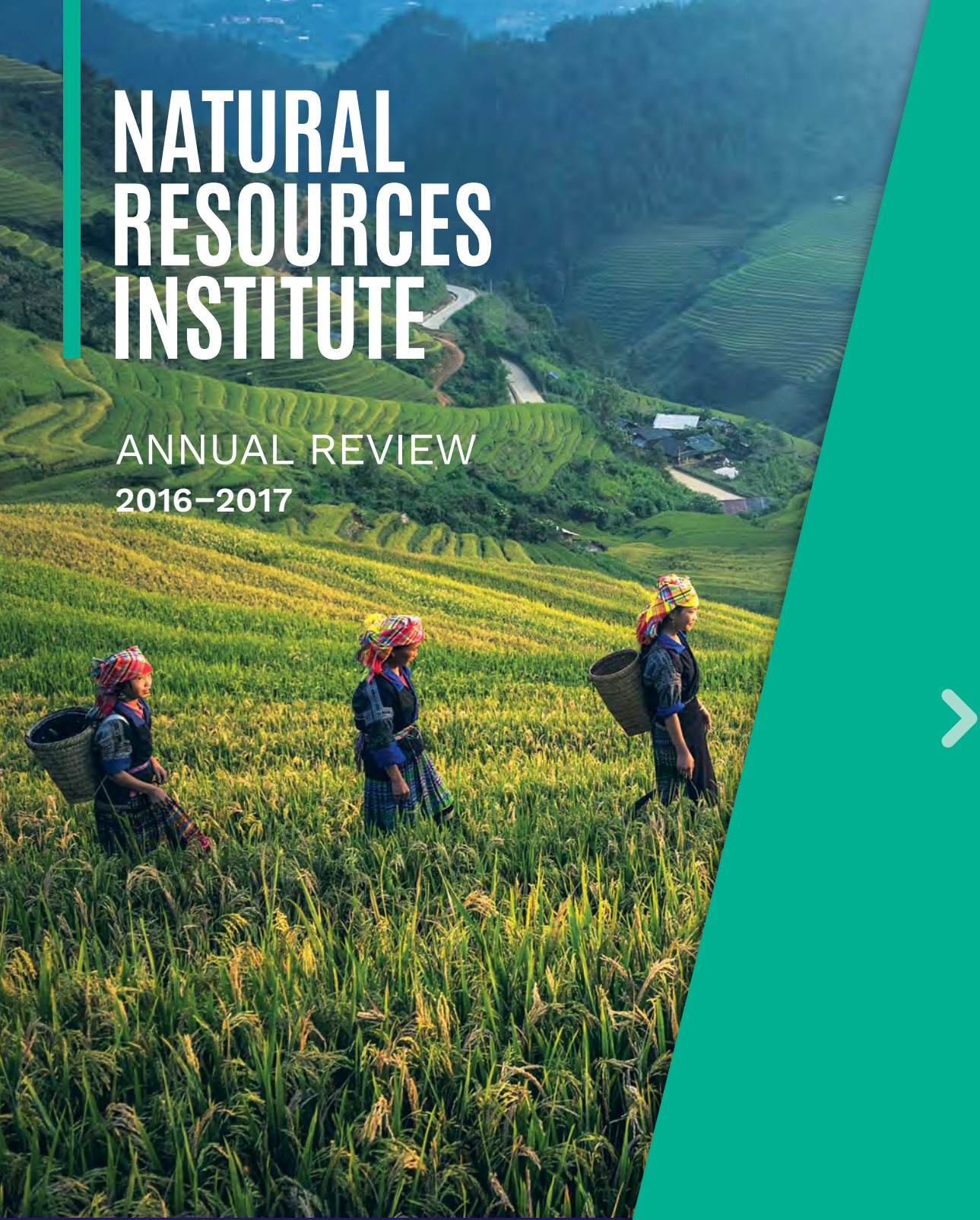

NATURAL RESOURCES INSTITUTE

ANNUAL REVIEW
2016–2017

Knowledge for a sustainable world

UNIVERSITY of GREENWICH

NRI | Natural Resources Institute

Annual Review 2016–2017

Transforming lives through world-class research, innovation and education

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

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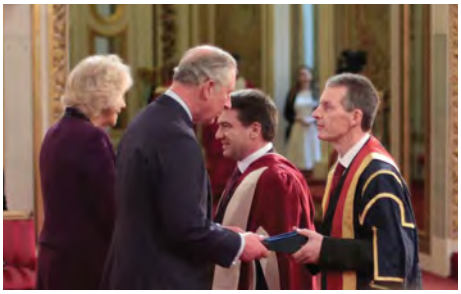


Vice Chancellor of the University of Greenwich, Professor David Maguire, and Director of NRI, Professor Andrew Westby, receive the Queen's Anniversary Prize scroll and medallion from the Duchess of Cornwall and Prince Charles at Buckingham Palace, February 2016

Foreword

Professor David Maguire, Vice Chancellor, University of Greenwich

We are enormously proud of our award-winning Natural Resources Institute. Since NRI became a part of the University of Greenwich in 1996, they have gone from strength to strength, consistently carrying out world-leading research that transforms lives. This year they were chosen to receive the highly competitive Rockefeller Foundation Cassava Innovation Challenge Award, building on the Queen's Anniversary Prize for Further and Higher Education awarded at Buckingham Palace in February 2016. This Annual Review shows how their research and teaching programmes are responding to global issues and illustrates how their approach echoes the University of Greenwich's core values of ambition, creativity, excellence, determination and inclusivity.

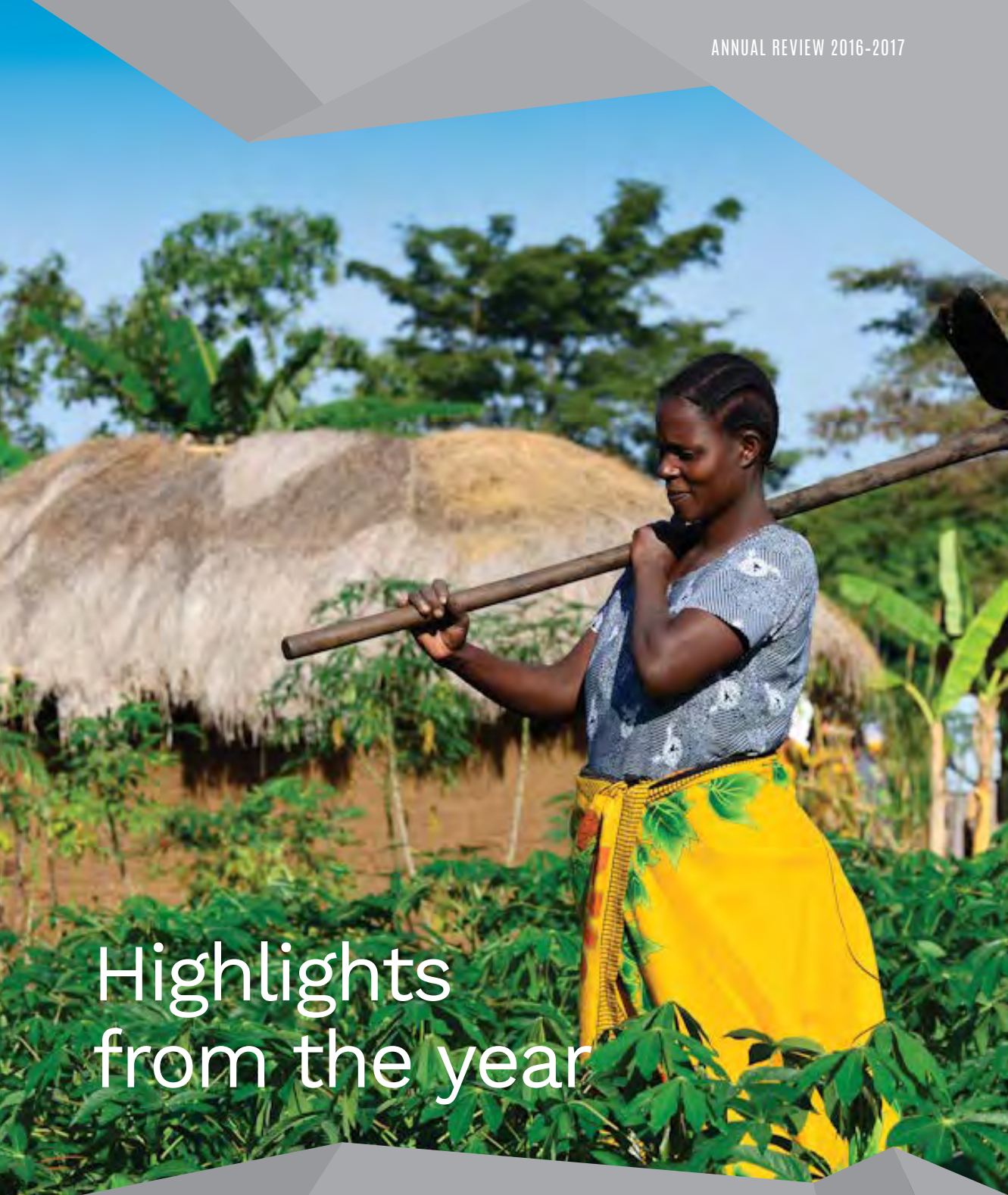
Introduction

Professor Andrew Westby, Director of NRI

I am pleased to present NRI's Annual Review, offering a snapshot of the work we do. Together with our international partners, we tackle the root causes of poverty to improve the lives of the world's poorest people, especially in smallholder communities in the developing world.

