

CONNECTED Network

Case for Support

Vision

A Sub-Saharan Africa where existing and emerging vector-borne plant diseases are swiftly detected, combatted and defeated using sustainable solutions, to ensure food security and reduce hunger and poverty for all in the region.

Our mission

Using research, training and networking to equip an international multidisciplinary network of researchers to lead the fight against insect-spread plant diseases that devastate crops in Sub-Saharan African countries, building capability and capacity in the region, and in so doing reducing poverty, malnutrition and food insecurity. Engaging policymakers, stakeholders and end-users to raise awareness and enable evidence-based decision-making for the benefit of those who need it most.

The need

The summary

- Crop diseases devastate staple food and cash crops in Sub-Saharan Africa, severely limiting food production and income
- This causes poverty, malnutrition and food insecurity, which in turn prevent economic and social development
- The situation is getting worse because of new challenges: the emergence and spread of new plant diseases and insect pests, climate change, growing populations, and resource limitations
- The approaches taken by policymakers and regulators can differ from country to country, yet these crop diseases know no boundaries
- For researchers and practitioners in the region very little training is available to help them battle these crop diseases

The detail

Crop losses

Plant vector-borne diseases (plant VBD) significantly constrain the production of staple and cash crops for smallholder farmers resulting in poverty and malnutrition, hampering economic and social development. Around 40% of all crops are lost to pest and disease, with annual losses of \$290 billion (FAO).

Vulnerability of Sub-Saharan Africa

The number of undernourished people is growing most rapidly in Sub-Saharan Africa: currently over 250 million people are undernourished in Africa. Sub-Saharan Africa is expected to see one of the

largest increases in extreme poverty, with 26 million more people living below the international poverty line as a result of the current pandemic (United Nations).

The impact on specific crops

Plant VBD affects a wide range of crops worldwide but the impact is felt most heavily on staple crops, including:

Cassava is a staple food for 800 million people worldwide and Africa's second most important staple. It is a vital energy source which can be planted and harvested throughout the year and kept in reserve for times of famine. Cassava grows in marginal soils with minimal inputs and thrives in environmental conditions where other crops fail. Productivity in East and Central Africa is devastated by cassava mosaic disease (CMD) and cassava brown streak disease (CBSD), caused by viruses transmitted by insect vectors such as *Bemisia tabaci*. These diseases can result in up to 100% crop failure with annual losses estimated at \$1 billion (IITA, 2014).

Yam is the preferred staple food for over 300 million people in West Africa, it has a high market value and is a major income source for smallholder farmers. 93% of world yam is produced in western Africa. Yam viruses such as yam mosaic virus which is spread by aphids, impact the number, size and weight of yam tubers resulting in average yield losses of 40% (Seka et al 2014).

Sweet potato is an excellent source of carbohydrate, protein, vitamins and minerals. Its root can be used as a low-cost substitute for bread and the leaves and shoots can also be eaten. Like cassava and yam it can be stored long-term in the ground until needed, giving valuable flexibility. Sweet potato virus disease, caused by a combined infection of 2 viruses carried by whitefly and aphids, causes up to 98% yield loss in east Africa (Gibson et al 1998).

Maize is the most important staple food crop in Eastern and Central Africa, particularly for smallholder subsistence farmers. Maize Streak disease, caused by Maize Streak Virus and spread by leafhoppers, can cause 100% yield loss. Maize Lethal Necrosis can also cause 100% yield losses and is caused by simultaneous infection of maize chlorotic mottle virus with one of several *Potyviridae*. It can be spread by various insect vectors including aphids, beetles, and thrips.

Agricultural systems

Agriculture is a primary driver of growth in many developing countries and there is a clear link between agricultural investment and economic development. Investing in agricultural research improves the lives of small holder farmers by providing food and income. Agricultural development also creates growth in manufacturing and service sectors through its links to urban consumers (World Bank, 2019). Plant health, in particular the requirement of citizens to report pest outbreaks and the improved online availability of phytosanitary information on plant pests and diseases, is one of the indicators used to measure success of national agricultural systems (World Bank, 2019). It is important to be able to survey, detect and diagnose disease and have research and learning capacity in place to develop and share optimal solutions to plant VBDs.

New challenges

Recent research has shown that plant VBDs are spreading globally, for example in CMD, previously found in Africa, India and Sri Lanka, has spread to Southeast Asia. First reported in Vietnam (Wang et al, Plant Disease 2015), the disease is currently spreading within Vietnam with disease symptoms suggesting transmission through both infected plant material and by the insect vector *Bemisia tabaci* (Minato et al 2019). This is of particular concern as cassava is grown by around 8 million small holder farmers as a staple crop across Southeast Asia (e.g. Vietnam, Myanmar, Laos, Cambodia, Thailand).

Cassava is also grown commercially as a bioenergy source and for industrial products such as starch supporting a \$5 billion export market in Southeast Asia (World Bank, 2015).

