

# Natural Resources Institute

Annual Review 2021-2022

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UNIVERSITY OF  
**GREENWICH**

Natural Resources Institute



# Annual Review 2021-2022

The Natural Resources Institute (NRI) is a specialist institute of the University of Greenwich. Combining the expertise of natural and social scientists, we engage in research, teaching, training and consultancy to address significant challenges and opportunities in the sectors and countries in which we work.

Among these are the challenges of food and nutrition security, agriculture and sustainable development in the face of climate change, land and environmental management, markets and responsible business, capacity strengthening, and gender and inequality. These global challenges are addressed through our thematic areas of work which are covered in this Annual Review.

[www.nri.org](http://www.nri.org)

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Front cover photo: Food market in Kampala, Uganda | Photo: Lora Forsythe

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# Foreword

*Professor Jane Harrington, Vice-Chancellor, University of Greenwich*

I am delighted to share with you the Annual Review from our award-winning Natural Resources Institute. NRI's staff and students are consistently pushing boundaries, carrying out research that makes an impact, contributing to the UN's Sustainable Development Goals (SDGs), winning major research grants and prizes, and representing the University on a global stage. Through dedicated teaching and research supervision, NRI's teams are helping to form the next generation of experts equipped with the skills to devise sustainable solutions to some of the world's most significant challenges.

Despite the many challenges in 2021, NRI has continued to deliver through academic excellence and teamwork, as this edition of their Annual Review shows. Among these examples I am pleased to highlight the official opening of three new research and teaching facilities at our Medway campus, which are integral to NRI and the University's ongoing success in the fields of agronomy, climate change and food innovation – read more on page 2.

I was very pleased to announce that NRI's Dr Uche Okpara was awarded a prestigious 'Future Leaders Fellowship' for a programme of work on prosperity and peace in countries facing interrelated risks of conflict and climate change. Dr Uche Okpara is the first of our researchers to become part of this UKRI scheme and we are very proud of his work and achievements in gaining this award – find out more about his work on page 20.

If you get the chance to visit NRI, I'm sure you'll agree that the enthusiasm and passion that our scientists have for their work is palpable – this is something that's felt from the students on undergraduate degrees up to Professors and beyond, and translated into a successful array of prizes, publications and innovations. Enjoy reading and learning more about NRI.

# Introduction

*Professor Andrew Westby, Director of NRI*

NRI's Annual Review for 2021 demonstrates our Institute's dedication to overcoming significant global challenges through our work. NRI began 2021 by hosting a virtual international seminar to share research insights and to discuss the challenges relating to food and nutrition security in sub-Saharan Africa as part of our Food and Nutrition Security Initiative (FaNSI) – find out more on page 2. Linked to FaNSI, NRI has continued its involvement with Growing Kent & Medway, developing food innovations to help regenerate the local economy – read more on page 30.

As the COVID-19 pandemic has continued to alter people's lives, I am enormously proud of how our staff and students have shown resilience and initiative, and continued to deliver world-changing research and teaching, supported by our excellent professional services team.

As much of the world shifted to working online, our teaching staff and students adapted to learning in virtual and hybrid classrooms, with lecturers creatively engaging with students in a variety of ways. Similarly, our PhD students adapted their study programmes and methods to deliver results. I thank you all for your outstanding efforts and wish you luck in your future studies.

In addition to our targeted research in 2021, NRI participated in UKRI's exercise to assess the impact of research outside academia, with seven impact case studies submitted to REF2021, the UK's system for assessing the quality of research in UK higher education institutions. Our academics also responded to global events by producing series of in-depth articles responding to COVID-19 and the UN climate conference, COP26. We hope you enjoy reading about our work. Join us!

# Highlights from the year



# FaNSI: boosting research capacity to tackle food and nutrition challenges

Andrew Westby

In January 2021, NRI hosted a virtual international seminar to share research insights and to discuss the challenges relating to food and nutrition security in sub-Saharan Africa. This was part of NRI's Food and Nutrition Security Initiative (FaNSI), through which the institute has been expanding its research capacity and partnerships with a specific focus on addressing climate change, food loss and waste, sustainable agricultural intensification and food systems for nutrition. Supported by Research England's 'Expanding Excellence in England' (E3) Fund, NRI's research team has grown through FaNSI, incorporating staff with expertise including biostatistics and bioinformatics, climate security, state fragility and climate change, public health nutrition, economics of food and nutrition, food security, behavioural sciences, agriculture and soil science, gender and diversity in food systems, food safety, and fish and food systems.

Through FaNSI, NRI's work has also benefitted from improvements to research infrastructure. In September 2021, Professor Jane Harrington, Vice Chancellor of the University of Greenwich, opened three new buildings at the University's Medway campus in Chatham. These include the Agronomy Laboratory, a Food Product Development space and the Climate Change Greenhouse:

- **The Agronomy lab** is equipped with the newest technologies for processing and analysis of crop plants and soils, which are used in cutting-edge research on plant physiology and soil physics. The lab allows the processing and measuring of plant materials and soils derived from greenhouses and from farmers' fields.
- **The Food Product Development space** provides a large area for food innovation research, where local businesses can work together with academics to create innovative products or improve their existing range. It also serves as a teaching space, where students are taught the process of developing new products as part of degree programmes.
- **The Climate Change Greenhouse** has five experimental compartments with temperature, humidity and lighting control that can be used to simulate growing conditions from temperate to tropical conditions. It is being used for FaNSI-related work on crops and biotic and abiotic stresses, and is crucial to NRI's research on drought-tolerant plants – of growing importance amidst a warming climate.

NRI also continues to build research collaborations with partners in Africa through FaNSI. NRI has made official visits to Bayero University and Benue State University in Nigeria, Haramaya University in Ethiopia, the International Centre of Insect Physiology and Ecology (icipe) and the University of Eldoret in Kenya, and Sokoine University of Agriculture and the Nelson Mandela African Institution of Science and Technology in Tanzania.

Find out more: [www.nri.org/development-programmes/fansi/overview](http://www.nri.org/development-programmes/fansi/overview)

NRI students and staff present their work to Professor Jane Harrington, Vice Chancellor of the University of Greenwich, who opened three new buildings at the University's Medway campus in Chatham: the Climate Change Greenhouse (bottom left), the Agronomy Laboratory (top) and the Food Product Development space (bottom right).



# Food systems for improved nutrition >

Achieving sustainable, ethical and efficient food systems in support of human health is among the greatest challenges facing the global community. Improving nutrition is a core priority of the current international development agenda, and an area of increasing attention for many national governments, research institutions and the international development community. SDG 2 highlights the multi-dimensional nature of food and nutrition security, encompassing the quantity of food available and issues of resilience, nutrient content and food safety, with targets incorporating both agriculture and nutrition, underlining the importance of food-based approaches in addressing nutritional challenges.

Sesame seeds, one of the ingredients that can be used to make RUTF.

## Treating severe acute malnutrition using locally available foods in Sierra Leone

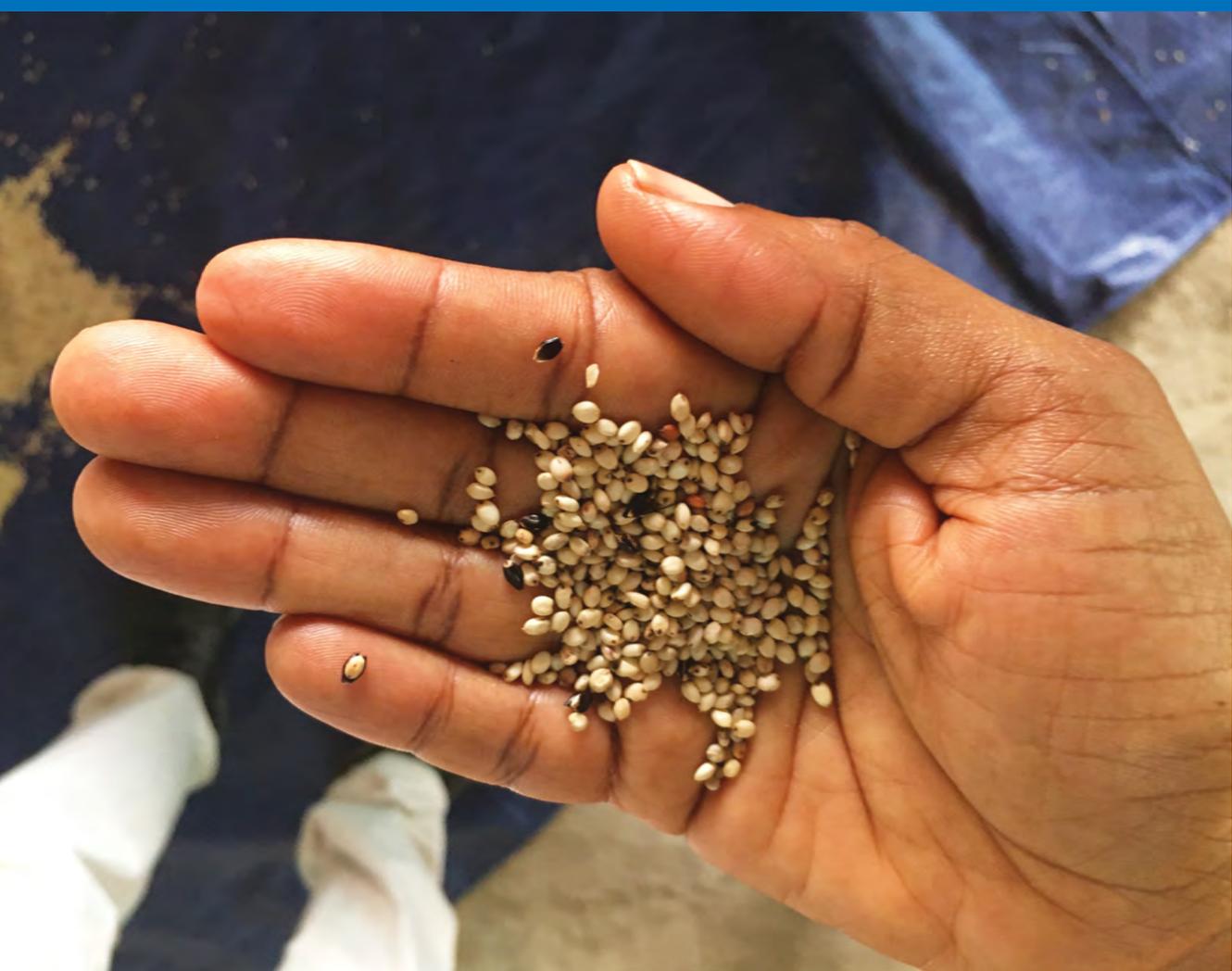
*Aurelie Bechoff*

UNICEF estimated that approximately 10.4 million children were at risk of suffering from acute malnutrition in 2021 in the Democratic Republic of the Congo, South Sudan, northeast Nigeria, the Central Sahel, and Yemen. Along with Sierra Leone, these countries or regions have experienced humanitarian crises, conflicts, intensifying food insecurity, and pandemics, raising the threat of severe acute malnutrition (SAM). The World Health Organization defines SAM as a very low weight for height, visible severe wasting, or the presence of nutritional oedema – swelling caused by the accumulation of fluid in the body tissues. SAM is caused by a significant imbalance between nutritional intake and individual needs, where diets are deficient in both the number of kilocalories/day and in the right vitamins and minerals. The median fatality rate for children under five suffering from SAM ranges from 30%–50%.

An established way of treating severe malnutrition is the use of ready-to-use therapeutic food (RUTF) – a paste made of peanuts, powdered milk, vegetable oil, sugar, and vitamins and minerals. RUTF does not require the addition of water, which could be contaminated, allowing at-home treatment for cases without medical complications. Since its launch 20 years ago, it has shown a high level of success in terms of recovery: in a couple of months, about 90% of children return to a normal weight. However, the majority of this ‘food-medicine’ is imported from private companies in high-income countries. As a consequence, the delivery of RUTF for malnourished children on the ground depends on foreign aid and its coverage is limited. The powdered milk ingredient contained in the formulation has to be imported, meaning that only 50% of its ingredients are available locally. Formulations have been developed in other countries which use about 95% local ingredients with the same health impact on malnourished children and for half the price.

NRI led a project in collaboration with the Ministry of Health and Sanitation in Sierra Leone with the aim of investigating the feasibility of developing RUTF using local ingredients and by local enterprises. After carrying out a literature review to identify existing examples of successful businesses, potential formulations using local crops, and quality assessment of such products, the team conducted a field trip to interview a range of local stakeholders in Sierra Leone, including the Ministry of Health, UNICEF, WFP, the private sector and NGOs. NRI’s Dr Aurelie Bechoff led the nutrition scope of the study, Dr Louise Abayomi investigated the food safety and product quality aspects and Prof Ben Bennett explored the market and business environments.

The team found that the range and diversity of locally grown crops and commodities would allow the development of local manufacture – Sierra Leone has a diverse agroecological system potentially enabling the cultivation of various food crops that could be used as ingredients, which are then combined using linear programming to meet nutritional requirements. On the other hand, the infrastructure and local laboratories available in Sierra Leone do not currently meet minimum quality standards. There will be a need to build local capacity in the years to come. These challenges could be overcome with targeted investment/support. Dr Bechoff was recently awarded a grant under the University of Greenwich Innovation Fund to pursue research on the development of suitable formulations. This research area is of growing urgency, given the increasing challenges of food security and nutrition amplified by the Covid pandemic, climate change, and environmental pressure on food systems.



# Evaluating public attitudes towards the environmental impact of salmon aquaculture in Scotland

Pamela Katic

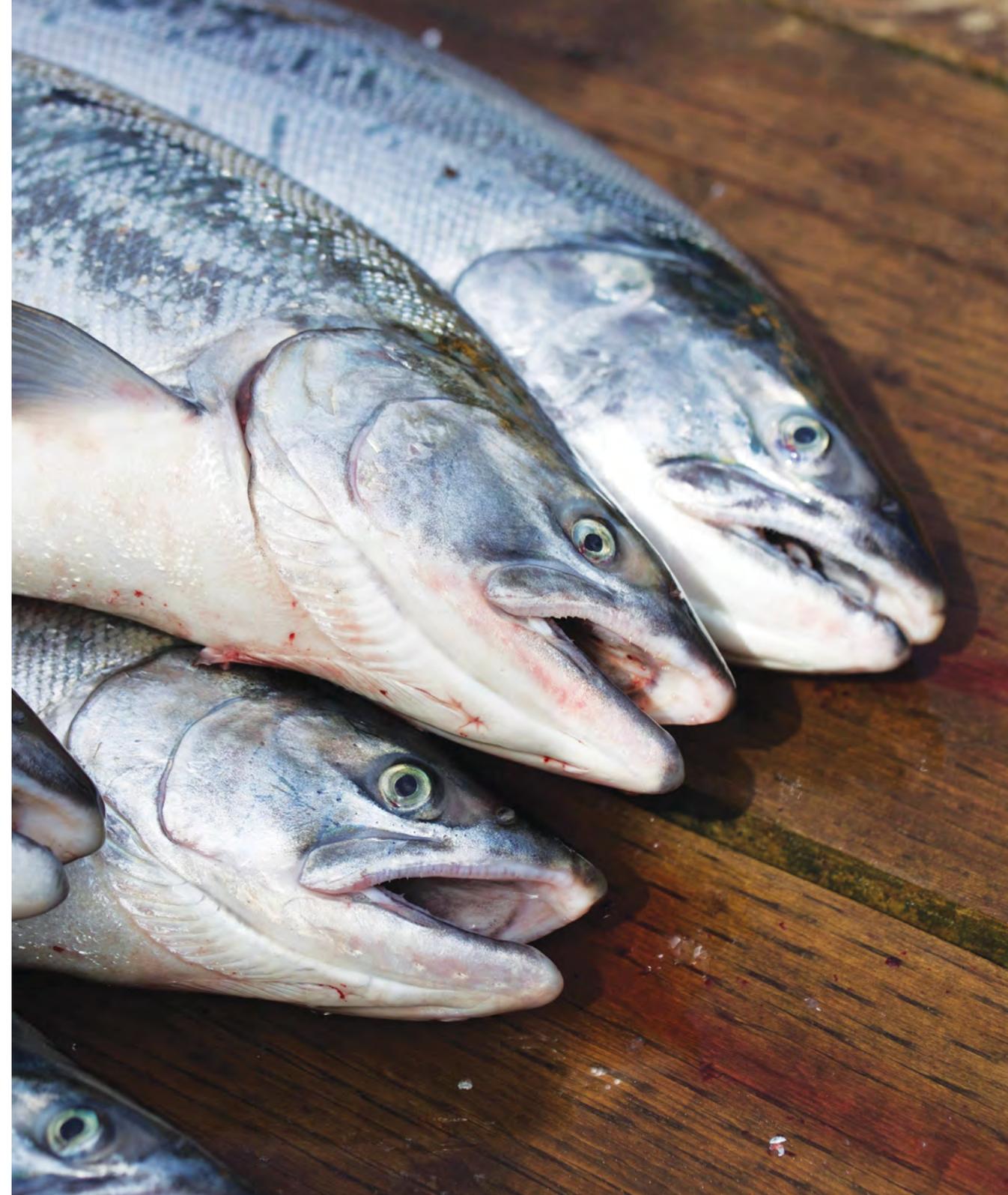
Aquaculture, which involves farming aquatic animals and/or plants in the oceans or freshwater, is one of the fastest growing food-producing sectors and currently contributes over 40% of world fish supplies. The benefits of this development are real and visible, both for producing countries and for consumers in the form of lower prices and access to healthy sources of fatty acids. Growing concern over the environmental impact of aquaculture, however, has prompted a search for a governance framework that can guarantee sustainability – that is, a financially viable aquaculture industry in which environmental damage is minimised.