NRI's work addresses the globally agreed UN Sustainable Development Goals (SDGs), which set out a framework for all countries – from the poorest to the most industrialised – to focus interventions designed to protect the environment and improve lives. Our work underpins SDG 1 – End poverty, SDG 2 – End hunger, achieve food security and improved nutrition, and promote sustainable agriculture, SDG 5 – Achieve gender equality, SDG 8 – Decent work and economic growth, SDG 12 – Responsible production and consumption, SDG 13 – Combat climate change and its impacts, SDG 14 – Sustainable use of life below the water, and SDG 15 – Sustainable use of life on land.

Through our research, development work and teaching, we set out to inspire the next generation of scientists and researchers to solve global challenges through our research-led degree programmes at undergraduate and Master's levels, our post-graduate research programmes and our in-country capacity-building activities. Discover our work and join us in our mission.



Highlights from the year

Agriculture, food and nutrition

Better nutrition for a growing population is a major challenge of our time. However, to improve nutrition, more understanding is needed of patterns of consumption, dietary practices and food systems. By improving standards for collecting and measuring data and developing innovative methodologies for evaluating agriculture and food systems, scientists will be able to build a robust evidence base, which in turn will guide actions to improve nutrition. Current examples of NRI's work in this area are two projects carried out under the research initiative known as 'IMMANA' or 'Innovative Metrics and Methods for Agriculture and Nutrition Actions', funded with UK Aid from the UK government through the Department for International Development (DFID) and coordinated by the Leverhulme Centre for Integrative Research on Agriculture and Health (LCIRAH).

Using ICTs to measure the impact of agricultural technologies on women's time use and mother and child nutrition

Author: Kate Wellard

Around 150 million people living in sub-Saharan Africa were food insecure in 2015, and over one-third of children were stunted. The international community, through the UN Sustainable Development Goals (SDGs), has pledged to end hunger, achieve food security and improved nutrition and promote sustainable agriculture. This has led to calls to make agricultural projects more nutrition sensitive.

The availability of women's time to care for children plus their ability to influence how household income is spent – including on nutritious foods – are known to be important factors in improved nutrition. But a lack of tools to accurately measure women's time use and maternal and child dietary practices is hampering design of effective nutrition-sensitive interventions.

NRI researchers, Dr Kate Wellard, Jan Priebe and Dr Lora Forsythe, are working with the London School of Hygiene and Tropical Medicine (LSTHM) and the Africa Innovations Institute (AfrII) to test new digital tools and metrics. Life-logging GPS-linked wearable cameras and computerised Interactive Voice-Response Diaries via mobile phone are being trialled with women in Eastern Uganda. These will be assessed against traditional recall and direct observation methods.

The project will also develop a framework for assessing the positive and negative impacts of alternative nutrition-sensitive interventions, such as production and consumption of nutritious foods, and labour-saving technologies.

> **The international community, through the UN Sustainable Development Goals (SDGs), has pledged to end hunger**

NUTRI-P-LOSS

Author: Aurélie Bechoff

Do not bin your nutrients!

How much of the food produced or bought by people around the world ends up in the bin? Vast amounts, according to the Food and Agriculture Organization of the United Nations (FAO), which estimates that one third of all food produced is lost or wasted. As the world population continues to grow, finding ways to reduce food wastage is becoming increasingly critical.

We need to save food – but how? Mapping the losses is an important first step. Through the 'NUTRI-P-LOSS' project, a team of international researchers is improving understanding of where nutrients are lost along the food chain, led by NRI's Dr Aurélie Bechoff. "We have selected key crops including sweet potato, cowpea and maize, and key nutrients such as protein, fat, carbohydrate, vitamin A, iron and zinc, in low- and middle-income countries, and we will predict the nutrient loss in the food chain, from harvest to market," says Dr Bechoff. "We are working in Uganda and Zimbabwe, where food security is a real problem. Reducing nutrient losses in the production of food could potentially have a significant impact on people's health there."

> **We need to save food – but how?**

Food can be lost or wasted for a number of reasons including unsanitary conditions, rotting, physical damage during transportation and insect infestation during storage. "One aspect we are looking at is how the presence of insects could affect food nutrient composition. For example, we want to know if insects consume the protein and carbohydrate elements of stored food in equal amounts, or if they selectively eat some parts of the grain and hence reduce those elements in unequal amounts."

Insects, pests, and human and plant 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 two examples that show how our work is exploring the crucial role of pollinators in our agriculture and food systems, and how we are developing innovative ways to control mosquitoes that pose a threat to human welfare.

Bumbleplus: training bees with caffeine for better harvests

Author: Sarah Arnold

Bumblebees are often the 'poster insects' for conservation awareness – and it's easy to see why. They're cute, fluffy, and, together with other insects and birds, they pollinate 75 percent of crops. Their role in global ecosystems is crucial, with a whole food chain depending on the small creatures whose sustenance comes from plants they've pollinated.

The 'pollination services' they provide are especially important for fruits, nuts and vegetables. As demand grows, pollinators are critical to ensuring continuing and increased sustainable food production, but there are numerous challenges. NRI's Professor Phil Stevenson, Dr Sarah Arnold, Professor Steve Belmain and Dr Jan-Hendrik Dudenhöffer are working on various projects to understand the behaviour and ecology of pollinators and to improve pollination services in the UK and overseas.

'Bumbleplus' is an innovative new project at NRI funded by the Biotechnology and Biological Sciences Research Council (BBSRC). It aims to improve pollination in UK fruit crops. Most soft fruit pollination in the UK is supplemented from commercially reared bumblebee colonies, but the bees from these colonies may abandon the crop to forage elsewhere, leading to poor pollination and low-quality fruit for farmers to sell. The Bumbleplus project is studying ways of using caffeine to train the bees to build a strong memory of the floral odour, improve their foraging focus and increase yields. In collaboration with horticultural research institute NIAB EMR, UK cooperative Berry Gardens Growers, and bumblebee producer Biobest, NRI is carrying out laboratory and field trials to develop this technology and quantify the benefits to farmers. The pollination team also works on smallholder low-output agriculture in Africa and the Caribbean to establish ways of managing landscapes to support healthy pollination populations as part of multifunctional landscapes and to increase production sustainably.

> **Pollinators are critical to ensuring continuing and increased sustainable food production**

Mosquito control: beating them at their own game!

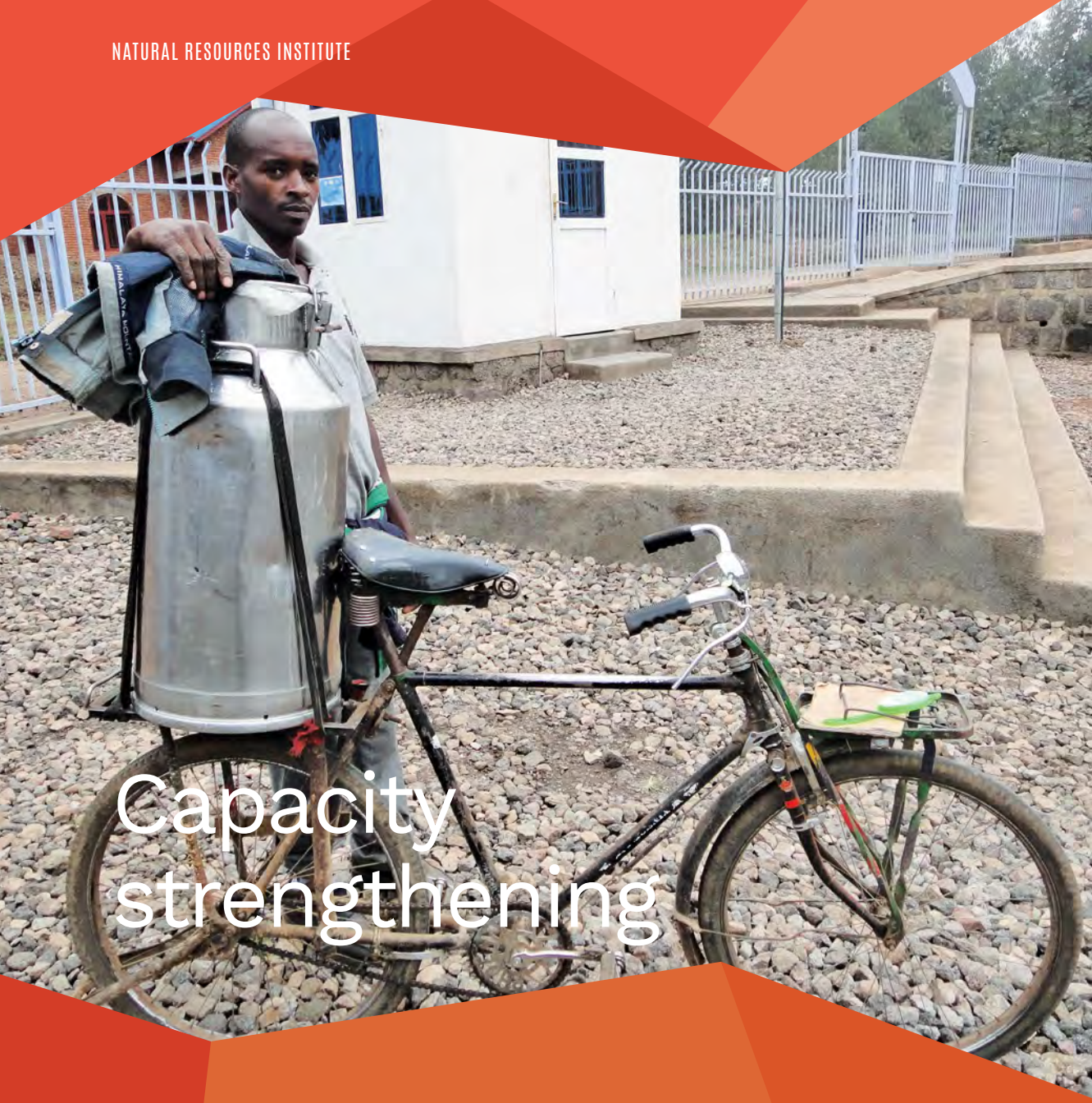
Author: Gabriella Gibson

Diseases associated with mosquitoes, such as malaria and dengue fever, kill more than 460,000 people every year, and cause an even greater number to be so badly affected by disease that they cannot contribute to the health and well-being of their families. Most control measures are based on insecticides that are expensive for the poor and can have harmful effects on humans and their environment. Dr Frances Hawkes and Professor Gabriella Gibson, medical entomologists at NRI, set out to beat the mosquito by exploiting its notoriously deadly habitat of blood-feeding on humans.

