively understand the existing financing mechanisms for sustainable cooling and cold-chain development, which include public finance (subsidies, tax measures, result-based finance), private sector finance (debt, equity, cooling as a service), incentives (carbon credits, true pricing, off-take guarantee, discounts loans) and a multitude of blended solutions. The activity further explores the applicability of different financing mechanisms, the accessibility that stakeholders have to the finance (especially ACES target groups) and affordability for the stakeholders. This allows mapping of the financing mechanisms landscape, including the emphasis and gaps of the current system and developments needed for inclusive financing mechanisms for communities, to finance sustainable community cooling hubs and other cold-chain investments.

Enabling environment - The Centre will develop a menu of enabling policies for cold-chain development and activities will include assembling an inventory of existing policies from conducted studies, enriching them through further interviews and elaborating those which can be implemented by national governments. A qualitative synergy and trade-off description will be provided with the described policies, for better guidance of implementation. The latter will be supported with a tool to help aggregate policies and consideration of them in a joined-up fashion, thereby stimulating the development of inclusive cold-chain sector development.

Financeable business models - The business models guidance work of ACES will set the scene for the need for cold-chains in the agricultural and food system, elaborating on the pre-requisites of viable business models, and potential candidate, including practical examples. The framework will be developed for use of business models for community cooling projects, prepare guidance and templates for communities for agricultural cold-chain investments which will be integrated into the ACES training and create a foundation for funding requests. This is guided by enhanced understanding of the socio-economic and environmental benefits that can be spurred by these investments.

■ DATA AND DIGITAL TOOLS

Central to our work, with Heriot-Watt University (Centre for Sustainable Road Freight) we are building a sophisticated, bottom-up, self-organising (i.e., with intelligent decision-making capability), virtual complex model which can be populated with a country's datasets to understand and develop optimised (i.e. by testing thousands of scenarios) cold-chain for food and health and associated cooling systems to simultaneously meet a Government's mission-driven social and economic targets whilst providing economic resilience to the smallholder farmers and stakeholders. It can help support robust business models; consider different energy strategies

and mitigate associated GHG emissions, as well as consider how to build resilience against future shocks and disturbances. From this, we can develop a holistic, robust, sequenced and budgeted evidence-driven cold-chain delivery roadmaps. As cold-chains are developed and we deploy telemetrics for data gathering, this can transition into a digital twin of the cold-chain where we can dynamically test and plan interventions – changes in need/demand, new technologies to climate risks. These data can support operational decision making, including based on real-time data feeds, and the ‘de-risking’ of key strategic decisions for future security.

Additionally, telemetrics and data connectivity labs/ training centres will be established as part of ACES, and their value and use will be promoted to the government and operators.

■ TECHNOLOGY RESEARCH

From a technology research perspective, ACES will primarily focus on four integrated technology areas - demand mitigation; conversion to renewables; thermal energy storage; data and control systems.

There is a specific work package for support of smaller / early-stage companies (including internationally) to develop their technology for market-driven solutions, including integration with the Community Cooling Hub and transition to lower GWP refrigerants. Within this we are undertaking research to understand what small businesses need, including those considering options to export to Africa, and how ACES can offer support.

■ ELECTRIFICATION OF ROAD FREIGHT

Many governments worldwide have begun to consider the decarbonisation of road freight and in this context it is important to understand the interaction between cold-chain provision and emerging options. Nearly all light and heavy commercial vehicle manufacturers have electric vehicle (EV) programmes that are entering production and responding to market expectations that electrification will play a dominant role across all classes of road freight vehicles.

Electrifying road freight has a number of implications for cold-chains:

- Vehicle range and payload constraints change the dynamics of cold-chain network design.
- Vehicle energy supply is more limited and therefore motive power and in transit cooling demands need to be balanced creating a significant efficiency premium.
- Locations for charging infrastructure need to be identified and this can impact routes options and transit durations, the latter having implications for in transit cooling technologies.

The interaction between cold-chain provision and road freight decarbonisation is poorly understood and to address this issue ACES will explore the practical implications of the interaction between cold-chains and electrification initiatives in Rwanda. The findings of this research, including best practice knowledge, will be disseminated to government and operational stakeholders.