Jointly implemented by the Scottish Association for Marine Science (SAMS), Newcastle University, the Tyndall Centre for Climate Change at the University of Manchester, and NRI, the DIVERSEAFOD project aimed to evaluate the potential of aquaculture diversification to improve nutrition and ecosystem sustainability in the UK. This type of aquaculture diversification is known as 'integrated multi-trophic aquaculture' (IMTA) which uses the by-products (including waste) from one aquatic species as inputs for another, for example as fertilisers or food. The idea is to create balanced systems that are more environmentally sustainable, economically stable and more socially acceptable. Using salmon farming in Scotland as a case study, NRI's Dr Pamela Katic and Dr Andrea Gatto developed a suite of research activities to understand a range of sustainability features of aquaculture.

In a subsequent phase, the project used a survey-based approach to evaluate public attitudes towards the environmental performance of aquaculture, with 1,800 respondents from all regions of Scotland. The survey first sought to shed light on how aware people are of aquaculture development and their opinions regarding the environmental, socioeconomic and nutritional impacts of aquaculture. They also investigated whether different types of aquaculture systems were perceived differently, in particular whether respondents supported or opposed the development of IMTA in Scotland.

The results indicate that public attitudes towards the future of the salmon farming industry are influenced by the importance people attach to the beneficial effects of industry expansion (i.e. job creation, etc.) as opposed to the perceived negative effects associated with environmental degradation. A further important aspect of the research relates to the observed regional differences in public attitudes towards salmon farming. Knowledge of such differences may be useful for policy purposes, particularly area and site selection, and in research terms it is also important to try to explain why some communities may be more favourably disposed to aquaculture development than others. To this end, the team looked at both attribute variables (i.e. those specific to the respondent) and context variables (principally, the characteristics of the area where people live.) The results broadly show that people in areas with higher levels of income deprivation and unemployment place a relatively higher priority on the benefits that salmon farming could bring in terms of regional development and community cohesion – specifically through its ability to support employment and incomes, compared to those living in areas of relative affluence.

*DIVERSEAFOD was funded through the Global Food Security's 'Resilience of the UK Food System Programme' with support from BBSRC, ESRC, NERC and Scottish Government.*



Freshly caught salmon, such as that farmed in aquaculture initiatives in Scotland.



# Improving nutrition policies and programmes through concerted monitoring and evaluation

Ravinder Kumar

Malnutrition refers to deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients, as defined by the World Health Organization. Undernutrition can be defined as an insufficient intake of energy and nutrients to meet an individual's needs to maintain good health. This form of malnutrition includes underweight (low weight-for-age), wasting (low weight-for-height) and stunting (low height-for-age). Stunting is the result of chronic or recurrent undernutrition which holds children back from reaching their physical and cognitive potential. Globally in 2020, 149 million children under five were estimated to be stunted.

Accelerating progress in the fight against malnutrition requires improvement in the design of nutrition policies and programmes. The European Union's commitment to nutrition is to support partner countries to reduce the number of stunted children under the age of five by at least 7 million by 2025. Effective monitoring and evaluation (M&E) of EU programmes can contribute to achieving this nutrition commitment. NRI is a partner in the 'Knowledge and Research for Nutrition' project of the European Commission which aims to provide improved knowledge and evidence for policy and programme design, management, and M&E in order to reach better nutrition outcomes.

The project has established a Nutrition Research Facility (NRF), implemented by Agrinatura – the European Alliance on Agricultural Knowledge for Development – an association of 35 universities and research institutes in 16 countries in Europe who are committed to supporting agricultural development in a sustainable manner in order to improve people's lives. An NRI team, as part of the NRF, is leading the work package on delivering technical and statistical support to the M&E of the programme's progress and performance at field level. As part of this facility, NRI is engaging at early stages in EU programme designs and is offering flexible, interconnected and demand-oriented support in three areas: planning, implementation and learning. This work will include the development of impact pathways and theories of change; the design of M&E frameworks, systems, assessments and evaluations to track programme impacts on nutrition; performance analysis and process evaluation; capacity building of programme teams; collation of M&E evidence and production of best practice compendiums; and promotion of M&E-related learning across stakeholders through knowledge exchange and peer learning.

The NRF is currently supporting the Indian Ocean Regional Programme on food and nutrition security, managed by the Mauritius and Seychelles European Delegation. The NRF is also providing M&E technical support to the EU programmes in Mauritania, north-west Africa. The NRI support, as part of the NRF, has the potential to contribute to improved knowledge and evidence for better tracking of nutritional benefits of policies and programmes at field level, which can consequently contribute to improved design and management of the EU programmes.



Groundnut farmers in Ghana, where groundnut is predominantly cultivated by women, bringing nutritional benefits for the family.



# Transforming food systems and food environments in Nigeria

Louise Abayomi

With over 200 million people, Nigeria has the largest population on the African continent, which is projected to double over the next 30 years. Current crop production is barely keeping up with these rates of population growth. With weak national food controls, and high levels of postharvest physical, nutritional and quality losses due to poor infrastructure, sub-optimal marketing information systems, and increased food consumption outside the home, how might closing the food security gap be achieved? This requires a transformation of national food systems, and of 'food environments' – which encompass social, physical, economic and political factors involving food availability, affordability, accessibility and acceptability. The Global Alliance for Improved Nutrition (GAIN) aims to transform food systems so that they deliver more nutritious foods for all people, especially the most vulnerable. Their aim is to lay the foundations for systemic improvements, which include opportunities for food-related activities of women and youth that address their specific needs and make their livelihoods more resilient.

GAIN has targeted Nigeria's four staple crop value chains – rice, maize, cassava, sweetpotatoes – for research and development. The functioning of these crop value chains is not homogeneous across Nigeria and so prior to project design, GAIN required a better understanding of the food systems in four key states – Benue, Kaduna, Nasarawa and Oyo – involving 16 local government areas. To aid with this preliminary work, NRI supported an appraisal of biofortification (where crops are bred or particular agronomic practices are adopted to increase the crop's nutritional value from a national or global baseline). In 2021, NRI led formative research to help design project implementation. This was coordinated by NRI's Dr Louise Abayomi, a postharvest and food safety specialist, and carried out with NRI colleagues, local partners the Federal University of Agriculture (FUNAAB), Nigeria, Agricultural Development Programmes and nutrition officers.

Key findings relate to emerging trends in consumption habits in the target areas, and more specifically, in contexts where most workers are eating outside the home. This situation has implications for addressing food safety practices during production, processing, marketing and food preparation, as well as access to healthy diets and the need for both general and targeted behavioural change communication strategies to inform consumers and sellers in traditional markets, their suppliers, and influence habits. The team tested key assumptions (e.g. that biofortified maize, orange-fleshed sweetpotatoes and yellow cassava can easily be substituted for the traditional varieties), projected growth trends, explored consumer acceptability of biofortified staple crops, and preferred traits by processors.

The successful outcome from this formative research led to the design of the project's second phase, consisting of strategies for capacity strengthening of micro, small and medium entrepreneurs, and for selected upstream and downstream innovators to act as champions in facilitation, advocacy, 'proof of concept' and 'scaling'. Behavioural change communication will also feature strongly in driving a shift to safer, more diverse, and nutritious diets. Policy coherence across national ministries including finance was identified as an important component within the 'enabling food environment'.



Peeling cassava at a cassava processing station in Nigeria.



# Sustainable Agricultural Intensification >

Increasing agricultural productivity is essential to feeding a fast-growing population and has potential to lift rural families out of poverty. Sustainable Agricultural Intensification (SAI) provides the means to do this with limited resources, while protecting our living environment and conserving natural and agricultural biodiversity. The ambition for SAI is highlighted in SDG 15 – Life on Land, which aims to sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss; and SDG 2 – Zero hunger which seeks to ensure sustainable food production systems and implement resilient agricultural practices.

Measuring water infiltration into the soil at the EMR experimental vineyard.



## Cultivating a sustainable vintage: healthy soil and terroir in English vineyards

*Marcos Paradelo*

Wine connoisseurs might describe the taste of a wine as earthy, round, robust, crisp, mellow, oaky, or any number of specialist terms. Much of the taste is attributed to its terroir – a term encompassing the complete natural environment in which a particular crop is produced, including factors such as the soil, topography, and climate. The terroir is the basis for protecting certain regional products – in Europe this is known as ‘protected designation of origin’ (PDO) which guarantees the product’s reputation. Famous examples of wine with a PDO are Champagne, Bordeaux and Beaujolais, to name but a few. England is not yet well-known for its wine-growing regions, though vineyard land in the country has doubled in the last decade amid climate change.

To understand land suitability and better management practices for vineyards, it is crucial to understand the factors that impact soil quality – including soil structure development (such as how particles are assembled and how air and water circulate through them), microbial activity (microbiological processes of soil microorganisms that improve organic nutrients) – and how these link to plant physiology or functioning.

In the case of ‘new’ wine regions like south-east England, the lack of long-term soil and management data makes it even more important to develop experiments and models that help the establishment of new vineyards in the best conditions. A project led by NRI’s Dr Marcos Paradelo, in collaboration with NIAB EMR, a horticultural research organisation in East Malling, Kent, UK, is investigating how soil changes when new vineyards are established, to propose better management practices to improve soil health and maintain terroir characteristics. The project includes measuring the relationship between soil structure, the microbiome (an interacting community of bacteria, viruses, fungi and other organisms) and plant physiology in the NIAB EMR concept vineyard. Established in 2015 over an area of 10,000m<sup>2</sup>, the vineyard makes it possible to deliver randomised and replicated trials to ensure the research is robust and supports viticulturalists. The team is studying the effects on soil properties of the year of planting, the rootstock variety, and weeding control (with herbicides, a mechanical weeder or strimming), using a Chardonnay variety.

The project has been helped by facilities for soils analysis. Officially opened in September 2021, NRI’s new Soils and Agronomy lab is specially equipped for the physical characterization of soil samples. In addition, the project began by winning an open call from the EU initiative Fields4ever ([fields4ever.biomemakers.com](https://fields4ever.biomemakers.com)) which provides microbial analyses for free. Fields4ever will carry out 100 microbiome analyses, sequencing the bacterial and fungal DNA in the soil. This is to understand the microbial diversity in the soil, which affects different functions of soil health and terroir. The microbiome data will be merged with a range of physical measurements. The team has also explored the management effects on soil properties, and grape quality. The team will use the results to engage with winegrowers to discuss and plan interventions for sustainable soil management. This project aims to help winegrowers in south-east England to adopt sustainable management practices that protect soil and enhance wine quality; it is hoped this work will be used as a benchmark for soil health in English vineyards.



# Keeping the cereal killers at bay: improved detection of viruses to monitor chemical-free plant protection

Sophie Bouvaine

Aphids – the tiny sap-sucking insects that are the scourge of many gardeners and growers – are the main insect vectors that carry and transmit barley yellow dwarf viruses (BYDV) the agents responsible for barley yellow dwarf disease. This is the most widespread viral disease of cereals affecting some of the world’s most economically important crops, including wheat, barley and maize. BYDVs are not transmitted mechanically or by seed; rather the spread of the disease is directly dependent on the dynamics of the vector population. Recently, the increase in winter temperatures linked to global warming and the ban on neonicotinoids – systemic insecticides shown to be harmful to a wide array of non-target wildlife – has led to an increase in aphid populations which translates into a higher impact of the disease. To limit the surge of the disease, it has become urgent to develop new methods to curb the aphid vector populations as soon as they arrive on cereal fields in late autumn. Usually during this period, a few winged aphids carrying the virus arrive on cereal fields and produce parthenogenetic offspring – progeny that are the result of asexual reproduction. While the initial flight brings the virus onto the field, the offspring then spread it from plant to plant, ensuring a wide distribution of the virus.

Previous studies have demonstrated that replacing the usual grass field margins with flowering margins could increase the number of beneficial insects such as aphid predators and parasitoid wasps – those that lay eggs inside the aphids which then develop and kill their host – which could contribute to decreasing the aphid populations. In addition to offering food and shelter to beneficial insects, these plants could also have a direct repellent effect on the aphid vectors.

NRI’s Dr Sophie Bouvaine, Plant & Insect Molecular Biologist, is leading a component on the ‘PlantServ’ project, a collaboration between the Université de Rennes and the National Research Institute for Agriculture, Food and Environment (INRAE) in France. The project’s overarching aim is to understand how an increase of plant biodiversity around agricultural plots can support biological control by conservation and reduce damage and yield losses caused by BYDV. Dr Bouvaine and NRI’s Dr Gonçalo Silva are using their expertise in plant virology to evaluate the effects of flowering cover crops on the joint dynamics of BYDV and pest communities at the plot and landscape scales.

This work includes investigating the prevalence and genetic diversity of viruses causing BYDVs in France and developing specific diagnostic molecular tests to differentiate between the species of viruses present in the field, in order to specifically target the species of interest. They will then use those tests for molecular screening of viruses in plant and aphid samples obtained by project partners in the experimental fields in Western France. Together with the data obtained from the partners on the prevalence of natural enemies and pests, the team is measuring whether the presence of flower field margins helps reduce the virus pressure in wheat and barley fields. If successful, flowering field margins could offer a partial control of viruses and their vectors and could be integrated as an effective tool for chemical-free disease management.



“It has become urgent to develop new methods to curb the aphid vector populations”

A grain aphid (*Sitobion avenae*) on a cereal leaf.



# Striga smart sorghum solutions for smallholders in East Africa

Jonne Rodenburg

Walking through a field of sorghum, your vision might be drawn upwards to the plant's impressively tall stalks, its waxy green leaves or its large panicles. You may be unaware of what is happening to the crops under your feet. A cereal species of the grass family (*Poaceae*), sorghum is an important crop worldwide. Its edible starchy seeds are used for food – it is a staple in sub-Saharan Africa, where it is primarily ground into flour and made into a stiff porridge. It can also be used for the production of alcoholic beverages and biofuels, and the stalks and leaves can be used as animal fodder or building materials. Despite its good adaptation to African growing conditions, the crop suffers from multiple production constraints. Underfoot, you will find the two most urgent constraints: poor soils, and infestation by a parasitic weed called *Striga* – also known as ‘witchweed’ as it causes damage to the host plant when it is still in its invisible underground stages. *Striga* parasitises sorghum through its roots, resulting in severe yield reductions.