Not all mosquito species bite humans, and those that don't bite us pose no threat to our welfare. In fact, these species have very important roles in natural ecosystems: they are the favoured food of aquatic fauna, such as fish and amphibians, and the adults are preyed upon by bats and birds.

The mosquito species that primarily bite humans, however, are responsible for the transmission of deadly pathogens, such as malaria parasites and dengue viruses, from infected people to those who are healthy. Dr Hawkes and Professor Gibson have developed a mosquito trap that is so similar to a human from the mosquito's perspective, that it should be possible to capture and kill mosquitoes before they feed on real humans. Laboratory studies established that the optimal combination of human-like cues consisted of human body odour emanating from a warm object about the size and shape of a person sitting cross-legged on the ground.

Successful field studies in collaboration with colleagues in Burkina Faso (Dr RK Dabiré, Institut de Recherche en Sciences de la Santé – IRSS), and in Benin and Cameroon (Dr R Djouaka, International Institute of Tropical Agriculture – IITA), have shown that this 'Host Decoy Trap' can catch more than ten times as many mosquitoes as the next best alternative trap. This research project, funded by the Medical Research Council, includes collaboration with Biogents AG, a company that has commercialised a range of devices dealing with insect vector-borne diseases. The ultimate aim is to increase the accuracy of surveillance traps and to provide user-friendly, cost-effective means of controlling mosquito populations that pose a risk to human health and well-being.



Capacity strengthening

NRI recognises that strengthening the capacity of individuals and organisations in low-income countries, especially in Africa, is fundamental for lasting development impact and to achieve the Sustainable Development Goals. Researchers and other stakeholders in smallholder agricultural systems need new skills to work together effectively, to engage in high-quality demand-led research and learning, and to deliver innovative solutions to promote sustainable development – especially in the face of climate change. Policy makers and civil society organisations require enhanced capacity to demand, evaluate and utilise evidence so that impact is achieved. This section includes a selection of NRI's activities in this field.

Capacity development for climate change researchers comes full CIRCLE

Author: John Morton

Climate change is arguably the most critical issue of our time. Africa is experiencing and will experience some of the worst impacts, on agriculture, the environment, human health and the livelihoods of both rural and urban people. But African researchers have not until now been able to make a contribution to scientific knowledge on climate change that fully matches either their potential or the seriousness of the impacts their countries face.

Against this backdrop, NRI's Professor John Morton has been leading the Quality Support Component of the DFID-funded programme 'Climate Impact Research Capacity and Leadership Enhancement', or CIRCLE. This innovative programme funds African early-career researchers, known as 'CIRCLE Visiting Fellows' or CVFs, working on various aspects of climate change, to spend a year at another African university or research institution. It is managed by the Association of Commonwealth Universities and the African Academy of Sciences and currently works with over 30 institutions in 10 African countries.

Together with our partners at University College London and the London School of Hygiene & Tropical Medicine, NRI adds an additional layer of support to this south-south exchange by identifying and contracting senior international researchers to interact by email with the CVFs, in particular on research design and on plans for disseminating research findings. These 'Specialist Advisers' have been drawn from universities and institutions from India, Norway, Spain, Turkey, the UK and the CGIAR system. Thirteen NRI staff members have served as Specialist Advisers for around 50 CVFs who come from countries including Ethiopia, Ghana, Kenya, Nigeria, South Africa, Sudan, Uganda, Tanzania and Zimbabwe. They have researched topics including local perceptions of climate change, agroforestry as a climate response, climate change and insurance, and the impacts of climate change on specific crops including maize, groundnuts, cocoyams and pineapples. The Specialist Advisers have successfully helped the CVFs to design and implement their research and publish in journals including Regional Environmental Change, Climate Risk Management, Agriculture and Food Security, and Weather and Climate Extremes.

Capacity Development for Agricultural Innovation Systems: CDAIS

Author: Claire Coote

In the face of climate change, innovative agricultural sectors are critical for increasing productivity whilst safeguarding the natural environment. Meeting such a challenge requires the engagement of the whole network of actors involved in improving agriculture, rather than approaching the challenge one sector or group at a time. This multi-stakeholder network of actors and institutions is known as the agricultural innovation system. To that end, CDAIS, an EU-funded global partnership on 'Capacity Development for Agricultural Innovation Systems', aims to make agricultural innovation systems more efficient and sustainable in meeting the demands of farmers, agri-business and consumers.

NRI is participating in CDAIS as a member of Agrinatura – a grouping of European universities and research organisations supporting agricultural development – which is co-implementing the project with the Food and Agriculture Organization of the United Nations (FAO). The project is testing an approach devised for the Tropical Agriculture Platform, a multilateral mechanism established by the G20 to boost agricultural innovation in tropical countries. Crucially, the approach operates at the individual, organisational and policy level and focuses on the strengthening of functional (soft) skills such as communication, collaboration, partnering, negotiation and advocacy, to accompany the essential technical skills on which so many other development programmes focus.

NRI is responsible for supporting activities in two of the eight pilot countries – Bangladesh and Rwanda – where several multi-stakeholder innovation partnerships known as 'niches' have been identified. Each is supported by specially trained national innovation facilitators who conduct capacity needs assessments (CNA) and facilitate coaching plans that focus on developing the capacities to work together to innovate.

Crucially, the approach operates at the individual, organisational and policy level and focuses on the strengthening of functional (soft) skills

Piloting the CDAIS approach in Bangladesh and Rwanda

Authors: Hans Dobson and Claire Coote

In Bangladesh, the CNA with fish stakeholder groups in Mymensingh district identified key capacities needed to support collective learning and adaptation to the numerous opportunities and challenges.

"I was impressed with the innovative approach of CDAIS in bringing together fish farmers and organisations that support us and providing opportunities to participate, learn together and formulate joint solutions. We hope this will usher in new horizons for marginal fish farmers to collaborate with stakeholders, and will surely help in successful implementation and achievement of our vision to increase profitable production and exports." Ritish Pandit, fish farmer and hatchery owner, Mymensingh, Bangladesh.

In Rwanda where innovation platforms are a more common feature in the agricultural sector and research and extension more closely integrated, the concept of innovation systems has appeared in national strategy documents and policies, yet the technology transfer model still predominates in practice.

In November 2016, a CDAIS CNA of a community milk processing centre started a process that has seen clear changes in less than a year. The Burera dairy was selected as one of the country's 'innovation niche partnerships', and the assessment, workshop and associated training allowed participants to better understand the value chain, the issues, problems, and possible solutions. Now, Burera dairy is moving forward, and quickly. This is due in large part to CDAIS activities at different levels, and the important role played by the national innovation facilitators.

> **I was impressed with the innovative approach of CDAIS**

"With CDAIS, I have learnt that for an improved and well-functioning milk value chain, we must build managerial 'soft' skills," said Jean de Dieu Nizeyimbabazi, Burera District Director of the Ministry of Agriculture and Natural Resources. "Before this project, whenever I saw a development partner I thought 'okay, they have brought machines or will help us build a milk factory'. But during the capacity needs analysis, we came up with doable action plans to help stakeholders work better together and that helped us get involved in the IFAD-funded Rwanda Dairy Development Project (RDDP) which provides the complementary technical skills."

Commonwealth Scholars solving development challenges

Author: Claire Coote

The Commonwealth Scholarship Commission in the UK (CSC) is responsible for managing the UK's contribution to the Commonwealth Scholarship and Fellowship Plan, an international programme under which member governments offer scholarships and fellowships to citizens of other Commonwealth countries. The CSC in the UK awards over 800 scholarships and fellowships for postgraduate study and professional development to Commonwealth citizens each year.