■ TRAINING AND EDUCATION

A range of training and education programmes have been launched, and are under development. These include bespoke courses for community uptake, capacity building, and demonstration programs; tailored MSc degree programs fully accredited by partner UK academic institutions (The ACES Centre for Master's Training (ACES-CMT)); and targeted Executive Education courses for development of senior managers within the sector. The initial programmes include:

- Programmes designed to provide bespoke training for community uptake, capacity building, and demonstration
 - **Cold-chain Foundation Programme** – to provide participants with a solid and comprehensive understanding of fundamental concepts, skills, and knowledge within food and pharma cold-chains. The Foundation course serves as a building block, preparing individuals for more advanced and specialised studies or practical applications.
 - **Train the Trainer** - to build out a cohort of highly qualified trainers to support mobilisers, communities, and co-ops aiming to establish community cooling solutions working either through ACES or with development agencies and organisations. The course duration is seven months and includes [ten] weeks of face-to-face modules on campus. At the end of the training, students will have developed a full community business model.
 - **Train the cold-chain Technicians** - to develop highly competent refrigeration engineers able to specify, design and commissions, as well as maintain cold-chain equipment, and train in-company refrigeration technicians.
- **Farmer Community Leaders/Mobilisers** – an intensive programme offered to farmer community leaders/mobilisers to provide them with the core knowledge and support required to develop market access strategies and financeable business models. A second follow-on course will address how to procure, commission, operationalise and manage the facility once financing is secured.
- **Short-course for government and policy officers** – an important offering of ACES will be short courses and tools for government and policy officers that will enable them to better create:
 - market development and transformation strategies for food and health cold-chains; quantify investment requirements, and impact and value of investment; assess operational/business models for cold-chain infrastructure.
 - an enabling environment for communities and private sector, for the uptake of sustainable food and health cold-chains, achieving societal goals on climate, improved income, food and nutrition security and health.
- **ACES Centre for Master's Training (ACES-CMT)** – The ACES-CMT will enable delivery of bespoke MSc degrees that combine online courses with in-person delivery of modules and practical exercises making full use of the ACES institute campus in Kigali. As a unique MSc program, the ACES-CMT will be able to attract students from Rwanda and ACES-SPOKE locations, as well as recruiting students globally. Access to the ACES-CMT program will be facilitated by the provision of scholarships (e.g., the Denis Goldberg Scholarship of HWU) for applicants and organisations that meet scholarship award requirements. The ACES-CMT will build in-country networks for learning and professional development and enhance the MSc degree programs of UK partner institutions by informing course content with real-life practical examples.



- **Executive Education courses** – to address the need of organisations to rapidly upskill senior managers that are charged with leading new initiatives related to the ACES mission, bespoke courses will be developed to provide the high-level understanding required to manage these initiatives.
- For the ACES health programmes we are engaged with partner organisations, such as the UK National Health Service and the East African Community Regional Centre for Excellence for Vaccines, Immunisation and Healthy Supply Chain Management (EAC RCE-VIHSCM), to fund 3-4 year PhD opportunities for future health leaders for Africa. These include bespoke projects around vaccine cold-chain data science, novel immune diagnostics for better vaccine needs forecasting, and bioinformatics for public health threats.

Training/education will be supported by a web-based suite and repository of materials and practical skill development opportunities, as well as follow-on modules to ensure a living and relevant learning programme. Within the training/education programmes are industry supported events and activities that will establish the professional networks required to sustain seamless delivery of cold-chains into the future.

■ COLD-CHAIN FOR HEALTH

ACES also aims to develop the 'next-generation' vaccine cold-chain infrastructure and systems. Critically, these will need to accommodate the advent of lipid-enveloped mRNA vaccine technologies developed through the recent COVID-19 pandemic and now in development against a plethora of infectious diseases, many of which are endemic to the continent of Africa and identified from WHO as having high-priority for vaccine development. The mRNA vaccine platform offers major advantages in flexibility for re-design towards new threats and relative ease of large-scale manufacturing, and mRNA vaccine manufacturing capacity will soon become an in-country reality for several African nations. However, regardless of the disease target, mRNA vaccines require ultra-cold long-term storage (-20°C or colder) that is simply unavailable to many African populations, plus matched to new ultra-fast fridge temperature deployment needs (28-days, compartmented with two years for 'standard' conjugate vaccines). Together with the uncertainties of climate change effects on the habitats of disease vectors and epidemiology of vector-borne diseases, and population movement that will stretch the fragile 'last mile' challenge further, ACES has recognised the need to review at a whole-systems level how vaccine cold-chains need to look and operate for reliable, resilient and sustainable vaccine security for Africa.