A Royal Society-funded project called ‘*Striga* Smart Sorghum Solutions for Smallholders in East Africa’ is running from 2019–2023. The project, led by NRI in close collaboration with Kenyatta University (KU) in Kenya, aims to overcome the above constraints. As *Striga* cannot be controlled sustainably by a stand-alone technique, the project aims to improve and combine two approaches: deploying sorghum cultivars with increased levels of *Striga* resistance, and applying fertilisers.

The team's biomolecular work, mostly carried out at KU, involves confirming the genes that are responsible for different resistance mechanisms by switching them on or off using a novel gene-editing technique called CRISPR/Cas. This technique is also being used to transfer resistance genes to cultivars that are preferred by farmers and adapted to local growing conditions. The team conducted trials in farmers' fields in western Kenya, where problems with *Striga* are severe. A range of sorghum varieties with previously identified *Striga* resistance were tested, and farmers were invited to evaluate them.

The team has also investigated which nutrients play a role in *Striga* resistance and tolerance and how they can best be delivered as fertiliser in order to enhance the efficacy of these *Striga* defence mechanisms and overall crop performance. The aim is to develop high-effect and low-cost fertiliser technologies, by determining the best composition, the minimum required amount, and best application mode. The team conducted a range of plant experiments under controlled environmental conditions in NRI's new greenhouse facility. In an experimental plant growth set-up called the mini-rhizotron (allowing the study of roots and ‘underground’ *Striga* infections), the team grew sorghum plants with pre-germinated *Striga* seeds under specific fertiliser regimes. Initial results show that macro-nutrients reduced *Striga* infection levels on sorghum varieties that already have partial resistance. In experiments where sorghum plants were grown in *Striga*-infested soil, the team found a positive effect from fertilisers on both *Striga* resistance and tolerance, in particular when the fertilisers were sprayed on the crop plant leaves, compared to the conventional soil application method. Next steps include farmer participatory testing combinations of sorghum varieties and fertiliser solutions on farms in Kenya. Dissemination of the technologies generated by the project have the potential to enable millions of farmers across Africa to become more food secure.



Measuring leaf-level photosynthesis and fluorescence in a greenhouse pot experiment where plant nutrition effects on *Striga*-infected sorghum plants are assessed, from L–R, Students: Yamuna Nuepane Ghimire (MSc) and Immaculate Mwangangi (PhD).



# Climate change, agriculture and natural resources >

Responding to climate change is one of the most urgent challenges facing humankind. The most severe impacts are likely to be suffered by the poorest and most vulnerable in society who live in more fragile environments and have the least resources to adapt and recover. The majority of the world's poor continue to live in rural areas and their livelihoods are heavily dependent upon agriculture and natural resources, which will be severely affected by climate change. Therefore, there are serious implications for their food security, health and well-being. NRI's work in this field aims to understand these challenges better, to build adaptive capacities, and to develop appropriate strategies for sustainable and equitable rural adaptation.

Terraced fields on smallholder farms on the southern slopes of the High Atlas, Morocco.

## Support on Climate Change for Morocco's National Institute of Agronomic Research

*John Morton*

The North African country of Morocco is heavily dependent on agriculture, which employs 40% of its labour force and is vital for feeding its growing population. However, it is extremely vulnerable to the impacts of climate change, with overall temperatures projected to increase, and precipitation to decrease sharply, leading to an increase in major droughts. Morocco's National Institute of Agronomic Research (INRA) has identified a need to increase its capacity to carry out agricultural research that addresses the needs of Moroccan farmers, especially smallholders in more marginal areas, to respond to climate change. In 2020, the British Embassy in Morocco, through the North Africa Technical Assistance Facility of the UK Government managed by Tetra Tech International Development, asked NRI to assess their capacity-building needs in this area. NRI Professors Hans Dobson and John Morton visited INRA headquarters and four of its Regional Centres, holding meetings and participatory workshops with INRA staff to identify research needs, seeing INRA research and getting the views of other stakeholders.

As a result of the mission, detailed proposals for capacity building for INRA involving NRI and other UK centres of expertise were drawn up, though their implementation was delayed by COVID-19. Further discussions led to agreement on a focussed programme of capacity building that could be delivered remotely, and three strands of training were delivered by NRI staff.

Prof John Morton delivered training to 34 INRA researchers on climate change, giving them a greater insight into the specific nature of climate change impacts on smallholders and the rural poor, the issues of adaptation and vulnerability that arise from those impacts, and some implications for the practice of agricultural research and the role of research organisations. The great majority of trainees were researchers in the biophysical sciences, who were introduced to some social-scientific and interdisciplinary perspectives as complementary to their existing expertise. Dr Andrew Armitage delivered training in bioinformatics (science of genome analysis and handling of large-scale sequence data), responding to the specific needs identified by INRA. This training in DNA analysis, genome sequencing and computing, supports researchers to identify and use genetic diversity in crop material within breeding programmes, a key component for breeding new crop varieties that may be more resilient to climate change and tolerant to drought. Researchers at INRA were also interested in applying genome sequencing to develop new diagnostic tests for plant diseases, particularly those whose spread may be subject to climate change. Dr Armitage delivered general training sessions to 34 INRA researchers followed by advanced training, open-forum discussions, and one-to-one engagement on research activities identified by individual trainees. Dr Huiyi Yang delivered training on use of climate and agri-climate models, a key training need identified by INRA, involving general sessions for 16 INRA staff, hands-on workshop sessions on the Linux Operation System and the General Large Area Model (GLAM) for Crops, advanced sessions based on case-studies, and drop-in sessions.

Overall evaluation by trainees was very positive with the training being evaluated as "good" or "very good" in all dimensions. The project allowed the NRI researchers to assist individual INRA staff with research design and the preparation of two peer-reviewed articles (Khayati et al. 2021 in *Mitochondrial DNA Part B*, Snaibi et al. 2021 in *Heliyon*).

*Note: NRI would like to thank the management and staff of INRA, and particularly Dr Abderrahime Bentaibi, Dr Slimane Khayati and Dr Tarik Benabdelouahab for assistance with needs assessment and management of the training.*



# Transformative pathways to sustainable peace and equitable prosperity in the age of compound risk

*Uche Okpara*

Peace and prosperity underpin the success of the Sustainable Development Goals (SDGs), from reducing extreme poverty and violent conflicts to ensuring peaceful and inclusive societies. But there are now more conflicts worldwide than at any time in the past 20 years, spurring massive displacement of millions of people, intensifying livelihood struggles, and reducing opportunities for social cohesion and economic development. Many conflicts are a result of extreme poverty, especially in the Lake Chad region, spanning a number of countries in West and Central Africa, where over 30 million people live in poverty and almost every family is threatened by violence. Without concerted, collaborative action to promote peace and prosperity across the world, violence could drive 100 million people into poverty by 2030. Dr Uche Okpara's research, as part of a 'Future Leaders Fellowship' run by UKRI, is a direct response to this concern.

The pursuit of peace and prosperity can involve interconnected social, economic, ecological and governance challenges that interweave competing interests, norms, values, priorities and memories. As such, research on peace and prosperity pathways must incorporate a diversity of perspectives, worldviews and knowledge systems. Working with partners across the Lake Chad region (which include the University of Diffa, Niger, University of N'Djamena, Chad and University of Maiduguri, Nigeria), the research will employ a range of interdisciplinary approaches and mixed methods, underpinned by the principles of knowledge co-creation – whereby researchers and all groups of people affected by the problem, jointly contribute to research planning and implementation, for improved and sustainable impact.

As part of this fellowship, Dr Uche Okpara will build an interdisciplinary team of early career and PhD researchers in conflict, peace, environment and development, launch a new 'Lake Chad Conflict and Environment Observatory', and establish local citizens' labs. These will bring together science, society and the state in a reciprocally useful way to explore the foundations of citizens' preferences and strategies for both socio-economic development – 'prosperity' and meaningful and non-violent interactions – 'peace'.

Working in three fragile and conflict-affected Lake Chad territories in Chad, Niger and Nigeria, the project will research and co-create – together with local communities, groups and partners – peace and prosperity pathways that will serve as decision-support tools to foster sustainable and inclusive development planning in fragile environments.

The research aims to generate new knowledge on the dimensions of, and pathways towards sustainable peace and equitable prosperity, enhancing progress towards SDGs 1 (poverty reduction) and 16 (peaceful and inclusive societies) – all leading to improved lives and livelihood opportunities for citizens. Further impact includes capacity building of a new generation of young academics in conflict, peace, environment and development research.



Dr Uche Okpara interviewing women fish farmers in the Lake Chad region.



# Helping African farmers future-proof against climate change

Laxmi Pant and Andy Frost

Climate change and the prospect of more frequent droughts in Africa are leaving farmers across the region facing an uncertain future and increasing risks of food insecurity. NRI is participating in a new project being implemented by the European Alliance on Agricultural Knowledge for Development (Agrinatura) which is designed to support an EC-funded Initiative – the Development of Smart Innovation through Research in Agriculture (DeSIRA). Together they will contribute to climate-relevant, productive and sustainable transformation of agriculture and food systems in low- and middle-income countries.

The objective of the Agrinatura-led project 'Leveraging the DeSIRA Initiative for Agri-Food Systems Transformation', abbreviated to 'DeSIRA-LIFT', is to support the DeSIRA initiative and its current and future activities in order to optimise its impact. 'DeSIRA-LIFT' is funded by the European Commission's Directorate-General for International Partnerships (DG-INTPA) and led by Wageningen University & Research, the Netherlands. The project will support DG-INTPA to deliver impact in this flagship initiative, including enhancing capacities of country-based implementers of climate-oriented innovation systems, supporting key research organisations to work effectively together in promoting agricultural innovation systems, sharing information and experience and contributing to the policy dialogue on agri-food system transformation.

NRI's Dr Laxmi Pant, an agricultural innovation systems specialist, together with COLEACP (an association of companies and experts committed to sustainable agriculture) is co-leading one of the project's three support service areas, which provides support to the regional and sub-regional research and extension organisations in Africa. NRI's contribution to this project builds on its experience in agricultural innovation systems thinking and practice. This incorporates the recognition that the innovation and development performance of a region depends not only on scientific research excellence, but also on how different actors engage in co-creating and using knowledge and technologies. The innovation systems approach has been widely adopted in building capacity for scientific research and technology development, as well as facilitating effective collaboration of the public, private, and non-profit private actors, such as through the formation of multi-stakeholder innovation platforms.

This is highly relevant to the DeSIRA initiative, which launched in 2018 from a growing recognition that many different people and organisations help bring about agricultural innovation, each playing a crucial role to ensure success, but not necessarily working together efficiently. Knowledge generation is a key part of the innovation process and scientific research is central to this. However, experience has shown that a combination of traditional academic research and participatory research with farmers and other 'innovation actors' is most likely to deliver impact. In other words, fully involving the people on the ground with the results and actions that come from scientific expertise will ensure the best outcome.



Farming on a slope in Colombia illustrates the risks when farmers are forced to grow crops on unsuitable land.



# Food loss, waste reduction and value addition >

Food loss and waste, including postharvest losses, represent both a major global challenge and an opportunity for improved resource use through value addition. NRI has been working to reduce losses and waste after harvest since the 1970s. The importance of food loss and waste reduction is recognised in SDG 12 'Responsible, Consumption and Production', SDG 2 'Zero Hunger', and several others. NRI experts on food losses and waste reduction and technologies for value addition, use their experience, insight and capability to measure food loss and waste, develop technical solutions, assess upgrading opportunities and provide guidance to researchers and practitioners, both in the UK and overseas.

The glass-covered insulated boxes housing the black tubes and reflectors which heat the water with solar energy, at their final stage of construction at the Intermech Engineering warehouse in Tanzania.



## Solar technology casts a bright future for improved cassava processing

*Marcelo Precoppe and Aditya Parmar*

After harvesting, fresh cassava roots must be consumed or processed within 72 hours, or they become unsuitable for human consumption. For this reason, the roots are usually processed into dried products including flour and gari – a granular, fermented, roasted product – that can be used later as the basis for various dishes. Cassava processing involves numerous stages including peeling, grating, pressing, pulverising, drying, and milling, which in many places, are carried out by hand. In order to make these tasks more efficient and less laborious, some cassava processing centres in Africa are looking to mechanise their operations. However, many of these are small or medium-sized enterprises (SMEs) whose expansion is constrained by a lack of appropriate, affordable and efficient processing equipment. Here we highlight two projects that are harnessing solar power and the latest advances in agricultural engineering design to develop efficient cassava processing technologies suitable for village enterprises. Such improvements can reduce postharvest losses and food insecurity, and improve livelihoods.

### Solar-powered pre-heater

Firewood is often associated with deforestation, exposure to pollutants, and CO<sub>2</sub> emissions, though it is still widely used as a heat source in many postharvest operations in developing countries, particularly in drying. Many projects have aimed to develop postharvest technologies that use more sustainable heat sources such as solar energy, biogas, or bioethanol, but in low-income countries, the adoption of those technologies by SMEs has been limited. To reduce fuel consumption, NRI's Dr Marcelo Precoppe, a Crop Postharvest Technologist, led a project funded by GCRF AgriFood Africa Innovation to develop a solar-powered pre-heater for a flatbed dryer used for cassava processing. By pre-heating the drying air, this reduces the amount of energy needed to reach the target temperature of the dryer.

The innovative aspect of this design is that it uses solar power to heat water, which stores more energy than air. The heater consists of a series of 12 black tubes containing water, which are heated by the sun. Surrounding each black tube is a parabolic reflector made of sheet metal which helps to concentrate the sun's rays. Each black tube and reflector is housed in a glass-covered insulated box to increase the heat of the water. Water heaters typically store hot water in a separate insulated tank, but in this project, Dr Precoppe designed an integrated system which acts as both storage tank and solar collector. The heat is then passed through an ordinary car radiator, placed at the heat exchanger air inlet, which transfers the heat from the solar collector to the air used for drying.

The heater is sturdy, durable, and was built and tested with project partners in Tanzania, Intermech Engineering, using locally available materials to reduce costs. It can reduce by up to 80% the fuel consumption used during a drying operation. Because of its low costs, the payback period from investing in its construction is short, and the team hopes this technology will proliferate throughout sub-Saharan Africa.



# Solar-powered multipurpose hammermill

During processing, cassava roots must be reduced to a manageable size. A 'hammermill' is one of the most-used pieces of equipment to do this and works by the repeated blows of little hammers. A project led by NRI's Dr Aditya Parmar, a Crop Postharvest Scientist, has developed a solar-powered multipurpose hammermill that can be used to grate the cassava root, pulverise it into mash and mill the dried cassava grits. It is a versatile tool to replace the two or more separate machines currently used for these processes – which could be transformative in terms of costs and benefits to many people in rural Ghana and potentially in other regions.

Hammermills are usually used designed for a single product and a single particle size. In this project, Dr Marcelo Precoppe used specialist particle simulation software – ESSS Rocky – to design a hammermill that can be used for several different products and different particle sizes. To grate the cassava and to pulverise the mash, the hammers rotate in one direction. To mill the dried grits, the hammers rotate in another direction. The hammers have a special design – with one sharp side and one blunt side. The direction of rotation for milling activates the fan; this is necessary to move the product through the machine, because when milling, the product is too small and light and does not move by gravity.

Instead of using diesel, this machine runs purely on solar energy – harnessing the daily average of six to seven hours of sunshine in West Africa, thus reducing production of greenhouse gases. Although the machine cannot store energy and will only power-up when the sun is shining, most processing traditionally takes place during daylight hours. It was carefully designed to run using direct current (DC) motors, which are much less powerful than the motors usually employed on hammermills. Unlike in typical photovoltaic systems with batteries, charge controllers and other additional electronics, the project team reduced costs further by adding a 'direct coupling system' by connecting the photovoltaic panels directly to the DC motors. Recent advancements in technology mean that the cost of solar panels has reduced the overall cost of photovoltaic systems by 90%. The absence of any maintenance or fuel costs will quickly offset the initial cost of buying this machine.