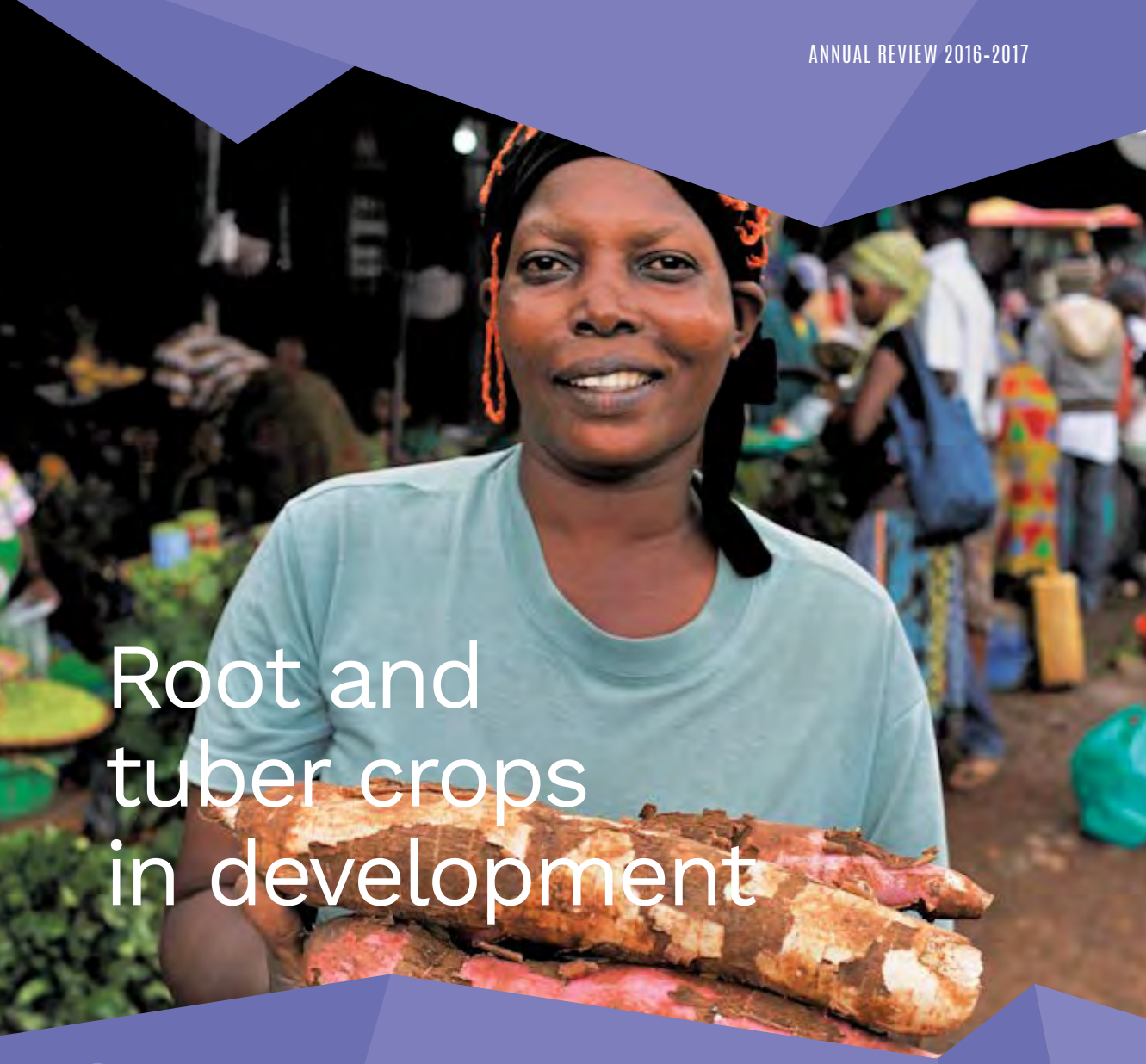
In 2017, NRI delivered training to 54 CSC-sponsored PhD Scholars with the aim of improving their capacity to use their academic training for development impact.

The Scholars, from a wide range of countries and disciplines, participated in two-day residential training courses at Cumberland Lodge in Windsor Great Park, Berkshire, during which they explored development challenges and opportunities and how they could play a part in addressing them.

"Our Development Training Module provides Scholars with a mix of learning methods, from individual presentations to group work and case studies and alternative ways to communicate ideas, which help them to reflect on development, the Sustainable Development Goals and how they could focus their research and practice towards the issues raised," explains NRI's Claire Coote, who led the course, along with NRI colleagues, Julie Crenn and Dr Baqir Lalani. "Presentations encourage discussion, participation and reflection. An important, additional outcome of the training is networking between the Scholars."

An example of feedback from the Scholars illustrates their experience. One said: "I learnt that there are many right ways to solving problems. My group looked at artisanal gold mining in Nigeria. If, prior to the workshop, I was asked to recommend a solution to the practice, bearing in mind the problems emanating from it, I would have suggested that the miners be asked to stop. However, from interacting with others during the workshop, I learnt that another way, in fact a better solution, is to 'formalise' the practice."

Commonwealth Scholarships and Fellowships for developing Commonwealth country scholars in the UK are funded by the Department for International Development, in conjunction with UK universities.



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 expansion of production and delivery at scale to processors and markets; root and tuber crops 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 undertake world-leading 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. This snapshot of our work looks at achievements in overcoming emergent diseases threatening crop production, adding value through processing and business development, and developing postharvest technologies.

African cassava whitefly: outbreak causes and sustainable solutions

John Colvin & the African Cassava Whitefly Project Team

In the field, cassava is vulnerable to attack by pests such as African cassava whitefly (*Bemisia tabaci*), which transmit devastating diseases including Cassava Mosaic Disease (CMD) and Cassava Brown Streak Disease (CBSD). When in high numbers, these can literally suck the plants dry. The diseases affect over 200 million smallholder farmers in east and central Africa, where they cause annual losses of over US$ 700 million. This causes serious hardship for the farming families who rely on cassava for their daily food and income.

The African Cassava Whitefly Project (ACWP), led by NRI and funded by the Bill & Melinda Gates Foundation, is investigating the causes of whitefly outbreaks in east and central Africa, with the long-term goal of developing sustainable control solutions which will also help to prevent future pandemics of CMD and CBSD. The research is identifying sources of resistance to whitefly which can be incorporated into improved cassava planting material for distribution to farmers and furthering the understanding of the genetics of the whitefly in order to exploit its vulnerabilities.

Some key ACWP discoveries and achievements are that:

- there are at least three species of *B. tabaci* whitefly that colonise African cassava
- promising African cassava genotypes possessing both whitefly and virus-disease resistance have been identified
- Latin American cassava genotypes with whitefly resistance have been identified and the resistance genes will be of great value to Africa
- at the cassava genome level, potential whitefly resistance genes have been located on a chromosome
- an African cassava whitefly genome has been generated and some critical genes for the survival of the pest which can be silenced via RNA interference (RNAi) have been identified
- six genes of *B. tabaci* have been silenced in insects that were feeding on plants that expressed the molecular components necessary for RNAi
- a gross margin analysis has been completed that demonstrates the urgent need for new whitefly control technologies.

The increased understanding we have gained of the importance of cassava whitefly in plant-disease pandemics places us in an excellent position to develop novel, robust and long-term solutions to these pest and disease problems that continue to cause food insecurity in sub-Saharan Africa.

Yam viral diseases: the next generation of on-farm diagnostic kits

Author: Sue Seal

Yams are large, starchy tubers that are a popular food source in Africa and Asia. In West Africa especially, yams play a paramount role in food and nutrition security and income generation for more than 60 million people and form an important part of cultural life.

Yams (*Dioscorea spp.*) are generally propagated vegetatively through their tubers, which leads to perpetuation and accumulation of tuber-borne pathogens. The economically important diseases are caused by viruses, and the only effective method of controlling these virus diseases is to use virus-free planting material. The scarcity and associated high expense of such material has been identified as one of the most important critical constraints to increasing yam production and productivity in West Africa.

> **...the only effective method of controlling these virus diseases is to use virus-free planting material**

The Bill & Melinda Gates Foundation has been addressing this need by supporting the supply of high-quality breeder and foundation seeds, and promoting a seed yam certification system to support the production and sustainable supply of high-quality seed yams through farmer seed growers and commercial seed entrepreneurs.

At NRI, Dr Gonçalo Silva is developing on-farm diagnostic kits for yam viral diseases to enable this certification in the field. The team has been discovering and characterising viruses using next-generation sequencing (NGS) and classic molecular tools in order to develop the kits. NGS is assisting also with the understanding of badnaviruses, a genus of viruses affecting plants that can potentially result in decreased yield. Badnaviruses pose a potential long-term threat to virus-free yam lines, as their genetic information can be found hidden ('integrated') in the host genome and these yam lines can therefore not be 'cleaned'. Dr Moritz Bömer is developing methods to distinguish integrated sequences from the true viruses affecting yam yields. A range of diagnostic tests have now been developed and the next step is to evaluate them under field conditions in West and East Africa.

Postharvest innovations, partnerships and technology: transforming cassava in Africa

Author: Ben Bennett

Cassava is a globally important food source for some of the most impoverished people in the world. Unfortunately, while it is easy to grow and resilient to drought, there are two big problems: it can contain potentially harmful levels of cyanogenic compounds and, once taken from the ground, it deteriorates at an alarming rate, becoming inedible in 72 hours. These two postharvest challenges have been at the heart of NRI's research and practice for the past 20-plus years and our achievements in the field, including the Queen's Anniversary Prize for Further and Higher Education in 2015, largely relate to some of the solutions we have developed.