The impacts of climate change on global weather patterns are becoming clear to all of us with increasingly unpredictable droughts and flooding. These changes affect entire ecosystems, driving rapid and dramatic changes in insect vector and plant virus populations. This has a particularly devastating effect in developing countries where farmers often lack the financial means to combat or ameliorate these problems.

The beneficiaries

- Citizens of Sub-Saharan African countries, who need staple food crops to eat
- Subsistence and smallholder farmers in the region, who need to produce food crops to eat and sell
- Researchers who need to develop scientific solutions to combat plant diseases, and the institutions they work in
- Policymakers, regulatory authorities and other influential bodies in Sub-Saharan African countries

Our solution and next steps

CONNECTED seeks to use multidisciplinary working to solve problems of plant VBD across the developing world, bringing to bear the vast wealth of knowledge and experience already amassed within the Network.

1. To fund new innovative international multidisciplinary research projects and further develop the existing CONNECTED research portfolio into larger-scale activities for greater impact
2. Work in partnership with African institutions to co-produce training events, thereby sustainably embedding knowledge and experience in these institutions, consolidating and expanding our capacity building programme in Sub-Saharan Africa
3. To co-produce new training opportunities and resources for researchers
4. To develop African researchers to be future leaders in scientific innovation
5. To expand the CONNECTED Network to incorporate more end-users, policy makers, and funders, and into new geographical regions where the need is greatest

The detail

CONNECTED's unique multidisciplinary remit brings together and integrates expertise in entomology and plant pathology, both of which are key to tackling the challenges of plant VBD. We continue to expand and reinforce global north-south and south-south research relationships and information exchange between and beyond these disciplines. Early career researchers (ECRs) are our focus for skills development and sharing, creating an international cohort of future leaders, maximising the impact of our activities.

We will run a new pump prime funding research call, using input from our network members to identify and prioritise the current major research questions and challenges in plant VBD. We will continue to manage our research investment portfolio ensuring all projects contribute to our research priority areas and that a variety of diseases, crops, and insect vectors are represented. We will encourage and empower ECRs and researchers in the global south to assume leadership positions within our projects, and ensure that research is contributed by a geographically balanced array of international institutions. We will run an additional competition for follow-on funding for a small

number of PPF projects previously funded by CONNECTED. This will allow our most promising projects to take their research to the next level and generate impact 'on the ground' in developing economies.

We will refine and enhance our existing CONNECTED training opportunities and resources, co-producing new content and offerings. Having forged strong links with African research organisations, BecA-ILRI Hub (Kenya) and IITA-Ibadan (Nigeria) we will continue to partner with them to further co-develop and co-deliver our Introduction to Virus and Vector Diagnostics course and support these organisations in delivering their training mandate within national research frameworks across SSA countries. We will also co-produce a novel Train-the-Trainer programme to run alongside the diagnostic course, enabling African researchers to deliver the course in their home institutions. This will not only accelerate the capacity building possible from delivering this course; it will embed the world-leading expertise in plant VBD research and teaching from across the CONNECTED Network in these institutions. Working in this way with key African institutions will create 'clusters' of high capacity in interdisciplinary plant VBD research, training and teaching across African institutions.

We will continue to work in partnership with the Swedish University of Agricultural Sciences (SLU) to enable Africa-based ECRs to access world class immersive bioinformatics training. We will continue to run our successful Training Grant Scheme, enabling Africa-based researchers to complete bespoke educational visits that support their current and future research goals and expand their professional networks internationally.

Our website will continue to support Network members and PPF teams through the dissemination and sharing of information and resources including research protocols and training videos. We will continue to run campaigns that stimulate and encourage member engagement, discussion, and cross-fertilisation of ideas. We will also continue to train ECRs in communication skills that maximises their personal professional impact in networking and collaborating.

We will roll out a new training opportunity to springboard the best Africa-based early career researchers from postdoctoral researcher to independently-funded team leader through a targeted Scholars scheme that nurtures their research ideas and enhances their international collaborations. The programme will incorporate specific training and skills accumulation by attending courses with senior researchers and trainers in the field, through work shadowing and educational visits. The programme will not only enable these individuals to leap to the next level of their own career but to also facilitate progression of colleagues through both research and training capacity building in their home institutions. As such, this programme will result in a capacity building cascade of knowledge and skills.

We will seek to increase membership of target groups: specifically plant VBD end-users, policy makers and funders. This will enable better dialogue and collaboration between interdisciplinary plant VBD researchers and these groups to bring about changes in both farming practices on the ground and high-level decision making. We will continue to expand the CONNECTED Network membership internationally, focusing on Sub-Saharan but also opening up to other regions where the need is great. Given the success of our previous CONNECTED launch conferences in engaging new members and providing a platform upon which many new international PPF collaborations were founded, we will run another conference in the UK, inviting existing and future members from across Africa (and further afield). The conference will include workshops to identify the most pressing research questions, share best practice, and identify training needs from the community. We will run a further conference in Africa later in the project focusing on 'CONNECTED futures': capturing member input into the future direction of the Network with particular focus on development of our PPF research projects. Both events will bring researchers and funders together with National Plant Protection Organisation (NPPO) representatives to discuss the best approaches and funding strategies.