A key objective was to strengthen local capacity, and the team worked closely with two Ghanaian partners, the Food Research Institute, and First Product Enterprise Ltd., who manufactured the hammermill. It is currently being used at a cassava processing centre in Accra. The next steps include scaling up production, collaborating with the local manufacturer, who will play a vital role in disseminating knowledge and creating new jobs in Ghana. If the machine is a success, NRI hopes to facilitate its production more widely across cassava-growing regions in Africa.

*This activity was part of a project funded by Agri-Tech Catalyst (Innovate UK).*



The solar-powered multipurpose hammermill at the manufacturer's premises, First Product Enterprise Ltd., in Ghana.



# Reducing food losses: measuring losses and mining data for evidence-based interventions

Tanya Stathers, Aditya Parmar, Gideon Onumah

Producing enough to feed their families is a back-breaking reality for millions in small-scale farming households across sub-Saharan Africa (SSA) and beyond. For example, cereal and legume grain producers have to store sufficient seed from the previous harvest, invest in land clearing, planting, manage pests and diseases, and control weeds using basic tools such as hoes and machetes. After harvesting, farmers transport their crop home, spread it out to dry – guarding it against wildlife and livestock and unexpected rain showers – and then thresh, sort and store, sometimes after mixing with a protectant to deter attack by insects and other pests. Usually, women then process the grains by pounding and/or milling them before cooking for their households. At every stage, losses occur, which can be quite high when added together – a loss of valuable food but also of the resources used to produce the crop, including land, labour, and other inputs. Reducing postharvest losses (PHLs) is important for smallholder households and has been prioritised under the African Union’s Malabo Declaration and the Sustainable Development Goal 12.3. However, reducing PHLs requires understanding the scale of losses, where and why they occur, and the loss-reducing interventions which different actors can use.

A team of NRI researchers, including Drs Tanya Stathers, Aditya Parmar and Gideon Onumah, are playing a pivotal role in PHL reduction in Africa. They are collaborating with the University of Zimbabwe, AKM Services, the European Commission’s Joint Research Council, among others, and a network of postharvest and agricultural information experts from across SSA on the African Postharvest Losses Information System (APHLIS) project. The APHLIS team has built a science-based system of PHL estimation for different stages in target value chains. The estimates are computed through screening literature, creating a database of high-quality measured PHL data, combining it with datasets on subnational level crop production, weather conditions, storage duration, pest incidence, marketing systems and PH-technology used. Losses are reported at national and provincial levels across SSA via the APHLIS website – [www.aphlis.net](http://www.aphlis.net) – an open-access, user-friendly information system. It covers estimates of volumes lost and as percentages of total output; projections of their financial and nutritional values and impacts – offering a crucial basis for decisions on interventions and investments by policy and investment decision makers.

In the current phase of the project, known as APHLIS+, one of the work packages has involved the NRI team collaborating with researchers in Benin, Togo, Tanzania, Nigeria and Uganda in piloting PHL measuring systems for bean, cowpea, groundnut, cassava and sweetpotato. The work is widening the knowledge base to understand the losses that occur during activities other than storage and for a range of important food crops beyond the cereals. This work is expected to support strategic targeting of PHL reduction investments and to improve capacity to robustly monitor and report on progress in achieving PHL reduction goals.



“Reducing postharvest losses (PHLs) is important for smallholder households”

Measuring losses during bean threshing, Hanang district, Manyara Province, Tanzania.



# Future-proofing our food: plant and algae proteins for NetZero

Parag Acharya

Livestock emit 14.5% of global greenhouse gases (GHGs), including methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O) and carbon dioxide (CO<sub>2</sub>). In response to the urgent need for a reduction in emissions and a transition to more sustainable diets, the uptake of livestock-free, alternative plant and algae proteins can play a key role. This fits well with the recommendation from the independent UK Committee on Climate Change for a 20% reduction in consumption of meat and dairy products to achieve NetZero carbon emissions by 2050. However, the modification of plant and algae proteins to functionally, nutritionally and sensorially mimic meat and dairy products via harnessing clean/green food processing is a key innovation challenge. A team of researchers at NRI is working to understand how to future-proof plant and algal protein supply, identifying the drivers of the plant-based food value chain, and developing solutions to innovation challenges for alternative protein-based food.

Algae are rather underexploited as sustainable sources of alternative protein, and do not compete with food crops for land and natural resources. Seaweed (also known as macroalgae) contains up to 47% protein but there is a lack of eco-innovative, or environmentally friendly, solutions for improved extractability of the proteins. NRI's Dr Parag Acharya has begun work on a project to develop scientific insights on how to improve the yield of seaweed protein extraction, in collaboration with the University of Lincoln, and ISIS Neutron and Muon Source (ISIS-STFC), UK. This project, funded by the Science and Technology Facilities Council (STFC) Food Network+, will involve experts from NRI's Aquatic Biotechnology group led by Professor Patricia Harvey and Dr Birthe Nielsen from the Faculty of Engineering and Science at the University of Greenwich.

Much of the approximately 1.6 billion tonnes of global agri-food loss and waste – responsible for around 8–10% of total GHG emissions – can be upcycled (Prandi et al., 2021) to generate alternative proteins with co-benefits of developing a circular food system and improving its resource efficiency. Dr Acharya is collaborating with Professor Chu-Ky Son from Hanoi University of Science and Technology, Vietnam, to decipher the techno-economics (i.e. the economic performance) of plant proteins from under-utilised rice and maize by-products while complying with food safety. Funded by the Global Challenges Research Fund (GCRF), this project involves NRI scientists Dr Conor Walsh and Dr Marcos Paradelo Perez as co-investigators.

As part of the 'Growing Kent & Medway' (GK&M) project (supported by UKRI's 'Strength in Places' fund and led by NIAB EMR), Dr Acharya, Prof Andy Frost and Dr Deborah Rees are involved in developing a plant-based food accelerator where new food start-ups can grow to regenerate the local economy. The accelerator is part of the state-of-the-art 'Medway Food Innovation Centre (MFIC)' being built at the University of Greenwich, through NRI's Food and Nutrition Security Initiative (FaNSI, supported by the Research England E3 scheme) and GK&M. MFIC is focused on strengthening the regional food and drink industries through research, innovation and enterprise. In this way, NRI's research on alternative proteins aims to accelerate a transition to climate-smart protein, while the concomitant collaborations seek to enable a much-needed ecosystem for alternative protein-based food innovation.



A student demonstrates food product preparation at the opening of the New Product Development facility, part of the Medway Food Innovation Centre - officially opened by Professor Jane Harrington (R), Vice-Chancellor of the University of Greenwich.

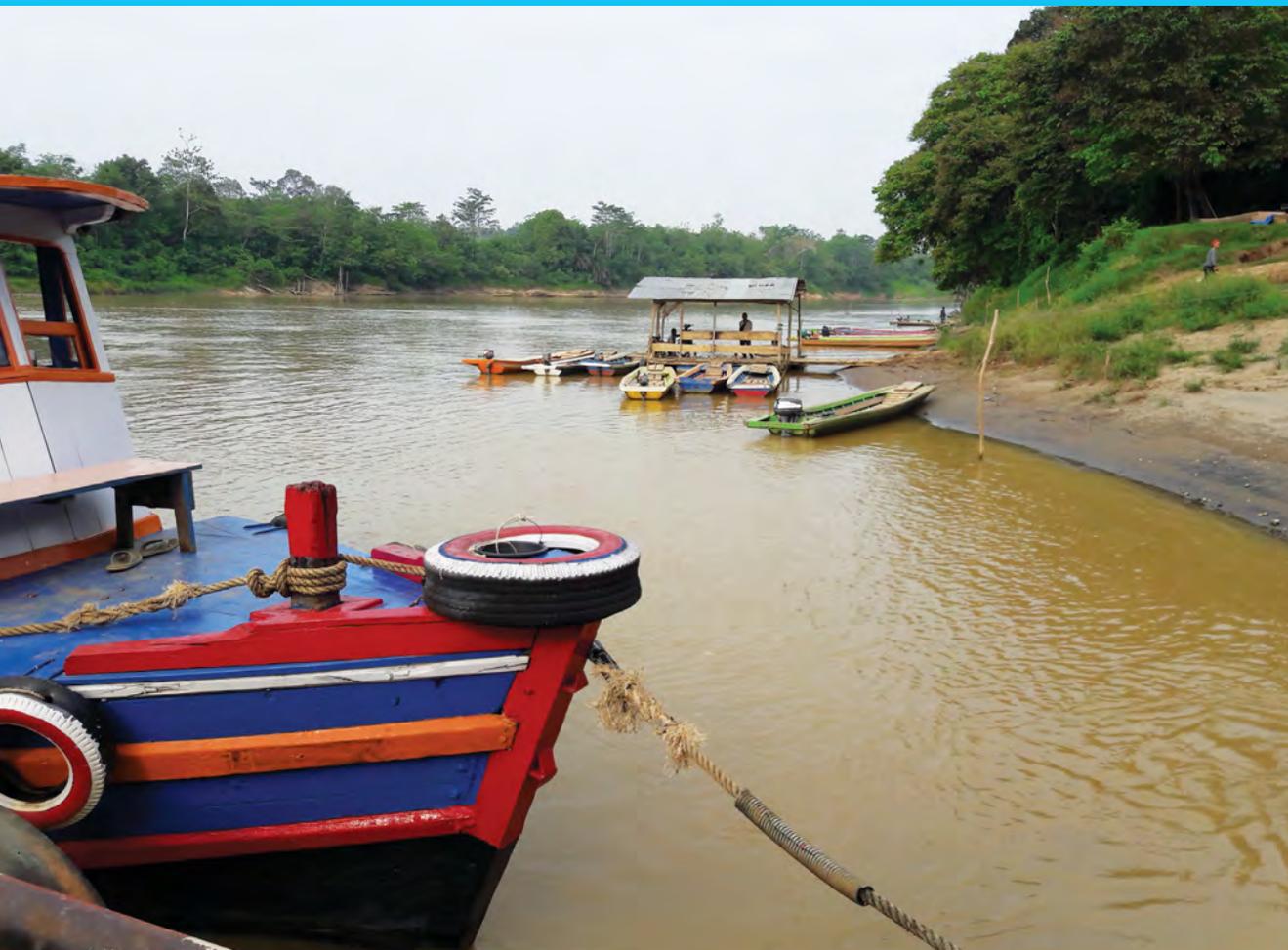


# Sustainable trade and responsible business >



Making enterprise, trade and consumption more responsible and sustainable has the potential to have a huge impact on millions of workers and communities whose lives are directly affected by business and supply chains, and on local and global environments. NRI's Sustainable Trade & Responsible Business programme aims to generate knowledge and lessons on the sustainability of trade and responsibility in business, in a context of globalization and changing world trade patterns, rising authoritarian governments, growing corporate and elite power, and crises in global social and ecological systems. It is critically important that social, environmental and economic dimensions are appropriately considered in an integrated manner in research, policies and programmes which aim to support economic development.

Tropical forest landscape, South Sumatra.



## Advancing understanding on protecting and restoring tropical forests for nature, people and climate

*Valerie Nelson*

Forests are critically important – they encompass vast terrestrial biodiversity, and they are culturally, spiritually and economically significant to millions of local communities, Indigenous Peoples and producers. Because of their role as carbon sinks, the protection and restoration of forests is central to any of humanity's efforts to mitigate and adapt to climate change. But deforestation and forest degradation continue at alarming levels; a particular driver is production of commodities such as beef, soy, palm oil and cocoa. Tackling this land use change and achieving sustainable production, trade and consumption is urgently needed. Researchers from NRI's Sustainable Trade and Responsible Business Development Programme have been exploring tropical forest ecologies, politics, and cultures, engaging on different aspects of forests, land use, land rights and the knowledge, livelihoods and experience of Indigenous Peoples, building on decades of experience in these areas.

During COP26 in November 2021, DEFRA – the UK Government's Department for Environment, Food and Rural Affairs – announced a second phase of the UK Government's flagship climate forestry programme, Partnerships for Forests (P4F). Since 2017, Professor Valerie Nelson has been conducting 'evaluation-for-learning' on this programme, incorporating a series of studies on P4F interventions, which seek to catalyse investments in sustainable land use and forestry, create forest partnerships, market demand measures and influence policies. The evaluation studies, carried out by Prof Nelson and a team led by LTS-NIRAS International in Indonesia, Brazil and Colombia, have generated findings on the effectiveness of P4F interventions. These findings were fed back into the programme during implementation and to inform future programmes.

The research indicates that the strongest potential for transformative change occurs where there is a holistic and shared vision of the desirable future system, root causes of challenges are identified and there is a design that responds to these aspects by integrating all five impact pathways which target 1) the producers, 2) producers' organisations, 3) catalyst companies, 4) forest/landscape actors and governance systems, 5) enabling conditions to support scaling and systemic change; or ensures that other actors are covering areas beyond the scope of the specific programme's interventions.

The studies highlight the need for greater attention in conservation finance and tropical forest landscape approaches to issues of equity, the terms of incorporation of smallholders and harvesters, including informal workers, gender issues, influencing policy through social learning processes, improving monitoring and evaluation systems and ways to assess the potential for transformative change and achievements. The team's report on transformative change, led by Prof Nelson, informed UK government thinking in advance of COP26, highlighting the need for combinations of interventions across production/extraction, trade, investment, governance and consumption aspects of the food and agriculture system.



# Corporate accountability for human rights and environmental challenges

Valerie Nelson and Adrienne Martin

How can we change corporate behaviour to stop the harm it causes to workers, Indigenous Peoples, local communities and environments in low- and middle-income countries? Corporate power has grown through globalisation, and state power to curb corporate impacts has decreased. Voluntary initiatives are widely promoted as a responsible business solution to international supply chain challenges. However, given the competitive pressures in global value chains, voluntary initiatives are insufficient. An increased focus on regulatory solutions, such as mandatory due diligence requirements for companies to tackle business, human rights, and environmental challenges is occurring in Europe and the United States. These may have more teeth, but their effectiveness requires scrutiny.

Following a study on human rights due diligence in 2019 for the Fair Trade Advocacy Office and Brot für die Welt, an NRI team recently evaluated two Dutch Government programmes, the Fund against Child Labour (FBK) and the Fund for Responsible Business (FVO), which subsidise companies to improve their due diligence and tackle local root causes of relevant challenges. Led by Professor Valerie Nelson, a team comprising Professor Adrienne Martin, Professor Vegard Iversen and independent consultants Michael Flint and Hannah Betts, conducted a portfolio review, analysed monitoring data, conducted extensive key informant and stakeholder interviews for 20 projects, and five in-depth project case studies. The evidence was used to assess progress and effectiveness and to generate lessons. 61 projects are supported by both programmes; examples include mica mining in Madagascar, gold mining in Tanzania and Uganda, cocoa in Ghana, Cote d'Ivoire, and Cameroon, digital innovation in Nicaragua, vegetable seed production and garments in India, rice in Pakistan, coffee in Vietnam, granite mining in India, medical waste recycling in Egypt, rice blockchain in Cambodia, timber in Gabon, and leather from China and India.