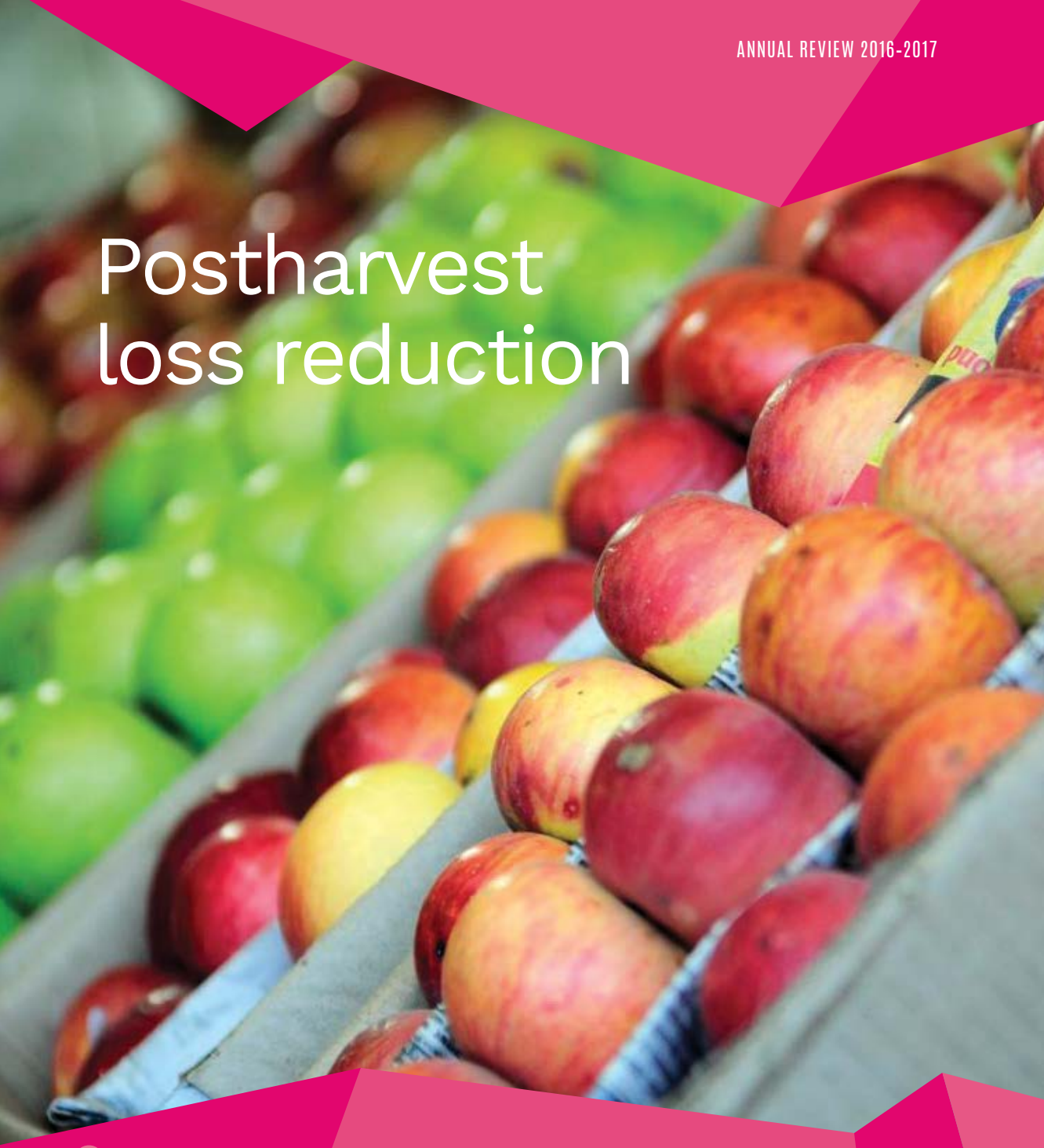
With our partners across Africa, we have been rolling out High Quality Cassava Flour (HQCF), a cheaply derived and safe food-grade intermediate product for a range of different industries like baking, paperboard manufacture and aquaculture feed. Allied to improved small-scale drying technologies and better farmer-organised processing businesses, HQCF producers are opening new markets for small-scale cassava farmers. NRI works on HQCF in Ghana, Malawi, Nigeria, Tanzania and Uganda, through projects like 'Cassava: Adding Value for Africa' (C:AVA) and its successor, C:AVA II, funded by the Bill & Melinda Gates Foundation.

NRI's latest innovation, the 'NRICassavaBag', addresses the challenge of fresh cassava's short shelf-life. With support from the Rockefeller Foundation and working with the Federal University of Agriculture in Abeokuta, Nigeria, NRI is testing and scaling methods to double shelf-life using locally available polypropylene bags.

Through innovation and partnerships like these, NRI is transforming the world of preserving and developing food products for small-scale agriculture.

NRI's latest innovation, the 'NRICassavaBag', addresses the challenge of fresh cassava's short shelf-life

Postharvest loss reduction



Postharvest losses refer to losses in food crops on their way from harvest to market, and include wasted agricultural inputs that were invested in growing the food and any pollution or carbon dioxide released during the process. NRI has been working to reduce losses and waste after harvest since the food crisis of the 1970s. Our postharvest teams use their experience, technical insight and capability to devise solutions to postharvest loss through innovative technologies, strategies and information systems.

Developing technologies to reduce losses during fruit storage

Author: Debbie Rees

Many of us will have observed how fruit, such as apples and pears, can go bad within a few days or weeks after harvest. But it is possible to store fresh produce for many months using a combination of low temperature and atmospheric modification, as low oxygen slows down deterioration. NRI scientists are working with equipment manufacturers and major fruit growers in Kent to develop the next generation of intelligent systems for long-term storage of fruit. As part of this initiative, NRI has set up 'The Produce Quality Centre', a postharvest research centre housed at NIAB EMR, a horticultural research institute located at East Malling in Kent. The University of Greenwich recently made a major investment to expand the facilities and support the work on handling of perishable fruit and vegetables.

One example of postharvest technology is the 'SafePod system' which can monitor the metabolic state of fruit during storage to optimise the storage conditions, and also to predict how long the fruit can be stored before the quality deteriorates. The system has been built by Storage Control Systems (SCS) Ltd, a company based in Paddock Wood, Kent. NRI has been working with SCS to improve the equipment design and develop protocols for fruit assessment. As well as enabling apple growers to store fruit for longer and reducing the risk of expensive store failures, the technology has great potential to improve storage during sea freight. This will reduce losses during global transport of fruit and vegetables and allow some produce to be transported by sea rather than air, thereby reducing the production of greenhouse gases.

> **NRI scientists are working with equipment manufacturers and major fruit growers in Kent**

Using information systems and Information and Communications Technologies (ICTs) to combat postharvest losses

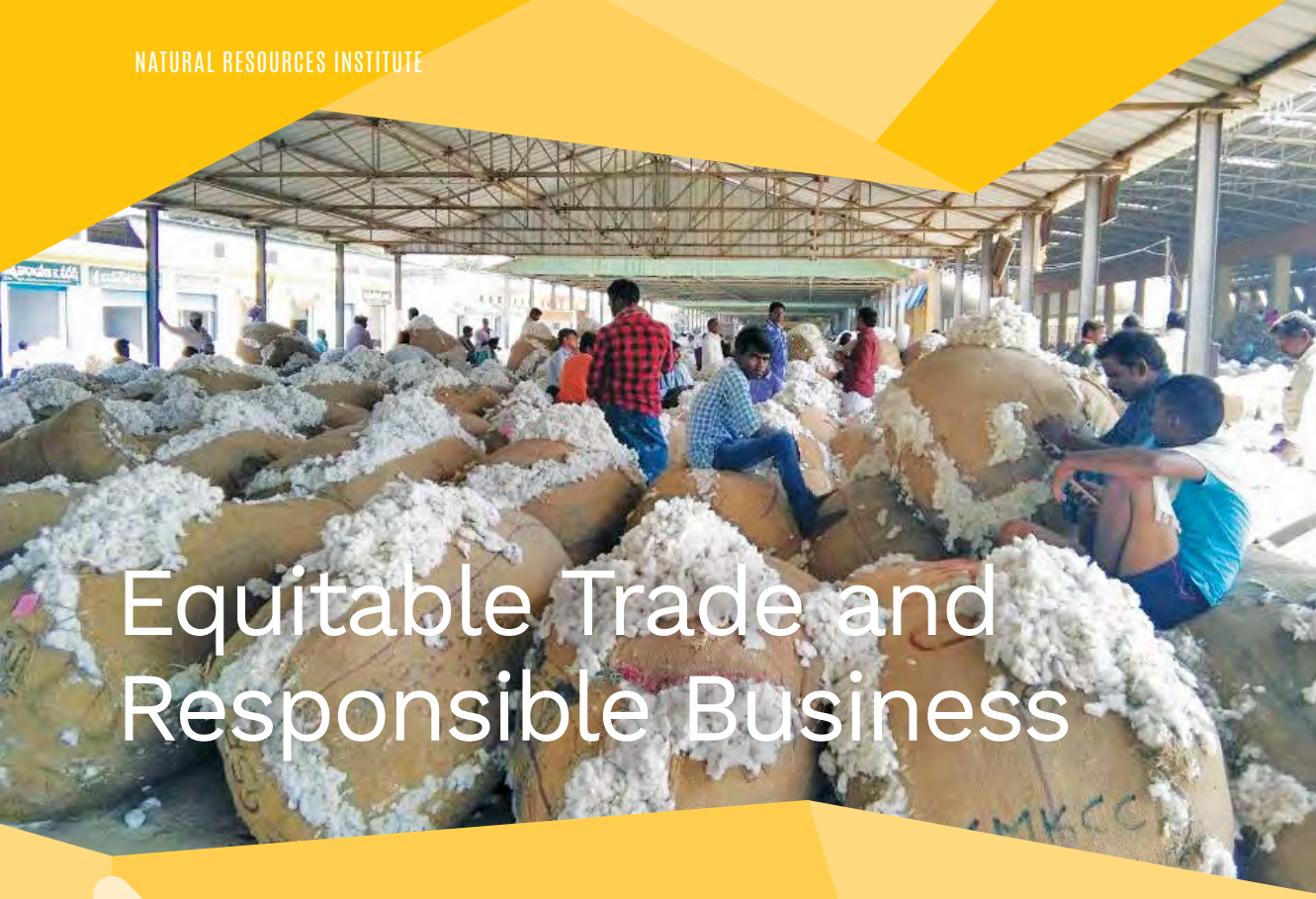
Author: Jan Priebe

A key inefficiency in agricultural systems is that crops lose weight and quality at the time of harvest and at subsequent stages in the postharvest chain. These physical losses deprive smallholders of food and sales, reduce food security by decreasing supply and increasing crop prices, and compromise the sustainability of the agricultural system due to the loss of inputs used in cultivation of the crop. To realise the full value of harvested and marketed outputs, it is therefore essential to reduce postharvest losses.