ACES health cold-chain work is underpinned by a core research programme that focus on optimising and designing the 'next-generation' vaccine cold-chain (VCC) systems for future resilience, sustainability, and value-for-money in low-income settings. A second programme has specific focus on integrating biomedical data (serology) into improved vaccine needs forecasting, and a third programme is looking to use bioinformatics to better understand the effects of climate change on future threats.

ACES, with RBC, will also be a hub in Africa for clinical vaccine trials (new vaccines as well as delivery strategies) providing the robust data to drive the design of vaccine cold-chain to support vaccination strategies.⁸

■ GENDER EQUALITY AND SOCIAL INCLUSION (GESI)

Through ACES work to date, we are, for the first time, understanding the significance of gender equality and social inclusion in the growth and transformation of the cooling and cold-chain sectors and the economic activities which they support. We are identifying the socio-economic, political, and institutional barriers that prevent equal access and participation of all members of society. Additionally, we seek to identify opportunities to make the sector more diverse and inclusive.

Specifically, we want to explore the key benefits that food and vaccine cold-chain can derive by integrating diversity, equality, and inclusion, and highlight potential value capture across different aspects of the supply chain. We are developing a research and programme design framework to understand how cold-chain infrastructure development can be gender and socially inclusive, furthering the role of women in agriculture and food systems and recognising their economic contribution to the sector. Further medium-term distributional benefits our programme can provide is enabling more young people, particularly

girls, in agricultural communities to participate in education. Through this, we are identifying how/what role Centres of Excellence can play to support the cold-chain technological development and diffusion and develop strategy/policies required to address socio-political and economic infrastructure necessary for sustainable adoption and dissemination, while maintaining gender inclusivity in its programme delivery. Our GESI framework emphasises the importance of an inclusive approach that focuses on three key elements: Access, Needs, and Participation. By addressing these elements, the framework aims to provide an holistic approach to address the inequality in cooling and cold-chain systems.

In parallel with the above programme, as we operationalise CES and the SPOKES, we are developing a SEAH (sexual exploitation, abuse and harassment) safeguarding risk assessment/audit and mitigation measures framework which will be adopted and followed throughout the ACES programme cycle across its sites.

■ COLLABORATION

ACES actively facilitates an environment for collaboration between the industry, governments, academia and development institutions. Major multi-national cold-chain technology partners are involved, including Danfoss, who are donating equipment for testing and supporting training and Carrier, who are supporting training and donating cold-chain equipment and telematic solutions for the new refrigeration training centre, and many others (e.g. SureChill, Inspira Farms) are contributing equipment, expertise, data and more. The IFC is funding the procurement and installation of innovative cold-chain solutions from its TechEmerge Program so that early-stage technologies for commercial application can be showcased and tested at the campus. Other such partnerships are being pursued with major industry groups, smaller and mid-size firms and



include the latest in digital tracking technologies re-purposed for vaccine accountability and security (Circular), unmanned aerial vehicles or drones (Zipline Inc) for vaccine distribution, and the latest pathogen-agnostic detection assays for wastewater detection programmes (Shinogi).

■ ON-LINE PLATFORM AND NETWORK

The programme is underpinned by its own on-line virtual network and online platform to aggregate, convene and sustain an inclusive and dynamic multi-stakeholder community to:

- ensure ACES understands and focuses on their strategic need;
- enable the co-creation of systems of system solutions, defining emerging issues and creating funded research programmes;

- be the vehicle to share new data, innovation pathways, methodologies, skills, trainings, practices and policies and synthesise, analyse and disseminate the outcomes of research to inform wider policies and strategies as well as consumer and producer behaviour changes;
- support strategic and operational needs;
- raise awareness and promote discussion around cold-chain sustainability at an international level.

This is also the repository for training materials, tool-kits, a literature library of validated reports, papers, tools and guides and the CSC Equipment landscape, etc.

The framework for this is already in development and it is planned to be fully developed with next phase funding.

**With sincere thanks to our project partners
who have made ACES happen**



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