Overall, the NRI study found that FVO and FBK funds are providing worthwhile support to improve how child labour and other Responsible Business Conduct (RBC) risks are identified and impact assessments conducted, and for Dutch companies to build systems to potentially address them. However, evidence of companies taking concrete action on risk mitigation, monitoring and remedy is less strong (and some projects have only recently begun). General progress of the projects against results has been good, although gaps in monitoring data make an accurate assessment difficult. Knowledge of RBC and child labour risks and root causes among project partners has been significantly improved. Some improvement in the earlier and easier stages of due diligence appears to have been achieved, and some innovative approaches have been facilitated, but it is not yet possible to know whether such initiatives will effectively tackle child labour and RBC risks. The study points to the limits of projects of this type, scale, and duration, often involving limited coalitions and with measures on enabling conditions being out of scope of the programme. Significant impact at scale is likely to require larger multi-stakeholder initiatives and changes to the 'rules of the game' in both consumer and supplier countries. The Dutch Government is acting on the recommendations to consider demand-side root cause issues, strengthening internal programme capacity and enhancing quality indicators for company due diligence.



Photographs from the Dutch Government programme, the Fund against Child Labour (FBK)



# Plant, animal and human health

At NRI, we deal with both beneficial and harmful insects, and other pests including rodents and birds, which have an impact on human and plant health. Here we highlight examples of our work in this area, which include investigating the role of rodents in spreading diseases on livestock farms and developing strategies to protect farm animals from rodent pest problems, controlling invasive insect pests with environmentally friendly approaches, understanding mosquito behaviour to help develop new control methods, and combatting destructive crop viruses.

At a make-shift field laboratory in a pig farm in Norfolk, UK, Dr Judy Bettridge adds preservative to freshly collected samples, which helps to preserve the quality of DNA for later testing back at NRI.



## Developing strategies to protect farm animals from rodent pests and the diseases they carry >

Steve Belmain

On farms, rodents consume and spoil animal feed, damage infrastructure and are a considerable threat to animal health and to achieving optimal health and wellbeing recognising the interconnections between people, animals, plants and their shared environment, an approach known as 'One Health'. Rodents can cause direct stress to pigs and poultry but are mainly important as carriers of pathogens. In pigs, this includes serious diseases like Swine dysentery, Aujeszky's Disease, PCV2 (Porcine circovirus 2) and Encephalomyocarditis. Wild brown rats can carry Influenza A and might act as an intermediate host for the transmission of avian influenza between wild birds and poultry. For other diseases like African Swine Fever, rodents may support ticks that can carry it, or act as mechanical reservoirs – whereby they spread the disease without being infected by it. Rodents also play a role in the epidemiology of leptospirosis (Weil's disease) and salmonellosis, or in spreading antibiotic-resistant bacterial strains such as livestock-associated MRSA. Rodents can pick up infections from pigs or poultry and spread them within and between farms, they can act as a bridge between wild fauna and livestock, and they can maintain the infection locally when a farm is emptied and decontaminated after a disease outbreak or livestock turnover. Some of these diseases can go on to infect humans, for example new strains of influenza, or rodents could facilitate the spill-over of novel diseases or future pandemics.

Thus, there are very good reasons for rodent management on pig and poultry farms. An important approach has always been the use of rodenticides. However, concerns about the environmental safety of the most common rodenticides have led to changes in European and national regulations that restrict their use and pose new challenges for efficient rodent management on farms. There is also the problem of resistance against these poisons.

NRI is part of a European consortium investigating the role of rodents in spreading diseases on livestock farms and developing future strategies to protect farm animals from rodent pest problems, through a research project known as 'RodentGate' (Future rodent management for pig and poultry health). Consortium partners include the University of Antwerp, Belgium, the Dutch Pest & Wildlife Expertise Centre, the Netherlands, Julius Kühn Institute, Germany and the National Veterinary Research Institute, Poland.

Led by Professor Steve Belmain, the NRI team includes Drs Judy Bettridge, Dan Bray, Sophie Bouvaine and Gonçalo Silva, who are looking at how different farm-rearing practices impact on the prevalence of rodent-borne diseases, trying to link farm activities with disease incidence and getting a better understanding of rodent movements and interactions with farm animals. A better understanding of the eco-epidemiological dynamics of rodents and livestock is expected to lead to more sustainable rodent management methods, with reduced reliance on using poisons.

*RodentGate is supported by the ERA-NET fund for International Coordination of Research on Infectious Animal Diseases; NRI's funding comes directly through UKRI (BBSRC).*



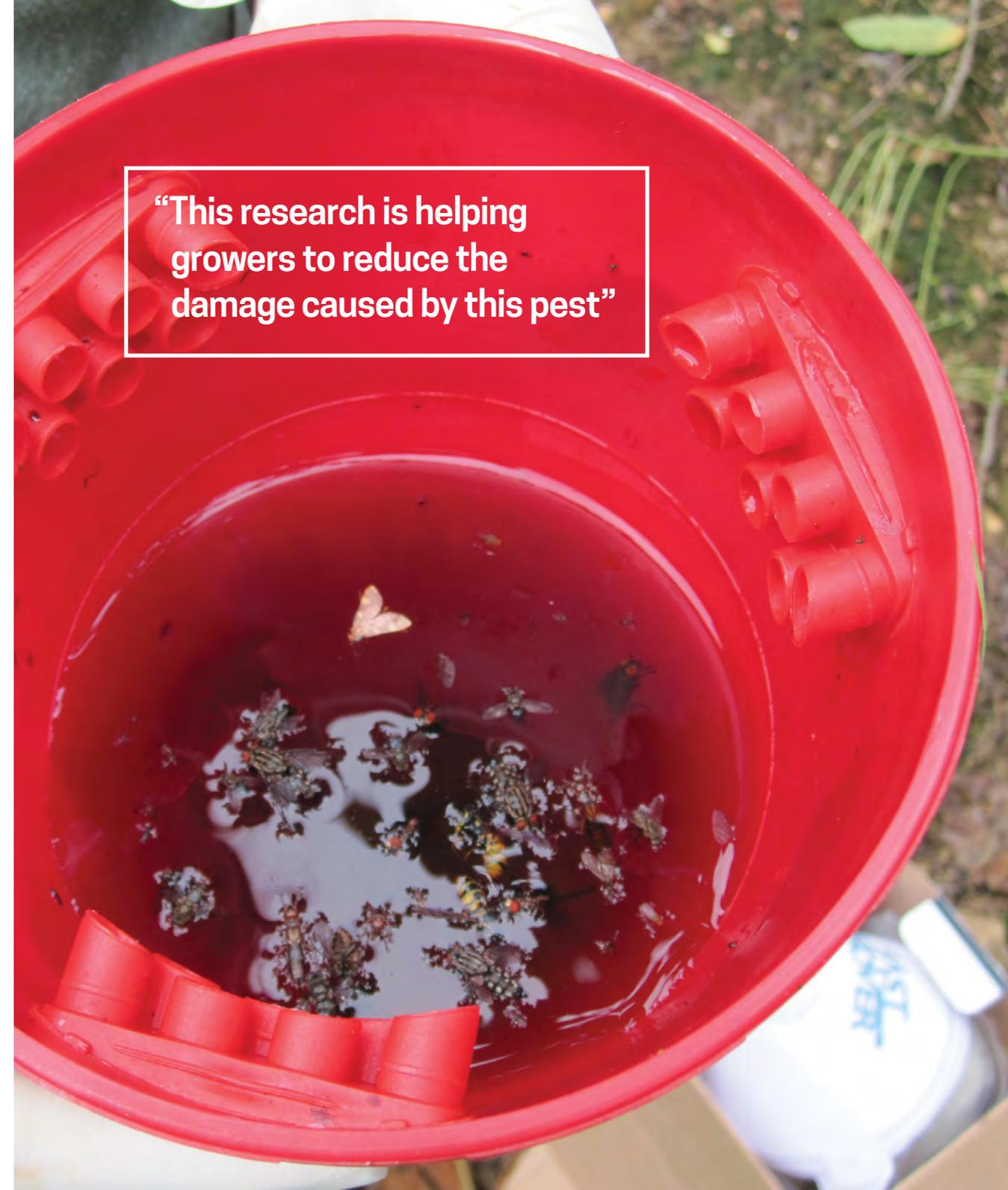
# Spotted wing drosophila: controlling the invasive fruit fly with environmentally friendly approaches >

Dan Bray and David Hall

Spotted wing drosophila (SWD) is a fruit fly that lays its eggs in ripening fruit. The larvae cause severe fruit damage and increases in production costs. This invasive pest was first detected in the UK in 2012 by NIAB EMR, a horticultural research organisation based in East Malling, Kent. Numbers have increased year-on-year and SWD has become the main pest of concern for UK growers of a wide range of horticultural crops, particularly strawberries, raspberries and cherries. Initially the only method of controlling SWD involved broad-spectrum insecticides, including spinosad and chlorpyrifos, which are designed to kill a wide range of organisms, without targeting a specific species. However, such insecticides can disrupt the integrated pest management (IPM) programmes used by growers against other pests and diseases which are based on more biological, environmentally friendly approaches.

NRI scientists of the Chemical Ecology Group led by Dr Daniel Bray have been involved in several projects in collaboration with NIAB EMR to develop better methods for control of SWD that are compatible with growers' IPM programmes. In projects funded by the Agriculture and Horticulture Development Board (AHDB), NRI has developed and supplied lures for traps used in a National Monitoring Programme to follow spread of the pest in the UK. Repellents for SWD have been discovered and work by NRI/NIAB EMR PhD student Christina Conroy has demonstrated that at least two of these can significantly reduce the numbers of SWD eggs laid in strawberry crops. In work funded by Innovate UK in collaboration with specialist crop-protection firm, Russell IPM, a new lure for SWD adult flies has been produced and marketed. Progress has been made on developing a device that attracts SWD flies and infects them with a fungus that specifically kills flies. The infected flies are released to infect other SWD flies before dying. A third project, funded by the Biotechnology and Biological Sciences Research Council (BBSRC) in collaboration with Berry Gardens, a major supplier of strawberries to the UK supermarkets, aims to discover why SWD doesn't lay eggs in fruit infested with other species of *Drosophila*. The NRI scientists are working to identify chemical signals which may be responsible for this deterrent effect. If successful, these could be applied to a crop to reduce damage caused by SWD.

SWD has become established on horticultural crops throughout the UK as well as in Europe, North and South America and even now in Africa, and this research is helping growers to reduce the damage caused by this pest. The approaches being developed are sustainable and compatible with IPM programmes on other pests and diseases, and will help growers reduce applications of traditional chemical pesticides. This in turn will help to reduce the risks to pollinators and other beneficial insects essential for maintaining our food supply, and to the wider ecosystem.



“This research is helping growers to reduce the damage caused by this pest”

Spotted wing drosophila in a trap.



# Harmonious matchmaking: understanding how mosquitoes hear and respond to each other >

Gabriella Gibson and Lionel Feugère

Mosquitoes can be loud and annoying – and it is precisely this whiny tone that they use to find a mate. But from how far away can they hear each other and at what level of sensitivity?

NRI's Dr Lionel Feugère and Professor Gabriella Gibson have been working on a research project to find out the answer – the first time this question has been addressed. The objective of the project was to identify visual, sound and chemical stimuli used by virgin females of the *Anopheles gambiae* s.l. complex which includes the most important group of malarial mosquitoes. The aim of this project is to detect, recognise and locate species-specific male swarms at long range, to provide the fundamental knowledge needed to develop new bio-inspired traps for their surveillance and control.

Dr Feugère and Prof Gibson worked on the sound cues that mosquitoes are sensitive to. They recorded the sound of males in mating swarms and assessed the distance over which females can hear this sound. The team used behavioural assays, supported by acoustic theory, to monitor the behaviour of mosquitoes in response to sound stimuli, i.e., how their flight speeds or their flight tones change in response to the sound of a potential mate. They used free-flying mosquitoes and ecologically relevant sound stimuli to test their hypotheses and discovered that inter-mosquito communication occurs only at close proximity to a mate. They also tested the minimum sound level of the female's flight tone that males can respond to, which was found to be significantly lower than previously reported.

Contrary to most studies, the team used free-flying mosquitoes rather than tethered mosquitoes or electrophysiological methods, which provided them with the natural sensory environment they needed to produce natural mating swarms. The mosquitoes were released in a large arena (approximately 4m<sup>3</sup>) with a visually conspicuous object on the ground that stimulates swarming behaviour, consisting of elliptical flight patterns over the object. Mosquitoes were exposed to a range of natural and synthetic played-back sounds of female flight emanating from a speaker located at the same height as the swarm centre. The team monitored their responses to flight-tone sound by recording the flight-tone and flight-dynamic responses of males using 3D video recording.

The outcome of this basic-research study contributes to a greater understanding of mosquito mating behaviour and can inform the development of more specific and effective sound-based traps to monitor and/or kill mosquitoes.

This research project was carried out by Dr Feugère and Prof Gibson as part of the project entitled 'How *Anopheles* Females seek males', led by Olivier Roux (IRD, France; IRSS, Burkina Faso) and the Human Frontier Science Program led by Rajat Mittal (Johns Hopkins University, USA). It also involved Nicholas Manoukis (USDA ARS, USA).



The antennae fibrillae of a male *Anopheles* mosquito, used to detect airborne sound.



# Combatting destructive crop viruses in tomato and cucurbit plants >

Maruthi Gowda

Every year, viral diseases wreak havoc worldwide on tomato and cucurbit crops (squash, pumpkin, courgette), causing huge yield losses ranging from 15% to 100%, accounting for losses of around €3.5 billion in Europe alone. The emergence of new and devastating plant viruses is fuelled by a combination of climate change, rising global trade and more interconnected agricultural sectors. Building on decades of expertise in plant molecular biology and sustainable pest management approaches, NRI is part of the EU-funded VIRTIGATION project, which aims to combat emerging viral diseases in crops, and to help prevent them from spreading around the world.

To date, few viable remedies have been made available to tackle the destruction of crops caused by these plant viruses. The VIRTIGATION project aims to cut tomato and cucurbit crop losses stemming from viral diseases by up to 80%, and it seeks to cut in half, or even eliminate the use of pesticides to control emerging viral diseases. VIRTIGATION will demonstrate several innovative biologically based solutions to safeguard tomato and cucurbit plants. These will include natural plant resistance, plant vaccines, a sustainable and integrated pest management (IPM) approach, and biopesticides – substances used for controlling pests made from natural products or micro-organisms, as opposed to the more conventional synthetic or chemical pesticides. VIRTIGATION will also implement new methods for the early detection and prevention and control of these plant viruses. It will further develop innovative diagnostic tools and online monitoring platforms to identify possible outbreaks to ‘test, track and trace’ the spread of viruses. With this toolbox, VIRTIGATION aims to assist the entire value chain – from farmers and plant health services, to policymakers and industry – in protecting tomatoes and cucurbits from viral diseases.

NRI's Professor Maruthi Gowda is leading NRI's contribution to VIRTIGATION which focuses on understanding how viruses jump hosts from tomatoes to cucurbits and expand their host range. The team aims to identify virus-resistant varieties from extensive germplasm collections to provide rapid and natural control measures for farmers. In addition to the use of naturally occurring resistance sources, the NRI team is exploring wide-ranging IPM practices such as the use of biopesticides, plant extractions and novel eco-friendly formulations for controlling whiteflies – one of the main insect vectors which transmit viral diseases. These efforts will minimise the use of harmful synthetic pesticides and thus help produce healthier vegetables.

VIRTIGATION is coordinated by the Department of Biosystems at KU Leuven University in Belgium and brings together 25 partners from universities, industries, research and technology organisations, agricultural extension services and small and medium-sized enterprises from 12 countries: Austria, Belgium, France, Germany, India, Israel, Italy, Luxembourg, Morocco, the Netherlands, Spain and the United Kingdom.

The VIRTIGATION project is running from 2021–2025 and is funded with EUR 7 million by the EU Horizon 2020 programme. [www.virtigation.eu](http://www.virtigation.eu)



Tomato plants are affected by viral diseases, along with cucurbit plants including squash, pumpkin and courgette.



# Capacity strengthening >

NRI recognises that capacity strengthening for agricultural development and food security is fundamental to achieving the Sustainable Development Goals. Researchers and other stakeholders in smallholder agricultural systems require new skills to work together effectively, to engage in high-quality, demand-led research and learning, to embrace interdisciplinary approaches and to deliver innovative solutions to promote sustainable development – especially in the face of climate change. Researchers, policy makers and civil society organisations are working together to build capacity to demand, evaluate and utilise evidence so that impact is achieved.