Reliable data on these losses are essential for the decision making that leads to investment in loss-reduction programmes. Yet for developing countries, such data are scarce; consequently there is little indication of what impact these losses have on smallholder productivity and welfare. In 2010, NRI and partners developed the 'African Postharvest Losses Information System' (APHLIS) to remedy this situation for cereal grains. APHLIS makes estimates of cereal grain postharvest weight losses (PHLs) for sub-Saharan Africa that are displayed as interactive maps and tables openly available online. APHLIS does this by combining seasonal data from local postharvest experts with loss figures derived from scientific literature.

Started in 2015, APHLIS+ is a five-year project, funded by the Bill & Melinda Gates Foundation, which will expand the current system by providing estimates for additional crop groups – roots, tubers, bananas, and legumes – adding nutritional and financial metrics, and early warnings for aflatoxin risk and larger grain borer outbreaks. A major collaborative effort of international postharvest experts led by the NRI, APHLIS+ aims to develop APHLIS into the recognised industry standard for postharvest loss estimation.

> **Reliable data on these losses are essential for decision making**



Equitable Trade and Responsible Business

Since the late 1990s, NRI staff working in this area have been analysing trade for development and responsible business in developing and emerging economies, contributing to applied knowledge and practice and influencing policy. Our work has identified the strengths and limitations of sustainability standards in tackling poverty and fostering environmental sustainability. Sustainability standards are sets of criteria defining good social and environmental practices in an industry or product. They are voluntary, usually third party-assessed and are used by producers, companies, governments, financial institutions and consumers. Our findings are informing wider thinking about the impacts of these product standards and on the need for complementary or alternative measures, including more intensive, integrated programming in specific localities.

We lead complex programme evaluations of new sustainable business initiatives funded by DFID, including Partnerships for Forests (P4F), the Responsible Accountable and Transparent Enterprise (RATE) programme, and the global component of Innovative Ventures and Technologies for Development (INVENT). The insights and experience garnered from these evaluation activities are combined with academic research to advance understanding and practice on sustainable trade and responsible enterprise. NRI also conducts extensive work on value chain analysis and development, producing knowledge on the contribution of value chains to inclusive economic growth and social and environmental sustainability. This knowledge contributes to enhanced project design and management, policy dialogue and decision making on value chains investment, operations and accountability.

Generating insights and evidence from sustainable trade and responsible business initiatives

Author: Valerie Nelson

The Trade and Global Value Chains Initiative (TGVCI). NRI's Valerie Nelson has been leading the independent Monitoring and Evaluation of the DFID catalytic fund, TGVCI, from 2013–2017. The programme was implemented in the horticulture sector in Kenya and South Africa, and in the ready-made garments sector in Bangladesh; it was intended to improve the lives, working conditions and skill levels of workers in value chains, leading to poverty reduction, long-term profitability and sustainability of supply chains. The main mechanism was through 'social upgrading', or investment in improving access to better work and better conditions at work, leading to economic upgrading.

The NRI team found that promising approaches include intensive coaching for unemployed youth, training for workers on technical, life and leadership skills, worker equity schemes, social dialogue processes and health interventions. Several of these approaches have enhanced workers' quality of employment, working conditions and health and have potential for wider uptake. The evaluation team noted the importance of integrating environmental issues and tackling strategic issues such as wages, housing, capacity strengthening and freedom of association in future similar interventions.

Assessing social, economic and environmental impacts of Voluntary Sustainability Standards in Cotton: This impact evaluation was commissioned by the sustainability standards organisation, ISEAL, and focused on the Better Cotton Initiative in Andhra Pradesh, India. The Better Cotton Standard System is a holistic approach to sustainable cotton production that covers all three pillars of sustainability: environmental, social and economic. The aim was to conduct an impact evaluation of pre-certification technical assistance and certification on previously uncertified smallholders. Working with three Indian partners, NRI's team, led by Ravinder Kumar, designed the evaluation using experimental approaches, and implemented the baseline and midline studies. The baseline produced insights into factors which can accelerate or hinder transformation of farmers' awareness into adoption of improved practices. It drew attention to the need to emphasise profitability as well as productivity and identified challenges to involving women in learning groups and meeting their information needs. Further constraints were high levels of illiteracy, indebtedness and conditions for hired labourers.

Value Chain Analysis for Development: analysing green beans in Kenya

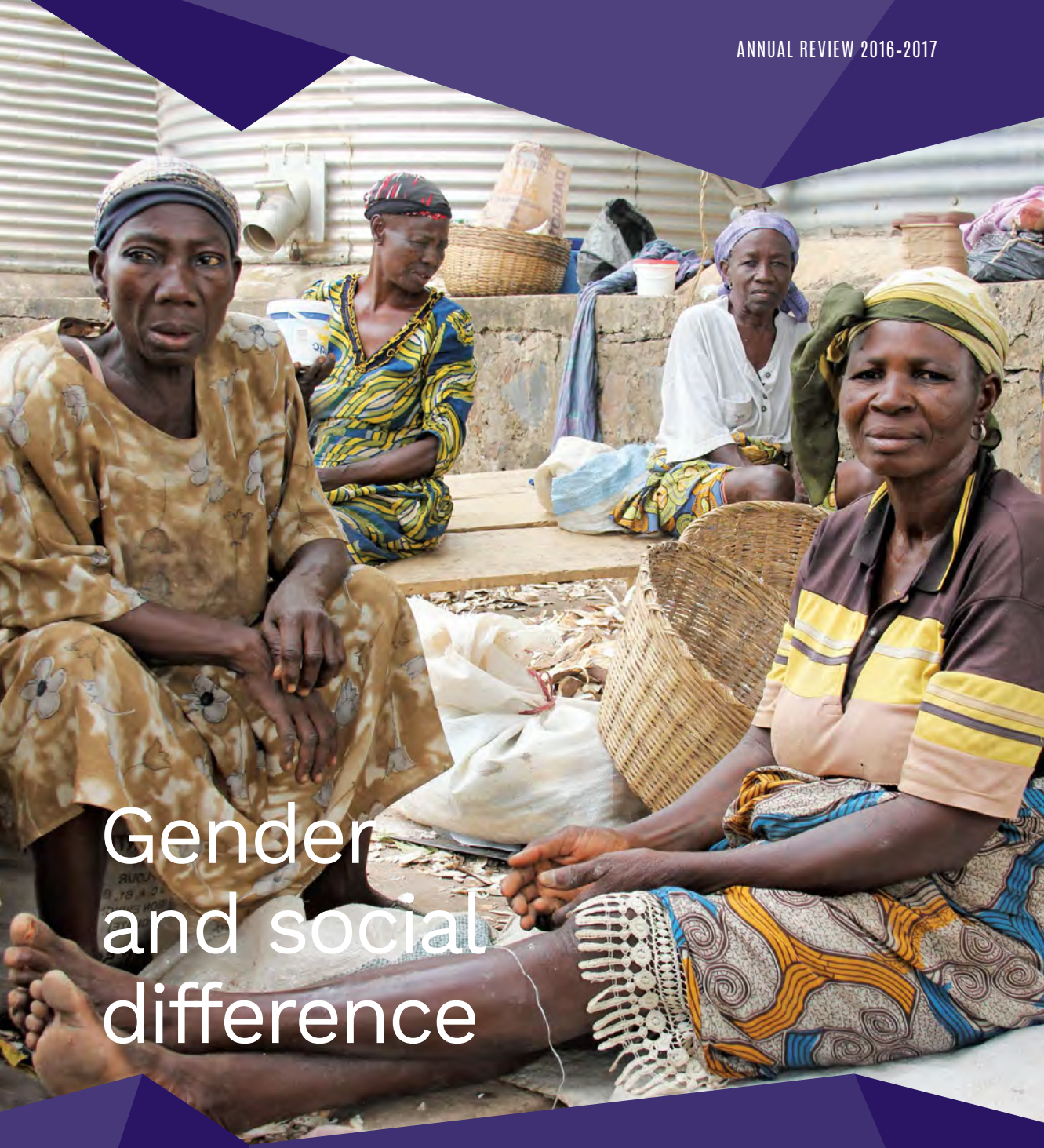
Author: Ulrich Kleih

Trade represents a huge opportunity for tackling poverty and generating wealth, yet poor and disadvantaged smallholders and workers face a range of challenges which prevent them from capturing benefits from trade.

Can agricultural value chain development generate economic growth, benefit the poor and be environmentally sustainable? This question is being explored in the Value Chain Analysis for Development (VCA4D) initiative, a series of value chain analyses implemented by a consortium of Agrinatura partner organisations, including NRI, as part of the European Union's Inclusive and Sustainable Value Chains and Food Fortification Programme. Ulrich Kleih, Marketing Economist at NRI, analysed the green bean value chain (VC) in Kenya, where green beans are almost exclusively produced for export. Major findings from this analysis include:

- The green bean VC is a major foreign exchange earner for Kenya, and a contributor to poverty reduction in that over 100,000 people are employed in the process, including smallholders, hired workers in production, packing and processing, brokers, wholesale traders, and retailers.
- The total value of exports from green beans is about US$ 82 million (of which US$ 13 million are for imported goods and services), and about US$ 9 million of value addition are generated by domestic marketing and consumption of green beans.
- Environmental impacts arise from the export of green beans by air freight and from farm production affecting water availability and quality. Fresh green beans at the market gate had environmental impacts about twice those of canned green beans.
- The VC appears to be inclusive in terms of smallholder participation and workers' employment opportunities. Women make up about 80 percent of the workforce and their earnings provide them a degree of financial and decision-making independence. However, the majority of workers are employed on a casual or temporary basis, which affects employment terms and job security.

There is a risk of exporters reducing purchases from smallholders due to the transaction costs and the lack of control over production. There is a need therefore to support farmer group capacity development, governance and communications.



Gender and social difference

Our innovative and high-quality research and practice in gender and social difference aims to make a demonstrable impact by 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.