Pictured with apple trees during a visit to NIAB-EMR at East Malling in Kent, UK, the first cohort of doctoral students from the UKFS-CDT learn about NIAB-EMR's research and contribution to UK Food Systems.



## UK Food Systems – Centre for Doctoral Training: developing the next generation of interdisciplinary food systems transformation leaders

*Chris Turner*

Food systems are complex networks of people and activities involved in the production, processing, distribution, preparation and consumption of food. There is an urgent need to transform food systems to achieve the 2030 Sustainable Development Goals (SDGs) and promote sustainable diets that are nutritious, healthy and affordable, whilst also recognising the importance of food systems to economic growth and social wellbeing. Such change requires transformation leaders. To that end, the UK Food Systems – Centre for Doctoral Training (UKFS-CDT), led by NRI, aims to train the next generation of UK food system transformation leaders for a healthy and sustainable food future.

The UKFS-CDT is a new programme that provides a unique opportunity for transformative and interdisciplinary food systems research. The UKFS-CDT welcomed its first cohort of fifteen doctoral researchers to NRI in October, 2021. From 2021–2027, the UKFS-CDT will train over 60 interdisciplinary doctoral researchers, who will undertake research linked to the programme's key themes: Healthy People: food environments, consumer behaviour, diets, nutrition and health; Healthy Animals: livestock health and welfare in sustainable food systems; Healthy Environment: environmental sustainability of food systems; Healthy Economy: food production, distribution, manufacturing and waste.

Alongside the programme, UKFS-CDT is building a transformative food systems community in the UK, with the vision of helping to shape a truly resilient, healthy and inclusive food system. This community is being created through the UKFS-CDT Academy – a dynamic learning network which provides a platform for collaboration around transformative food systems research by bringing together doctoral researchers, supervisors and over 130 Associate Partners from across businesses, government, and civil society.

The UKFS-CDT features a unique approach to doctoral training, with students recruited according to their aptitude for interdisciplinary food systems research, rather than on the basis of a PhD proposal. In year one, the students receive bespoke training in food systems at NRI in collaboration with the Innovative Food Systems Teaching and Learning (IFSTAL) programme led by Oxford University's Environmental Change Institute. This is followed by two four-month rotations with UKFS-CDT partners, where the students will undertake short research projects, or 'kernels' (one social science-based, one natural science-based). This unique approach is based on the principle of co-design, with project kernels developed collaboratively between Associate Partners from across businesses, government, and civil society, academics across the UKFS-CDT consortium and the students.

The UKFS-CDT is supported by UKRI's Strategic Priorities Fund 'Transforming the UK Food System for Healthy People and a Healthy Environment Programme' and managed by the Partnership for Sustainable Food Future (PSFF). Led by NRI, the consortium includes University College London, Royal Veterinary College, Institute of Biological, Environmental & Rural Sciences at Aberystwyth University, Centre for Food Policy at City University, University of Sussex, Brunel University London, NIAB EMR and Rothamsted Research.



# Keeping CONNECTED: molecular diagnostics training to tackle vector-borne plant diseases

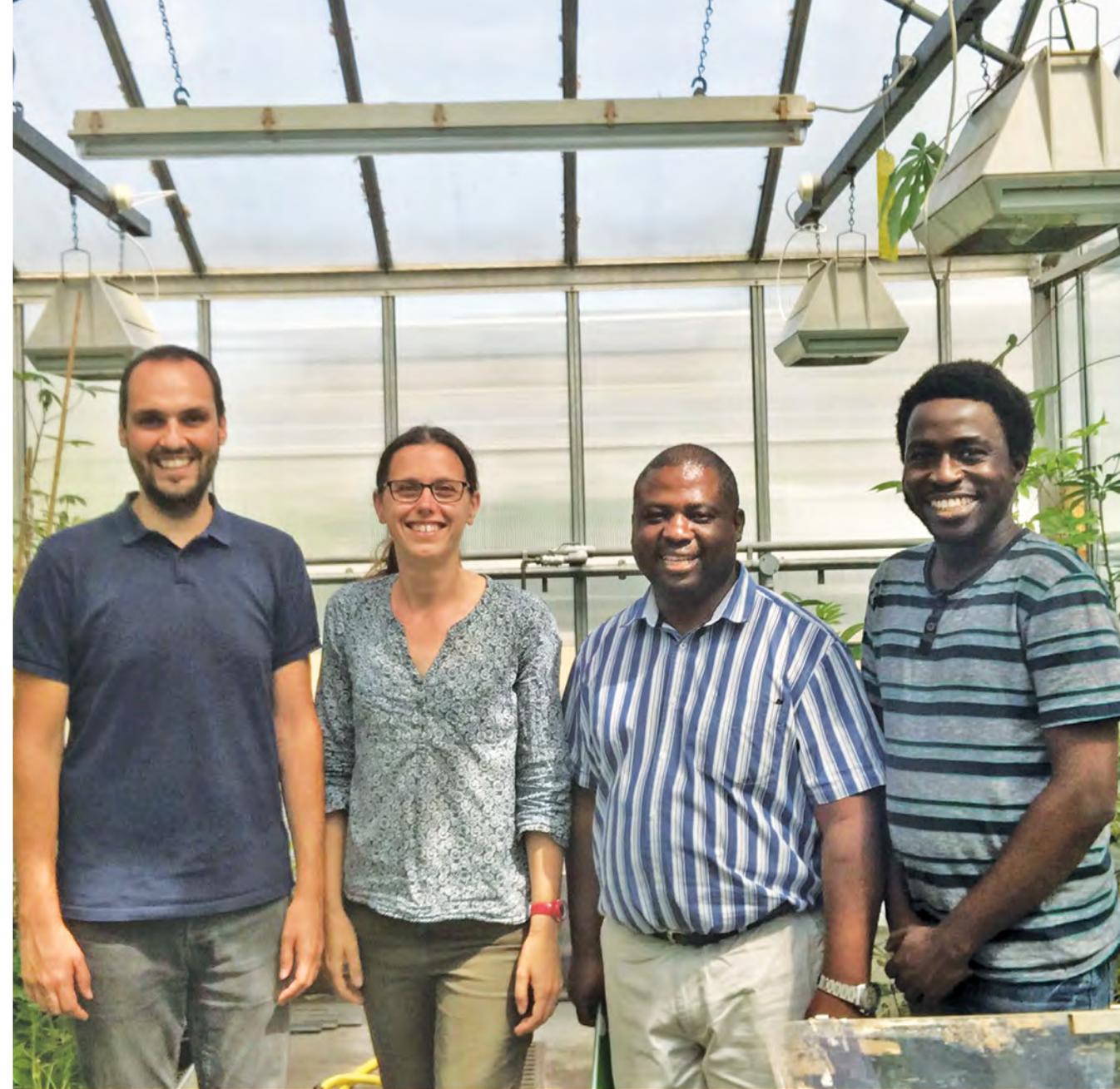
Sophie Bouvaine and Gonçalo Silva

NRI experts in entomology and plant virology have been involved in a suite of capacity-strengthening initiatives, as part of the 'Community Network for African Vector-Borne Plant Viruses' (CONNECTED). Funded by GCRF and directed by Professor Gary Foster, University of Bristol, and Professor Neil Boonham, Newcastle University, CONNECTED endeavours to establish and consolidate collaborations of international researchers to tackle vector-borne plant diseases. In addition to providing funding, the network offers 'training vouchers', workshops and training videos. As part of CONNECTED, NRI members, Dr Gonçalo Silva, Dr Sophie Bouvaine and Prof Susan Seal have contributed to knowledge transfer with members of participating African universities.

One example which demonstrates the urgent need to build capacity in combatting plant virus diseases and their insect vectors is maize streak virus (MSV), which is transmitted by the insect leafhopper *Cicadulina* spp. In maize plants, MSV infection initially manifests as small, round, scattered spots on their leaves, which get larger as the plant grows until the spots resemble broken yellow streaks. Severe infection causes stunting, and plants can produce malformed cobs or no yield at all. Despite a number of control strategies, the ensuing threat to food security and economic impact is significant for smallholder farmers across sub-Saharan Africa, where maize is often the most important crop. By using molecular techniques, scientists can detect viral diseases at an early stage of infection, and identify and differentiate between vectors that appear identical. Accurate and rapid diagnostics are crucial to develop precise and sustainable measures to control these serious diseases and their insect vectors.

From 2019–2020, several recipients of the network's training voucher scheme chose NRI to obtain training on molecular techniques for diagnostics, characterisation and monitoring of viruses causing plant diseases and their insect vectors. Scientists had the opportunity to use NRI's infrastructure and facilities and to interact with virologists and molecular biologists to develop and expand their research on the crop viruses of their choice. In 2021, Drs Bouvaine and Silva developed a series of videos for online demonstrations of several molecular techniques for the identification of insect vectors and detection of plant viruses, including polymerase chain reaction (PCR), recombinase polymerase amplification (RPA) and loop mediated isothermal amplification (LAMP) – alternatives to PCR which use lower-cost equipment that is robust, and can be battery-powered to protect the equipment from fluctuations in energy supply. These videos constitute a step-by-step protocol that will be provided to the network members so they can be replicated in the scientists' own laboratories worldwide.

Drs Bouvaine and Silva have also delivered CONNECTED training courses on plant virus detection, insect vector molecular barcoding, and molecular diagnostics for plant virus surveillance in Kenya, Nigeria, and the UK. Together, the CONNECTED training activities contribute to knowledge transfer and provide scientists from around the world with the necessary technical skills to further their research and to bring sustainable solutions to vector-borne plant viruses.



(L-R) NRI's Dr Gonçalo Silva and Dr Sophie Bouvaine welcome Mathias Tembo from Zambia and Dr Adedapo Adediji from Nigeria to NRI for a training course in diagnostic tools for plant virus detection.



# Understanding what works to promote science, technology and innovation in East Africa

Andy Frost

The sustainable development agenda is a response to a new class of challenges that call into question current patterns of human activity in relation to production and consumption, access and distribution of resources, and the way these processes and patterns of human activity are governed and directed. Broadly these challenges relate to environmental sustainability of the resource base and the planet as a whole and the crisis of unbalanced patterns of growth that are failing to eradicate poverty, inequity, and food, water and energy resource insecurities. These are global-scale issues, but have particular poignancy and manifestations in low- and middle-income countries (LMICs) where poverty is widespread and where climate change is a major threat to already fragile and degraded environments.

Science, Technology and Innovation (STI) could form a central pillar in addressing these challenges. But that will require a form of innovation that is much more deeply embedded in society than it has been in the past. This will entail a much closer alignment of STI policy with development priorities in a particular country and will require patterns of governance and participation that give ownership of both the priorities and the outcomes of the innovation process, to a wider set of stakeholders. Building this new form of innovation capacity will need to look beyond traditional science and technology providers – although it is essential to strengthen these too – and will need to embrace the full gamut of knowledge production and use, actors and processes that society has to offer.

The Knowledge Systems Innovation (KSI) project, funded by UK Aid through the East Africa Research Hub, seeks to develop a practical approach to guide capacity development and investment in knowledge systems in Kenya, Rwanda and Tanzania. The project was led by Professor Andy Frost and also included Associate Professor Apurba Shee, who worked on the economics and financial analysis. Working with in-country teams and colleagues from ACTS in Kenya, CSIRO in Australia, and the University of Sussex and UCL in the UK, the team first undertook case studies and quantitative work. They observed diverse STI contexts across the three countries, research investments poorly aligned to the majority of SDG targets, interventions tackling recognised innovation system gaps, particularly those aimed at enhancing brokering, without appropriate evaluation. Significant informal-sector knowledge activity was seen in all three countries which was of high relevance to local communities and SDGs but these are not mainstreamed and hence overlooked. In order to address this, the team proposed a practical conceptual framework which defines a sufficient set of STI investment and capacities required to drive the transformational change necessary for balanced and sustainable growth. The framework is intended for use by donors, to design projects with a fresh outlook that are fit for purpose.



Bottom left: Dr Shemdoo of COSTECH presenting on the STI policy environment in Tanzania; Top: Prof Andy Frost introducing the project to the participants; Bottom right: a participant explaining a potential approach to engaging stakeholders in knowledge systems.



# Gender and social difference >

At NRI, we understand that inequality is a result of powerful social norms, stereotypes and power relations that influence attitudes and behaviour. Over the past three decades working with our Northern and Southern partners, we have extensive experience in development and empowerment pathways that focus on equitable processes and outcomes in development. These approaches place capabilities, dialogue and accountability at the centre of our work. The goal of our work in gender and social difference is to produce innovative and high-quality research and practice for demonstrable impact on reducing inequalities and achieving gender justice in sustainable development. The ultimate aim is to contribute to theory, policy and practice to benefit the lives of women, men, girls and boys, as a matter of human rights, gender justice and good development.

Selling attieke, a product made from cassava, in Ivory Coast.



## Gender in RTB product preferences: developing Food Product Profiles

Lora Forsythe

Gender equity may not immediately come to mind when thinking about crop breeding. However, the influence of gender roles and social relationships on crop breeding is considerable, particularly with root, tuber and banana (RTB) crops which are vital for people's food and income across sub-Saharan Africa. While breeding programmes have been working for decades on developing new varieties to increase yield potential, pest and disease resistance and for new markets, gender issues and post-harvest and consumer preferences, have tended to be overlooked. This has led to significant problems of acceptability of new varieties among farmers, partly due to a tendency for women, and hence women's priorities, to be excluded from varietal development programmes.

Crop breeders can have a significant positive impact on women's lives by breeding for traits in which women in particular have a high interest. For example, any trait that would reduce RTB processing and product preparation time – which involves a significant amount of women's labour in sub-Saharan Africa in general – would reduce women's workloads. RTB products are often sold on 'local' markets by women, and therefore improving product yield or taste may lead to improvements in women's income. To meet this challenge, NRI has been collaborating on the project 'RTBFoods' led by CIRAD, as part of the CGIAR Research Program on RTBs. Now in its fifth year, RTBFoods continues in its aim to link local consumer preferences with breeders' selection criteria, to encourage adoption along the value chains of cassava, yam, sweet potato and cooking banana products; focus countries are Benin, Cameroon, Ivory Coast, Nigeria and Uganda.

NRI's Dr Lora Forsythe leads the project's largest work package on understanding the gender and socioeconomic and cultural drivers of food quality preferences, which is contributing to a growing movement in crop breeding programmes towards promoting gender equality. The project has carried out innovative research that profiles the preferences of women, men and other social groups, from producers to consumers, in 'Gendered Food Product Profiles', FPPs (Forsythe et al., 2021). Lora and the RTBFoods Gender Working Group (GWG) – a collaboration of 18 specialists from 10 institutes in the project – developed an RTBFoods FPP gender assessment, which draws extensively on ground-breaking work of the Gender in Breeding Initiative's (GiB) G+ Product Profile Tool, to assesses the gender impact of RTB plant traits listed in the FPP. A team of plant breeders and social scientists will use this tool to identify how a set of proposed traits will be harmful or beneficial to men and women and the trade-offs between different breeding objectives.

These activities are highlighting essential information for breeders about food products at each stage of the food and product development chain. This will contribute to improving the adoption of new RTB varieties, and most importantly, increase their development impact, particularly in terms of the livelihoods of women.



# Depleted by debt? Using a ‘gendered lens’ to bring into focus climate resilience, credit and malnutrition

Fiorella Picchioni

The work of social scientists involves taking an in-depth look at the many, often interlinking aspects of how society works. In order to understand certain facets of social relationships in more detail, it is sometimes necessary to apply a specific ‘lens’ to highlight these, especially where they tend to be neglected. A ‘gendered lens’ allows us to examine gender bias, gendered power relations and resulting inequalities in economic and social relations and institutions.