Impacts of cassava commercialisation on smallholders: changes in poverty, gender relations and food security

Author: Lora Forsythe

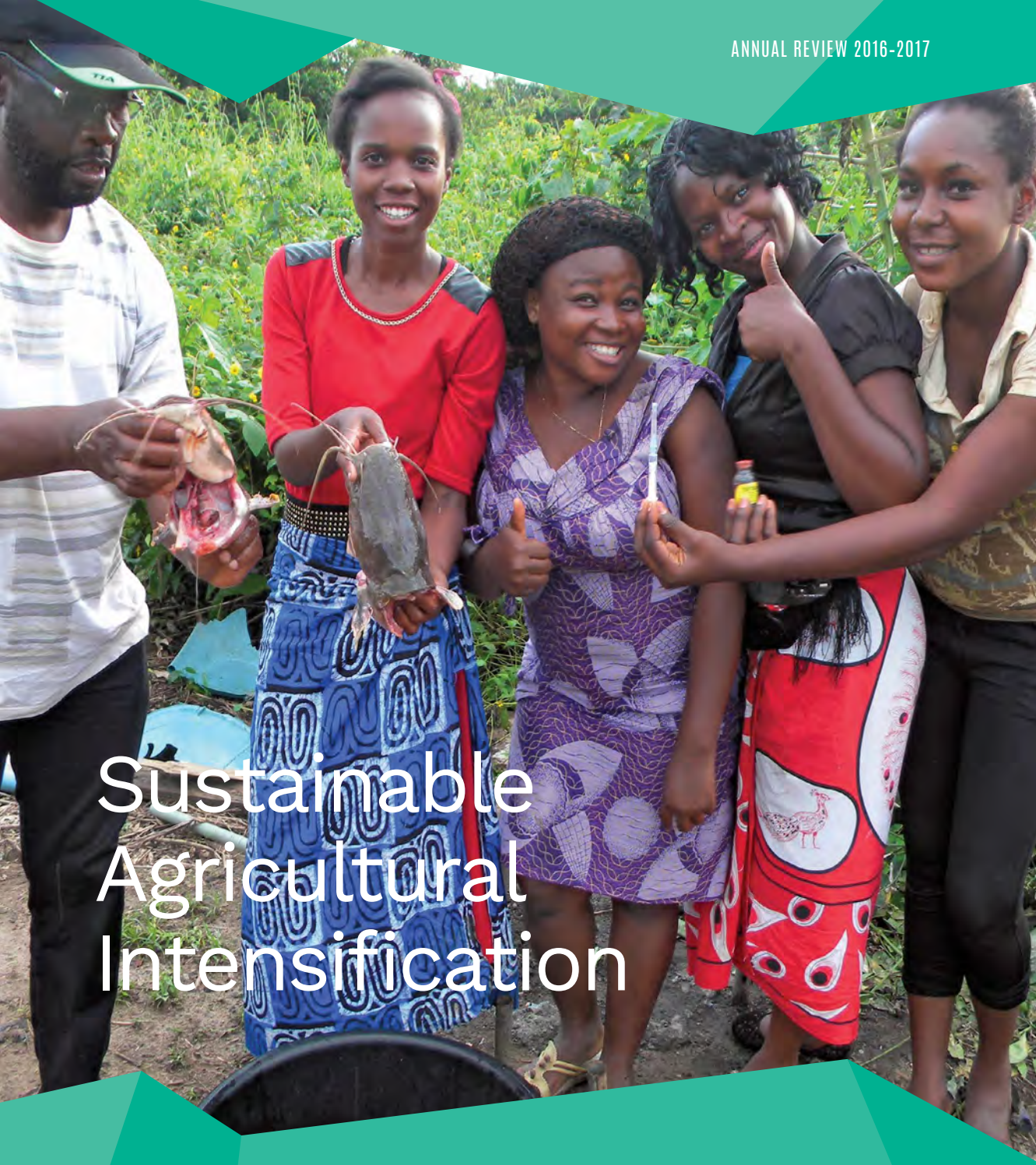
At NRI, we understand that inequality is a result of powerful social norms, stereotypes and power relations that influence attitudes and behaviour. Over the past three decades working with our Northern and Southern partners, we have built up extensive experience in development and empowerment pathways that focus on equitable processes and outcomes in development. These approaches place capabilities, dialogue and accountability at the centre of our work.

Recent NRI research under the broad theme of gender and social difference explores whether staple crop commercialisation can work for the poor. Focussing specifically on the commercialisation of cassava in sub-Saharan Africa, the research investigates how smallholders, particularly women, are involved in cassava commercialisation and the resulting livelihood outcomes, with case studies from Malawi and Nigeria.

This work partially supports the claim in development narratives, that smallholders who commercialise often acquire more income, and that it is spent on food, education, healthcare and small assets that contribute to household resilience. However, the transformative power of cassava commercialisation to reduce poverty is limited due to uncertain economic and environmental contexts. Certain cassava value chains, particularly industrial markets, can pose greater risks for food-insecure smallholders, especially if sales divert cassava away from household consumption. There are also different opportunities for men and women. Some markets, particularly those involving community-level cassava processing, provide space where women can benefit. However, constraints on women's agency, the social conditions of access to assets, and responsibilities for food security, limit women's ability to respond to new market opportunities and participate in more formal cassava value chains.

The outcomes of this research have important implications for international development thinking and practice, where contemporary narratives promote staple crop commercialisation as the pathway to change.

This work was part of the Cassava: Adding Value for Africa (C:AVA) project funded by the Bill & Melinda Gates Foundation.



Sustainable Agricultural Intensification

Increasing agricultural productivity in agriculture and aquaculture in Africa is essential to feeding a fast-growing population, but also has the potential to lift rural families out of poverty. NRI's work in Sustainable Agricultural Intensification (SAI) examines efforts to increase productivity while maintaining environmental sustainability, keeping in mind that implications for social equity need to be closely monitored.

Aquaculture in Africa - Unlocking the potential

Author: John Linton

The demand for fish as food continues to grow as global populations increase. This is particularly so in Africa where it is expected that populations will grow at a greater rate than elsewhere and where fish is a major source of proteins and micronutrients for the poor.

Global supply from capture fisheries, estimated at 92.6 million tonnes per annum (FAO 2017), is not likely to increase significantly. Any major increase will have to come from aquaculture. Today, half of all fish eaten is farmed, whereas twenty years ago, only one in ten fish eaten was farmed. Yet despite demand, aquaculture in Africa produces less than 3 percent of globally farmed fish.

Working in partnership with researchers from China, Ghana, Malawi and Nigeria, NRI led a study of success factors in aquaculture to see if these could be replicated to encourage rapid growth of aquaculture in Africa. The research was funded by a DFID project, AgriTT, which ended in 2017. The main findings were:

- **A demonstrably viable business model is key to success** – in Nigeria, aquaculture is seen as aspirational and smallholder farmers are eager to become cooperative members because of its visible success.
- **Committed individuals drive successful farms** – they are professional, dedicated and passionate about aquaculture; farms are well managed and profitable, and actors in the value chain seek knowledge and innovation and develop a voice.
- **Location is important** – in Nigeria, China and Ghana, productive activities are clustered in areas of high population and demand, but not in Malawi.
- **Value chain governance is critical** – including access to inputs, market intelligence, research linked to innovation, value addition and demand-driven extension. Driving factors are professionalism and public–private partnerships based on commitment to achieving mutual goals.
- **A responsive and supportive public sector** – an enabling environment that promotes sustainable, transparent growth, ensures the quality of inputs, and works closely with the private sector.

Sustainable Agricultural Intensification Research and Learning in Africa - SAIRLA

Author: Jeremy Haggar

The SAIRLA programme (2015–2020) funded by the UK's Department for International Development (DFID) supports research and social learning to inform decision makers in policy and investment processes as to what works to improve the access to and benefits from SAI by poorer smallholders, especially women and youth.

The programme has contracted eight research projects working across six countries: Burkina Faso, Ethiopia, Ghana, Malawi, Tanzania and Zambia. The programme is addressing three broad themes by developing evidence and tools focused on:

1. **Improving equity of outcomes from SAI**, particularly across gender and generations
2. **Managing the social, economic and environmental trade-offs** in selection of SAI agronomic practices, intensification of livestock value chains, and social differentiation of trade-offs
3. **Improving the supply of and demand for agricultural services** through the use of ICTs to increase access to agronomic knowledge, inputs and markets for smallholders.

To facilitate social learning between researchers, decision makers and other stakeholders around the above themes, we have established a **SAIRLA Learning Alliance**. National Learning Alliances (NLAs) have been established and key issues identified within each theme which respond to country priorities and are informed by the research projects. An Africa-wide International Learning Alliance on SAI is being established between the projects and NLAs to widen the social learning through engagement with international actors in agricultural development.

Taking part in Ghana's NLA is Dr. Mrs. Mary Opoku Asiamah, Director of Women in Agriculture Development of Ghana's Ministry of Food and Agriculture, who commented: "Through SAIRLA, researchers will provide us with evidence and through this evidence we are going to generate information and then share this among decision makers [...] This information will allow us to increase production, but bearing in mind the trade-offs with the environment, using our scarce resources, managing them well and not having an effect upon our ecology or ecosystem and also improving the livelihoods and food security situation."

Land, rural institutions and governance

Ensuring secure land and property rights is fundamental to achieving the Sustainable Development Goals. NRI's work on land tenure and governance has scaled up significantly in the last year through leadership of two high-impact globally significant workstreams: DFID's LEGEND programme and work on land indicators for the UN Habitat's Global Land Tools Network (GLTN).