Development Economist, Dr Fiorella Picchioni, Fellow in Gender and Diversity in Food Systems at NRI, is working on a project entitled ‘Depleted by debt? Focusing a Gendered Lens on Climate Resilience, Credit and Malnutrition in **Translocal** Cambodia and South India’. ‘Translocal’ in this context refers to the interconnected, interpersonal relations and processes that happen through migration flows and networks, beyond geographical boundaries. The initiative uses a feminist political economy lens to guide critical inquiry on financial inclusion, in a context where the market-driven global system has demonstrated disastrous impacts on the environment and in the management of the COVID-19 pandemic.

A gendered or feminist lens highlights the risks of individualised solutions, such as microfinance, as key tools to mitigate and adapt to climate and environmental change. By taking into account social reproduction, which considers the multitude of everyday ‘invisible’ activities that regenerate life and societies, a feminist reading of financial inclusion highlights the inadequacy of such tools that offer only a temporary and risky solution to the deepening environmental and climate crisis and its effects on health and food security.

As with many projects that involved primary data collection in early 2020, this one was also delayed by the COVID-19 pandemic: travelling was impossible and concerns about infection and survival raised by communities took priority over the project’s timeline. However, almost two years into the pandemic, the project has made great progress: Dr Picchioni developed an online training module and provided desk support for the nutrition and physical activity arm of the project in Cambodia. The data from this module is combined with environmental profiling, household surveys, nutrition and physical activity assessments, photovoice and qualitative interviews, where possible, in Cambodia and Tamil Nadu, India.

The analysis is still ongoing, and it is too early to talk about results and outcomes at this stage. Nevertheless, the interviews evoke a picture of vulnerabilities within and outside the households. Families were living on the “edge”, with limited resources and missing the public sector to help them cope with external shocks. This is compounded by: 1) environmental crisis and natural resources mismanagement that has made agriculture an unreliable source of income; 2) debt-related stress and anxiety due to the fears of losing land and other collateral.

Funded by the Global Challenges Research Fund (GCRF), the project brings together a team of 20 interdisciplinary scholars and practitioners from Cambodia, India, the UK, and continental Europe.



Preparing a variety of dishes in Cambodia.



# Rural institutions, land and governance >

NRI's work in this field aims to assist policy and institutional innovation for sustainable, socially inclusive economic development in rural areas, particularly in Africa, with a focus on improved governance of land and natural resources, extending market participation by small farmers, strengthening rural advisory services and the social impact of agricultural and other investments, and responds to several SDGs.

Labouring on a sugar plantation – one of the sectors covered for private-sector agricultural investment addressed by the Land Collaborative learning cycle.



## Strengthening engagement with the private sector for responsible agricultural investment through social learning

*Julian Quan*

Over the last 15 years, there has been a significant expansion of private-sector agricultural investments in low- and middle-income countries. Too often, such investments have led to dispossessions, forced resettlements, lost livelihoods and human rights abuses for smallholders and local communities, with few real beneficiaries. In many cases, misguided large-scale investments have trampled over local people's land rights, failed to include them in projects or to generate real economic benefits in developing countries – leading to opposition from civil society – or even failed completely. To promote more inclusive and environmentally sustainable approaches to public and private agricultural investment, international agencies have begun to channel resources to country-level initiatives that bring stakeholders together into multi-stakeholder platforms (MSPs) and alliances for reform.

The Land Collaborative, a partnership of organisations including the International Land Coalition, the German NGO Welthungerhilfe, and the Mekong Region Land Governance Program, have developed a global Community of Practice on MSPs and alliances for progressive change in land governance. In one of its first initiatives, Land Collaborative commissioned an NRI team to design and deliver a participatory 'Learning Cycle' on how to engage with private investors for over 30 platform participants from Burkina Faso, Cambodia, Cameroon, Ethiopia, Laos, Liberia, Mongolia, Myanmar, Philippines, Sierra Leone, Tanzania, and Vietnam. Led by Professor Julian Quan, with Professor Valerie Nelson and Richard Lamboll, the team employed a 'social learning' approach, to facilitate learning through stakeholder interaction.

Participants were supported to conduct country diagnostics of agri-investment issues, and to prioritize their learning needs to engage effectively with the private sector. As a result of the COVID-19 pandemic, interactive and participatory learning has been delivered entirely online, with NRI sharing expert knowledge of practical case experience, relevant international policy, law and sustainability standards to help fill knowledge gaps. Topics include how to build trust and communicate with the private sector, the incentives driving private-sector decision making and how to improve the broader enabling environment for responsible investments. Learners were encouraged to reach out to private-sector and government actors to establish more open dialogue, and to promote practical collaboration and appropriate regulatory reforms. The NRI team is also producing comprehensive guidance notes, supporting country-level MSPs to develop action plans for engaging with the private sector, and developing a set of practical tools, learning materials and case studies for wider future application in Land Collaborative's continuing efforts to promote better, people-centred land governance and necessary stakeholder learning and collaboration globally in multiple countries.



# Assessing orangutan conservation investment considering social and environmental contexts

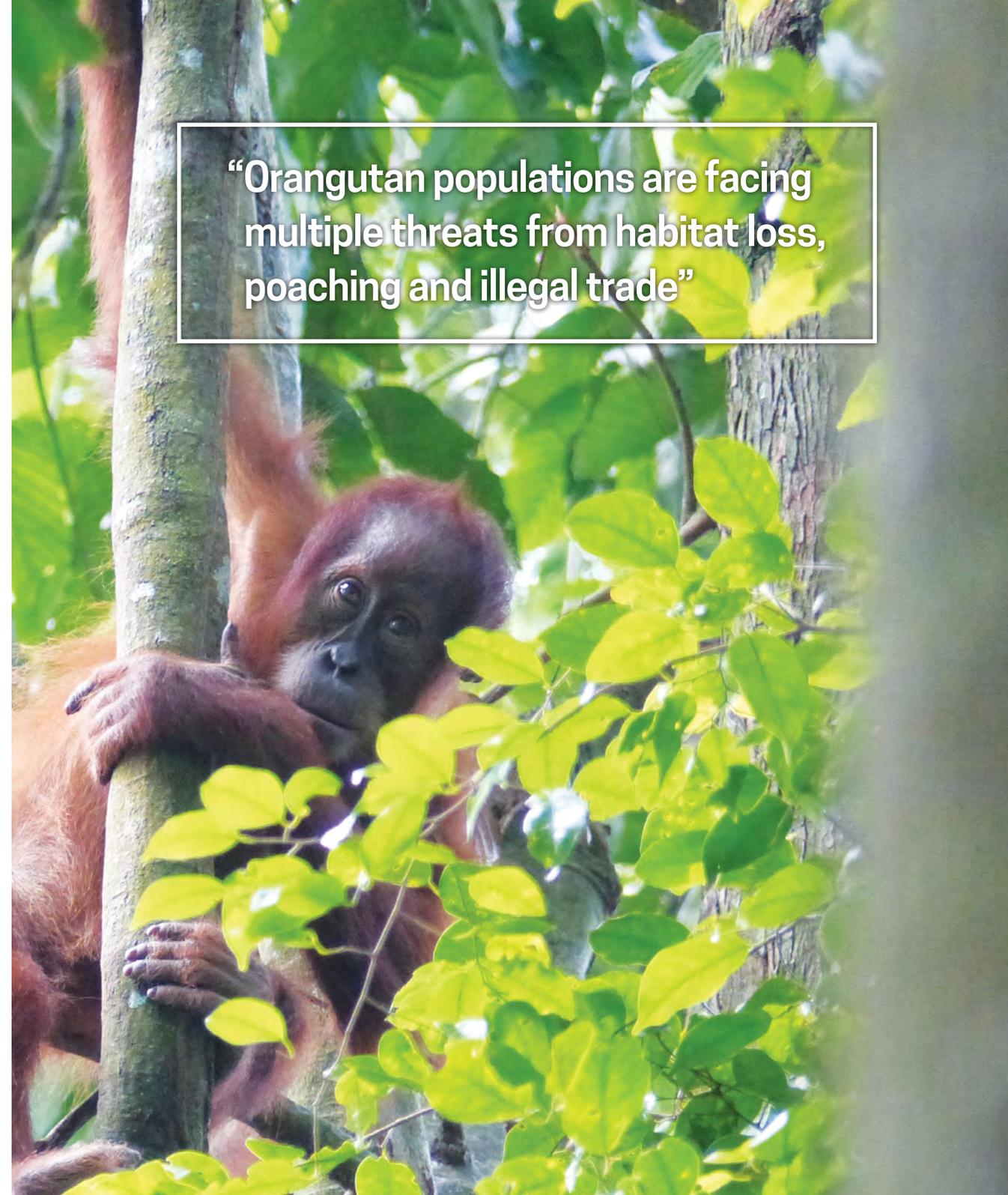
*Truly Santika*

Like many endangered species worldwide, orangutan populations are facing multiple threats from habitat loss, poaching and illegal trade. Conflicts with humans also arise, as competition between the two species increases due to the shrinking of land and natural resources. In south-east Asia, the rapid shrinking of forests in Indonesia and Malaysia – especially due to the expansion of agriculture, timber, and mining industries – reduces the habitats for orangutans, and affects local people who depend on goods and services provided by the forests and natural environments for their livelihoods and wellbeing.

Since 2019, NRI's Dr Truly Santika has collaborated with more than fifty research institutes and non-governmental organisations (NGOs) in Indonesia, Malaysia, the UK, Australia, and Europe on a project supported by the US Fish and Wildlife Service (USFWS). The project aims to unravel the state of orangutan conservation and funding across Indonesia and Malaysia. Despite considerable investment that has been put in place every year to conserve the species, detailed knowledge is lacking about these conservation activities. The project seeks to understand orangutan conservation through systematic evaluation of the change in orangutan populations between 2000–2019, the environmental and social factors driving this change, the different types of conservation interventions that have been implemented to save the species, the amount of investment spent on these conservation activities, and the relative benefit of these activities.

The team developed a model that links data from surveys on orangutan occurrence, conducted by NGOs, with the environmental and socioeconomic variables known to have important effects on orangutan population and their habitats. Environmental variables such as forest cover, rainfall, and land degradation were obtained from satellite-based data. Data on socioeconomic variables such as distance to market, poverty, presence of agricultural and forest concessions, and community-based land tenure were obtained from censuses and land records. Given data on investment in orangutan conservation activities, the team estimated the benefit of these activities in reducing the rate of decline of orangutans, per unit of investment.

Findings show that habitat protection, patrolling, and community outreach provided large benefits in slowing the decline in orangutan numbers. However, given the variability in threats, land pressure, and poverty levels in different regions where orangutans occur, the most cost-effective conservation activity was different for each region. Hence, instead of trying to provide a generalised one-size-fits-all recommendation for the most effective conservation approach for orangutans, the project is developing a specific conservation action for each environmental and social context.



“Orangutan populations are facing multiple threats from habitat loss, poaching and illegal trade”

Orangutans in their natural habitat is south-east Asia.



# Root and tuber crops in development >

Root and tuber crops, including cassava, sweet potato, yams, potato, cocoyams and other minor root crops, are important to agriculture, food security and income for 2.2 billion people in developing countries. Several factors constrain the contribution of root and tuber crops to development; they are often affected by pests and diseases passed on through vegetative propagation and, compared to cereal crops, they are bulky and have a relatively short shelf-life. NRI's team of experts undertakes worldleading research and development activities to address key challenges at all stages of root and tuber crop value chains, from farm to fork. NRI's strategies for root and tuber crop development are economically sound, environmentally, culturally and socially appropriate and gender sensitive, to ensure broad-based beneficial development outcomes.

Blending fortified cassava flour.



## Fortified cassava flour: development of an international specification

*Louise Abayomi*

It is estimated that 10% of the world's population rely on cassava as a staple food. Cassava is one of the world's most versatile crops, with uses for both food and industry –for example, it can be used to make animal feed, ethanol, or adhesives. As a food, although cassava is probably the most energy-dense of all staples, it is lacking in micronutrients. A reason for its popularity is that cassava is a relatively drought-resilient crop, and can stay in the ground, once mature, until harvesting for processing or preparation for consumption. Another of its attractions is that it's affordable, relative to maize and rice. However, where cassava is consumed daily by communities or whole populations with limited dietary diversity, such as in the Republic of Congo, there is an increased risk of micronutrient deficiencies. This has been recognised by the United Nation's World Food Programme Republic of Congo Office (WFP-RoC) who are interested in supplying fortified cassava flour within their school feeding programmes – principally for the preparation of a fermented cassava product known as fufu (or fufou), a dough cooked with water and consumed with a variety of stews or sauces.

Blended or composite flours, such as wheat and cassava flour, cassava and rice flour (often used as a weaning cereal for babies), maize and wheat, or banana and maize, are usually created to add nutritional balance or to meet desired organoleptic characteristics, such as flavour, texture and colour. In addition to these, the development and utilization of a fortified cassava flour may be viewed as a complementary strategy for consumers to access and contribute towards their daily recommended nutritional intake, and increase diversity of convenient foods, particularly for countries with high levels of undernutrition.

With technical assistance from NRI, the WFP-RoC has taken the lead in developing a new product – fortified cassava flour – produced with added vitamins and essential micronutrients. There are a number of organoleptic and textural characteristics preferred by different communities across cassava fufu-consuming countries. The aim of the international specification is to set targets and tolerances for these attributes, which include acidity (sourness), and aroma and granulation (fineness), reflecting preferences across a diverse set of consumers, thus making the specification adoptable by a greater number of countries.

The project's technical lead is NRI's Dr Louise Abayomi, who is also undertaking the validation of portable test kits and will provide capacity building of national laboratories in RoC. NRI's Dr Corinne Rumney, microbiologist, is supporting the project with sample analyses and validation with an external accredited laboratory in Italy. Storage trials are under way at NRI, examining the stability of the vitamins within the cassava flour matrix in order to establish optimum vitamin and micronutrient addition rates, packaging specification requirements, and thus, shelf-life under particular conditions.

Building on NRI's commitment to collaborative research with positive impacts for development in this area, this initiative is supporting the development of the industrial cassava flour industry in RoC, which is in its initial stages. The cassava value chain is being supported by the national government more broadly.



# Strengthening yam seed systems in sub-Saharan Africa using High-Throughput Sequencing technologies

Gonçalo Silva and Susan Seal

Yams look similar to sweet potatoes – they both grow herbaceous vines and produce edible tubers. Their taste, however, is quite different – yams are starchier and more potato-like whereas sweet potatoes are sweeter with a creamy texture. In West Africa, yam (*Dioscorea* spp.) is a preferred staple food for over 300 million people where the crop is prepared in different ways to make a variety of dishes. However, yam productivity is severely compromised by the impact of viruses and by the lack and high cost of virus-free planting material. Like sweet potato, yam is propagated vegetatively, meaning that edible tubers known as ‘seed yams’ are planted. Traditionally, farmers save their seed yams from one generation to the next. This system has led to endemic pathogens persisting in the germplasm over generations, and ultimately production in the field is compromised.

Ghana is the second largest producer and leading exporter of yams worldwide. The availability of a ready and reliable source of certified virus-free, premium-quality planting material is critical in Ghana, where farmers obtain their planting material – often of low quality and infected with viruses – either from their own farms, or through any surplus from neighbouring farmers. There is the need to utilize cutting-edge technologies that facilitate the availability of virus-free seed in required quantities to supply industry and other users. However, the lack of a formal seed system and high costs associated with seed yam production are a major constraint to yam productivity in the country. To meet this increasing demand, Ghana’s Biotechnology Laboratory of the Council for Scientific and Industrial Research-Crops Research Institute (CSIR-CRI) developed an aeroponics and hydroponics system to boost the production of seed yam. This system has a very high multiplication rate and thousands of plantlets can be generated from a single plant. However, virus titres (quantities) in the generated tissues are generally decreased but not eliminated. This poses an increased challenge for reliable virus detection, which makes it difficult to ensure that planting material is virus-free.