Farm risks – including exposure to climate events, difficulties in acquiring farm inputs, uncertain access to markets for farmers' produce, high price volatility and huge postharvest losses due to limited access to reliable storage and processing facilities – need to be managed in order to improve smallholders' livelihoods. NRI's work in managing farm risks through the FARMAF programme involves advising on the reform of policy and regulatory frameworks to assure the sustainability of risk management tools.

Land matters at NRI: getting governance right through LEGEND and land indicators

Author: Julian Quan

Imagine waking up one day to find a forestry company destroying your vegetable garden, planting eucalyptus trees outside your house, or demarcating a huge plot of land adjacent to your village, occupying fallow fields and grazing land for your family's and neighbours' cattle. These scenarios can occur anywhere, with insecure land and property rights affecting millions of people, especially in the developing world. When crops and natural resources are the main source of people's diet or income, the problem is particularly acute. Current examples of NRI's work in this area include:

'Land: Enhancing Governance for Economic Development' or LEGEND is a DFID programme for which NRI's Dr Julian Quan is technical lead and principal coordinator, working with a wide range of global partners. Focussing on innovations to help African countries including Mozambique, Sierra Leone and Tanzania to implement globally agreed voluntary guidelines on governance of land and natural resource tenure, LEGEND aims to enhance the benefits and mitigate the risks to rural communities and small farmers of expanding private business investments in land and agriculture, and to reduce the huge financial and reputational risks companies themselves face in failing to recognise people's existing land rights and engage effectively with local communities.

In addition, Dr Quan's ongoing work for the **UN Habitat's Global Land Tools Network (GLTN)** together with NRI Monitoring and Evaluation specialist, Ravinder Kumar, is helping to develop and apply globally agreed land indicators to measure tenure security of women, men, rural, urban and indigenous communities across the world, and to build capacity of National Statistics Organisations to gather and report on data gathered from the people themselves.

With LEGEND's support and the energy and commitment of a growing network of global partners linking global policy, investment planning and business practice to land rights protection for grass roots communities, global efforts to get land governance right to help feed the world and protect the environment are now gathering strength.

LEGEND's UK consortium comprises the Overseas Development Institute (ODI), the International Institute for Environment and Development (IIED), NRI, and KPMG as the overall management agent.

Managing farm risks in Africa: lessons from FARMAF

Author: Gideon Onumah

FARMAF or the 'Farm Risk Management for Africa' project was set up to promote and facilitate enhanced access to innovative agricultural risk management (ARM) tools and methods in the farm sector in Africa. Led by NRI's Dr Gideon Onumah, FARMAF ran from 2011–2016 and was implemented by Agrinatura-EEIG in partnership with eight African farmers' organisations at national, regional and continental levels. Funded by the European Union and Agrinatura, FARMAF was implemented in Burkina Faso, Tanzania, and Zambia, with the goal of transferring lessons learnt to other countries in sub-Saharan Africa.

One of FARMAF's unique design features was the lead role that national farmers' organisations (NFOs) played in prioritising and implementing actions to develop effective ARM tools in the three countries. The menu of ARM tools includes agricultural insurance, innovative marketing systems, market information systems, contracting and collective action. Evidence from FARMAF shows:

- Promoting a combination of ARM tools, rather than individual tools in isolation, enhances uptake, effectiveness and derived benefits to farmers.
- Over 175,000 smallholders benefited directly through better access to finance on competitive terms as well as obtaining higher producer margins. It is anticipated that as the ARM tools promoted are scaled up, over 3 million farmers in the three countries could benefit within 5–10 years.
- Uptake of crop insurance increases when it is bundled with production financing interlocked with secure marketing arrangements. It is important to assure sustainable provision of insurance by means of credible reinsurance or a calamity fund which can mitigate catastrophic risks.
- Structured output marketing systems developed around warehouse receipt systems (WRS) proved viable at commercial scale whilst being accessible to smallholders, for example in Tanzania, though disabling policies and regulations must be avoided.
- At the small scale, WRS or Warrantage, as it's known in Burkina Faso, also opened up access to remunerative markets for smallholders, significantly increasing household income. This occurred when a robustly enforced, trade-friendly quality assurance system was instituted.

These lessons are to be further shared through publication of policy briefs and peer-reviewed articles as well as through study visits and dissemination workshops by the farmers' organisations and Agrinatura.

Research-led teaching

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

Research-led teaching: snapshots from our programmes

Author: Claire Coote

In 2015, NRI added two undergraduate degree programmes to its portfolio – Geography, BSc Hons, and Environmental Science, BSc Hons, along with teaching on Biology, BSc/MBiol – which have provided further opportunities for students to benefit directly from our international social and natural science research. Dr Sarah Arnold, NRI Research Fellow in Insect Behaviour and Ecology, draws on her research in Tanzania to provide a subset of field survey data for biology students to plot a pollinator-plant network. They are then shown the whole dataset and asked to consider their results compared to what the experts found.

Chris Atkinson, Professor of Sustainable Agriculture, draws on his considerable research in optimising water use to control yield and crop quality in the water relationships and crop irrigation lectures for the MSc Agriculture for Sustainable Development's Agriculture and Crop Physiology course. Student feedback has highlighted the timeliness and usefulness of this research knowledge into practice dimension as an important, positive attribute of NRI MSc programmes.

> **In 2015, NRI added two undergraduate degree programmes to its portfolio**

Recent research for a local coffee company by NRI's Linda Nicolaides, food safety expert and programme leader of our new eLearning Food Safety and Quality Management (FSQM) programme, highlighted the likelihood of the formation of aflatoxin, a family of dangerous toxins found on food crops, in a delivery of beans which led to their rejection by the company. Food loss is a global concern and the costs for individual companies can be substantial. Students on the FSQM programme are now working on a case study of how to ensure such wastage is avoided. As a result of long-standing links with food industries, students have opportunities to visit wholesale and retail outlets and to find out first-hand about the challenges currently faced. Where possible, students are linked to companies to undertake research as part of their MSc project and can be taken on for internships and employment after graduating.

Annual Review story authors

- **Agriculture, food and nutrition**
  - Dr Kate Wellard, Principal Research Fellow – Natural Resource Management and Innovations
  - Dr Aurélie Bechoff, Research Fellow, Food Technologist
- **Insects, pests, and human and plant health**
  - Dr Sarah Arnold, Research Fellow – Insect Behaviour and Ecology
  - Professor Gabriella Gibson, Professor of Medical Entomology
- **Capacity Strengthening**
  - Professor John Morton, Professor of Development Anthropology
  - Claire Coote, Principal Scientist, Agricultural Economist
  - Hans Dobson, Principal Scientist, Pest Management Specialist
- **Roots and tuber crops in development**
  - Professor John Colvin, Professor of Entomology and Plant-Virus Epidemiology
  - Professor Susan Seal, Professor of Molecular Biology
  - Professor Ben Bennett, Professor of International Trade and Marketing Economics
- **Postharvest loss reduction**
  - Dr Debbie Rees, Principal Scientist, Reader in Plant Physiology
  - Jan Priebe, Research Fellow – ICT for Agriculture
- **Equitable Trade and Responsible Business**
  - Valerie Nelson, Reader in Rural Development; Social Development, Learning & Evaluation Specialist
  - Ulrich Kleih, Principal Scientist, Marketing Economist
- **Gender and social difference**
  - Dr Lora Forsythe, Senior Research Fellow, Gender and Livelihoods
- **Sustainable Agricultural Intensification**
  - John Linton, NRI Commercial Director
  - Professor Jeremy Haggar, Professor of Agroecology
- **Land, rural institutions and governance**
  - Dr Julian Quan, Principal Scientist: Land, Rural Institutions and Innovation
  - Dr Gideon Onumah, Principal Scientist, Agricultural Marketing and Finance Economist
- **Research-led teaching**
  - Claire Coote, Principal Scientist, Agricultural Economist

The NRI Team

NRI's team is made up of over 100 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's 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 our staff and their contact details, visit www.nri.org/about-us/alphabetical-staff-listing

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Adrienne Martin, Director of Programme Development

John Linton, Commercial Director

Dr John Orchard, Director of Postgraduate Research Studies

Dr Tim Chancellor, Director of Capacity Strengthening and Partnerships

Claire Coote, NRI Teaching and Learning Leader

Professor John F Morton, Head of Livelihoods and Institutions Department

Dr Andy Frost, Head of Food and Markets Department

Professor Jeremy Haggar, Head of Agriculture, Health and Environment Department

Photo credits

Front cover: Rice terraces

Credit: Pixabay

Page 1: Farmer in her cassava field, Tanzania

Credit: N Palmer/CIAT

Page 2: Mama Pamela and her child, who are taking part in the IMMANA project testing ICTs (camera and phone) for data collection on time use and nutrition in rural smallholder farming communities in Uganda.

Credit: J Priebe

Page 5: Bottom left – *Bombus terrestris* on a strawberry flower

Credit: M Fountain

Top right – Close-up of a mosquito in the NRI lab

Credit: R Zipaj

Page 8: Milk transport in Rwanda

Credit: H Dobson

Page 13: Selling cassava in Kampala, Uganda

Credit: N Palmer/CIAT

Page 17: Apple market

Credit: N Palmer/CIAT

Page 20: Cotton is gathered before an online auction, Adoni Market yard, Adoni, Kurnool District, India.

Credit: S Reddy

Page 23: Female cassava peelers in Odogbolu, Ogun State, Nigeria

Credit: L Forsythe

Page 25: Malawian fish farmers at a Nigerian catfish farm

Credit J Linton

Page 28: Maize field in Mozambique

Credit: N Palmer/CIAT

Page 31: Students on the BSc Environmental Science, BSc Geography and MBiol get a hands-on introduction to plant diversity surveys in Sorbas, southern Spain.

Credit: D Sikorska

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