Through a collaborative research project between NRI and CSIR-CRI, funded by the Royal Society in the UK, NRI’s Professor Sue Seal and Dr Gonçalo Silva are using High-Throughput Sequencing to strengthen the yam seed systems in Ghana. High-throughput sequencing describes technologies that sequence multiple DNA or RNA targets in parallel, enabling millions of sequences to be generated at a time. This has the advantage that the virus status of germplasm can be obtained for multiple known as well as novel viruses in a rapid and relatively cost-effective manner.

This project will transfer the state-of-the-art diagnostic techniques to Ghana to improve capacity for yam disease diagnostics and seed certification in the country. The project aims to ensure the timely availability of virus-free seed yams at low cost, thereby establishing a sustainable seed system and contributing towards the safe distribution of yam germplasm. CSIR-CRI has accredited a virus-indexing cassava test and through this project the team will set up the facility to accredit the test for yam diagnosis which will subsequently enhance NRI’s laboratory quality management system.



Participants from the Yam Virus Diagnostics Training Course at the Council for Scientific and Industrial Research-Crops Research Institute (CSIR-CRI) in Ghana, 2019.



# Research-led teaching >

Contact: Claire Coote

NRI's research responds to global challenges. Our researchers also supervise the research of our PhD students and teach on our undergraduate and postgraduate programmes, with new elements from their research and enterprise work being rapidly introduced into individual courses and lectures.

Valentine Seymour (right) with samples taken from a river.



## My Future in Five: perspectives of life and study at NRI and beyond

Linden Kemkaran

'My Future in Five' is a series of articles created by NRI Communications Officer, Linden Kemkaran, who chats for five minutes with NRI alumni and current students, asking them all about their time studying at NRI, and how they've used their degrees to get where they are today or where they hope to get to with an NRI degree. This selection of excerpts introduces former and current students from our undergraduate and postgraduate degree programmes.

### Valentine Seymour – Environmental Science BSc

I'd had a passion since childhood to work with the aquatic environment. I was fascinated by freshwater species and coastal sciences, and that's what drew me towards taking a degree in Environmental Science at NRI. When I read the University of Greenwich prospectus, the programme was given a huge double-page layout, dedicated to freshwater research that was going on in the River Medway. I immediately thought 'right, that's where I want to go'.

My passion has always been to understand the different species that live in rivers, how they are interrelated and what processes go on just beneath the surface of that body of water. I wanted to know the different effects that water quality has on these creatures and what improvements we can make to help them flourish. The NRI programme also contained a module on environmental impact assessment where I could learn about water management.

It represented a change in career for me going from the arts to the sciences and I was very excited, but a bit nervous. I began the academic year wondering if everyone else was going to know more than me, but the lecturers explained that the first year of any degree lays the foundation of knowledge and you build on that as you go. Two of my lecturers – Dr Peter Burt and Professor Colin Hills – gave me such a high level of support and encouragement. My first year provided me with a solid understanding of the subject, giving me the basic skills and the necessary reading materials. There was a lot of lab work and field work, which I loved.

After graduating, I went on to complete a Master's degree in freshwater and coastal sciences at Queen Mary's on a scholarship that came about directly from my work at NRI/Greenwich. From there I had the confidence and contacts to complete my PhD at University College London. Now I'm a Research Fellow at the University of Surrey and my work focuses on the interface between human health, policy and the natural environment.

Find out more: [www.nri.org/study/undergraduate-taught-programmes](http://www.nri.org/study/undergraduate-taught-programmes)



## Babajide Milton Macaulay – Sustainable Environmental Management, MSc

Over a decade ago and fresh out of university, I taught biology as my National Youth Service – mandatory for every Nigerian graduate for one year. After I'd finished, I was retained by the Federal University of Technology Akure (FUTA) in Nigeria, and I realised there were some gaps in the Department of Biology – one of them being in environmental science – we had just one environmental expert. I vowed to study this subject abroad.

I applied for the Commonwealth Shared Scholarship and found that the University of Greenwich offered a funded MSc in Sustainable Environmental Management, taught at NRI. I'd never left Nigeria before, so travelling to the UK was slightly nerve-wracking. It was my first time on a plane; then I remember arriving at the Chatham campus in Medway and being so shocked at how cold it was and it wasn't even winter!

As I began to study, I found the pace really fast and full on – and my weakness was revealed. I knew how to write, but I didn't know how to write academically. When we were assessed in Nigeria, it was strictly by examinations, rather than long-form essays, so I simply didn't have the right skills. I went from being a straight A student in Nigeria, to getting disappointingly low scores in the UK. I joined a writing skills class at the Drill Hall Library on campus and gradually my scores improved as I learnt to drop the emotive words I had been using and write with a purely academic focus; impartial and scientific.

I got a lot of help from my supervisor, Dr Debbie Rees – she was so calm and patient, and she understood the difficulties of coming to study in a foreign country. NRI support staff like Caroline Troy were always happy to lend a hand with practical, emotional and moral support and would just check in with us to make sure everything was going ok; it made us feel like part of the NRI team.

After graduating from NRI, I returned to FUTA, and was promoted to Assistant Lecturer. I was awarded another Commonwealth Scholarship for my PhD, which took me to the University of Manchester to research Environmental Geochemistry and Geomicrobiology. I focused on arsenic in groundwater, using samples from Cambodia, where arsenic flows from the Himalayas and ends up in the drinking water. After my PhD and back at FUTA, I was promoted to full-time lecturer specialising in Environmental Toxicology and Pollution Management.

Every time I'm published as an academic, I have NRI and the Drill Hall Library to thank for teaching me how to do it, and Dr Debbie Rees, Dr Peter Burt and Dave Grzywacz – I'm still in contact with them and I'm so grateful for their continued support. My journey into environmental science began with NRI; they set the firm foundation upon which I built my career.

Find out more: [www.nri.org/study/postgraduate-taught-programmes](http://www.nri.org/study/postgraduate-taught-programmes)



Babajide Milton Macaulay



## Richard Lloyd Mills, PhD student

My PhD is in chemical and molecular ecology, and I research the Poultry Red Mite – a small blood-feeding external parasite that primarily infests chickens. I'm essentially trying to find new ways of controlling it. Previously I've worked on Zebra fish embryos and water-fleas, and I was intrigued that there was not much information on poultry mites at all. People knew they represented a serious threat to the poultry industry, but no one really knew how to contain or control them reliably, so that was my main focus. I felt I could make a real impact in an area that was relatively under researched.

One approach to control is through a classical chemical ecology solution where you identify the chemicals emitted by chickens that are attractive to mites, and design traps based around these chemical formulations. I wanted to try a novel approach focusing on chemosensory genes, identifying exactly what genes the mites use to sense and become attracted to chickens. If I can find the repertoire of genes that the mites are using to locate the chickens, new molecular-based mite control methods can be developed.

As my PhD budget wasn't enough to complete this work, my NRI supervisors, Dr Dan Bray and Professor Richard Hopkins, suggested that I apply for a range of grants. They explained that it was rare to get the first one you apply for, and I knew I'd be up against other established researchers. I applied for a grant from the British Egg Marketing Board – I heard back from them pretty quickly and was awarded the full amount, £11,000. I think my application appealed to them as it's a collaboration with a group at the Moredun Research Institute in Scotland which specialises in promoting livestock health and welfare and is recognised for its research into infectious diseases of farmed livestock.

My research offers a potential long-term solution for mite control and offers an alternative to the over-reliance on pesticides. If we can disrupt this fundamental mechanism that they've relied on for millions of years, it's not going to end well for the mites. I've always been interested in how things work at a fundamental level and I love finding out things that no one else knows. I could have directed that curiosity towards anything really, but my early love of biology just kept on growing.

The key thing about a PhD which a lot of people seem to forget is that it's a training degree or programme; we're being trained for a possible future career. We're not full-blown academics just yet. Studying at NRI is great as there's a good level of integration between students and staff and all my supervisors are top scientists and well-renowned in the scientific world. Getting a grant for my PhD work is quite unusual; I don't think many students receive grants. It's enough money to get me through and I'm really excited to see how my research unfolds.

Find out more about PhDs at NRI: [www.nri.org/study/mphil-phd-opportunities](http://www.nri.org/study/mphil-phd-opportunities)



Richard Lloyd Mills



# New degrees at NRI: focus on climate change, transformative change, and food safety and innovation

Despite progress in many aspects of global development over recent decades, 690 million people experienced hunger in 2020. Degradation of our natural resources – land, water, forests, and biodiversity – continues at alarming rates. The food supply chain faces a series of global issues concerning sustainability, safety and innovation. These challenges are exacerbated by climate change and violent conflicts in many parts of the world. How will we tackle ongoing global challenges? Join our new study programmes:

**Climate Change, BSc:** Climate change, together with food security and inequality, is a top concern for many around the world; as climate science is reported more in the media, 'climate literacy' is becoming ever more important too. This cutting-edge degree offers the skills to assess the impact of our changing climate, to develop solutions to mitigate emissions and adapt to a changing world. This new BSc combines a diverse range of subjects, from land use, water use and energy management to topics in the social sciences and economics, such as law, equity and climate justice, business and trade, and explores the interactions between the atmosphere, the biosphere and the economy that underpin the current mitigation gap and emerging adaptation challenges.

[www.gre.ac.uk/undergraduate-courses/engsci/climate-change-bsc](http://www.gre.ac.uk/undergraduate-courses/engsci/climate-change-bsc)

**Transformative Change for Sustainable Development, MSc (TC4SD):** Tackling serious global challenges and ensuring a sustainable future will require Transformative Change (TC) – change that is disruptive, systemic, occurs at relatively large scales, and involves a reconfiguration of technology, economy, institutions, and society. Our TC4SD MSc provides students with an in-depth understanding of Development Studies theory and practice, including different conceptions of human, societal and environmental changes. Drawing on real-world lessons from various domains, sectors and contexts, students will develop the capacity to critically discuss, analyse, and evaluate TC and develop hands-on skills in sustainable development design and planning, project management, research, and impact evaluation methods.

[www.gre.ac.uk/postgraduate-courses/engsci/transformative-change-for-sustainable-development-msc](http://www.gre.ac.uk/postgraduate-courses/engsci/transformative-change-for-sustainable-development-msc)

**Applied Food Safety and Quality Management, MSc & Food Innovation, MSc – with Industrial Practice:** Our two-year food programmes with Industrial Practice will suit graduates and entrepreneurs who are looking for careers developing safe and sustainable food within the supply chain. Students from both programmes look at cross-cutting aspects and will discover the importance of enhancing sustainability and creativity within food supply chains, the design, implementation and management of food safety and quality systems, and developing new ingredients and products. Our popular programmes include a one-year internship with a relevant employer, preparing graduates for a range of managerial roles. Current students are finding the knowledge and skills gained on the MScs highly relevant when they go into the placement, which are then supplemented by practical experience.

[www.gre.ac.uk/postgraduate-courses/engsci/food-innovation-with-industrial-practice-msc](http://www.gre.ac.uk/postgraduate-courses/engsci/food-innovation-with-industrial-practice-msc)

[www.gre.ac.uk/postgraduate-courses/engsci/applied-food-safety-and-quality-management-with-industrial-practice-msc](http://www.gre.ac.uk/postgraduate-courses/engsci/applied-food-safety-and-quality-management-with-industrial-practice-msc)



New degrees at NRI: Top left: Transformative Change for Sustainable Development, MSc. Top right: Climate Change, BSc. Bottom left: Food Innovation with Industrial Practice, MSc. Bottom right: Applied Food Safety and Quality Management with Industrial Practice, MSc



## Annual Review story contributors

### Food and Nutrition Security Initiative

- Professor Andrew Westby, Professor of Food Technology

### Food systems for improved nutrition

- Dr Aurélie Bechoff, Senior Research Fellow – Food Technologist & Nutrition Specialist
- Dr Pamela G Katic, Senior Social Scientist (Quantitative Socio-economic Methods)
- Ravinder Kumar, Associate Professor of Monitoring and Impact
- Dr Louise Abayomi, Senior Research Fellow – Postharvest Specialist

### Sustainable Agricultural Intensification

- Dr Marcos Paradelo Pérez, Fellow in Soils
- Dr Sophie Bouvaine, Plant & Insect Molecular Biologist
- Dr Jonne Rodenburg, Associate Professor of Agronomy

### Climate change, agriculture and natural resources

- Professor John Morton, Professor of Development Anthropology
- Dr Uche Okpara, Fellow in Climate Change and State Fragility
- Dr Laxmi Prasad Pant, Senior Lecturer/Researcher – Human Geography/Food Systems

### Food loss, waste reduction and value addition

- Dr Marcelo Precoppe, Crop Postharvest Technologist
- Dr Aditya Parmar, Crop Postharvest Scientist
- Dr Tanya Stathers, Associate Professor of Sustainable Agri-food Systems; Postharvest specialist
- Dr Gideon Onumah, Principal Agricultural Marketing and Finance Economist
- Dr Parag Acharya, Senior Fellow in Food Innovation, Innovation Growth Manager, Growing Kent & Medway Cluster

### Sustainable trade and responsible business

- Professor Valerie Nelson, Professor of Sustainable Development, Social Development Specialist
- Professor Adrienne Martin, Professor of Development Studies, Social and Institutional Development Specialist

### Plant, animal and human health

- Professor Steve Belmain, Professor of Ecology
- Dr Daniel P Bray, Associate Professor in Chemical Ecology
- Professor David Hall, Professor of Chemical Ecology
- Professor Gabriella Gibson, Professor of Medical Entomology
- Dr Lionel Feugère, Senior Research Fellow in Acoustics & Computer Programming
- Professor Maruthi M N Gowda, Professor of Molecular Plant Pathology

### Capacity strengthening

- Dr Christopher Turner, Research Fellow in Food Systems and Public Health Nutrition
- Dr Sophie Bouvaine, Plant & Insect Molecular Biologist
- Dr Gonçalo Silva, Research Fellow: Molecular Biologist / Virologist
- Professor Andy Frost, Director of Business Development and Partnerships

### Gender and social difference

- Dr Lora Forsythe, Associate Professor in Gender, Inequalities and Food Systems
- Dr Fiorella Picchioni, Fellow in Gender and Diversity in Food Systems

### Rural institutions, land and governance

- Professor Julian Quan, Professor of Land and Development Practice
- Dr Truly Santika, Senior Fellow in Biostatistics for Food and Agriculture

### Root and tuber crops in development

- Dr Louise Abayomi, Senior Research Fellow – Postharvest Specialist
- Dr Gonçalo Silva, Research Fellow: Molecular Biologist / Virologist
- Professor Susan Seal, Professor of Molecular Biology; Molecular Plant Pathologist

### Research-led teaching

- Claire Coote, Teaching & Learning Leader
- Linden Kemkaran, Communications Officer

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## The NRI Team

NRI's team is made up of over 130 members of staff including natural and social scientists, technicians, and specialists in project management and administration, communication, finance, IT and other fields. We are based at the University of Greenwich Medway campus in Chatham, UK, with many of our staff undertaking overseas assignments all over the world, working with international partners to achieve our mission.

To see the full list of staff and their contact details, visit:  
[www.nri.org/about/organisation-and-staff/all-staff](http://www.nri.org/about/organisation-and-staff/all-staff)

### Senior Management Team, as of 31st March 2022

Professor Andrew Westby, Director of NRI, Faculty Director of Research and Enterprise

Professor Ben Bennett, Deputy Director of NRI, Deputy Faculty Director of Research and Enterprise

Professor Adrienne Martin, Director of Programme Development

Mark Parnell, Commercial Manager

Dr John Orchard, Director of Postgraduate Research Studies

Professor Andy Frost, Director of Business Development and Partnerships

Claire Coote, NRI Teaching and Learning Leader

Professor Vegard Iversen, Head of Livelihoods and Institutions Department

Dr Nazanin Zand, Head of Food and Markets Department

Professor Richard Hopkins, Head of Agriculture, Health and Environment Department





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