Throughout the life of the network, we will engage with our members through communications and surveys to capture our influence and impact alongside understanding our members changing needs in response to changes in local and global research and agriculture, and how we can support them with resources, information, and opportunities. This fits within our wider monitoring, learning and evaluation (MLE) framework, see below.

Philanthropic opportunity

A 4-year programme for CONNECTED includes the following elements and outcomes:

1. Funding the Network Team at University of Bristol: £250,000 per year, £1,000,000 total cost. Includes all staff salaries, overheads and general network running costs (such as the CONNECTED website)
2. Eight new PPF projects (4x6 month-long projects, £50,000 each; 4x12 month-long projects, £100,000 each) funded plus four existing PPF projects awarded follow-on funding (£50,000 each): £800,000
3. Two full international conferences for 50-100 delegates each: £100,000 each, £200,00 total cost
4. Two instances of our Virus and Vector Diagnostics course at BecA-ILRI, Kenya for 20 delegates: £30,000 each, £60,000 total cost
5. Two instances of our Virus and Vector Diagnostics course at IITA, Nigeria for 20 delegates: £30,000 each, £60,000 total cost
6. Two instances of our novel Train-the-Trainer course run in a hub-spoke model at BecA-ILRI and IITA: £30,000 each, £60,000 total cost
7. Two participants to attend field-leading bioinformatics course at the Swedish University of Agricultural Sciences (SLU) per year: £15,000 per year, £60,000 total cost
8. A cohort of 6 individuals visiting international research groups for educational visits, learning excellent techniques in plant VBD (Training Grant Scheme) per year: £80,000 total cost
9. Development and delivery of two new course offerings (e.g. insect chemical ecology, short course in plant VBD bioinformatics): £30,000 each, £60,000 total cost
10. New Network Member Resources and engagement activities including online training courses, infographics, educational animations, stakeholder workshops: £60,000 total cost.

Total cost: £2,540,000

Our track record

The summary

- The CONNECTED Network is unique, bringing together researchers in insect pests and plant disease, plant pathologists with entomologists, to develop innovative solutions
- In its first three years it developed a network of over 1,500 members, from more than 80 countries
- It is co-ordinated by a Management Board comprising global experts in plant virology, entomology and impact
- The CONNECTED Network has awarded 104 places on courses, investing over £150,000 in training
- It has quickly developed multi-disciplinary international partnerships
- It has a strong track record of delivery and innovation in:

- Research funding: CONNECTED has invested over £700,000 in novel, innovative research projects tackling plant VBD. This has created an interlinked portfolio of 20 pump-prime funded projects, each one a joint collaboration between African and UK researchers
- Training: new, interdisciplinary programmes delivered in-person and online, backed up with downloadable training materials to build research and teaching capacity
- New research collaborations, arising from its approach to its conferences and networking activities
- Resource provision for researchers: training materials and films, infographics
- Measuring impact

The detail

A unique approach

CONNECTED is unique in bringing together plant pathologists and entomologists to share knowledge of plant VBD problems and to develop innovative real-world solutions: we have created a 1500-strong worldwide network of researchers from over 80 countries. Traditionally plant pathology and entomology, despite both being crucial to tackling plant VBD, have been distinct disciplines with little natural cross-over. CONNECTED energised plant VBD research by bringing these two communities together within our Network, allowing new cross-fertilisation of ideas and development of innovative solutions to the intractable problems of plant VBD.

CONNECTED research projects, networking and training activities align with UN sustainable development goals and national mandates on agricultural research in Sub-Saharan Africa, and aim to inform best practice guidelines for National Plant Protection Organisations (NPPOs) and feed into government policy development.

Pump priming new research projects

CONNECTED has funded a portfolio of 20 novel, innovative pump prime funded (PPF) projects that represents an interlinked research programme operating in 14 countries, involving collaborations of 55 researchers in 34 institutions. All collaborations include partners from African countries on the OECD DAC list, demonstrating how CONNECTED directs its funding to promoting the economic development and welfare of developing countries. The research projects encompass 11 different crops, including orphan crops that are often neglected by large strategic research programmes yet are relied upon by many for food and income. The investment portfolio comprises projects that are interdisciplinary in nature and contribute to specific UK and international research priorities for vector-borne disease: 1) disease control strategies 2) vector biology 3) new diseases 4) vector-virus interactions and 5) diagnostics, surveillance, and forecasting. CONNECTED has promoted the role of Early Career Researchers (ECRs) in leadership positions in these projects, encouraging senior specialists to mentor junior researchers to give them valuable experience. In overcoming challenges associated with setting up operational collaborations between the UK and developing country-based institutions, the CONNECTED Team gained valuable insight into UK due diligence requirements and processes, which were fed into a novel toolkit being developed by University of Bristol RED to support GCRF projects.

More information on the CONNECTED research projects may be found [here](#).

Training activities

CONNECTED has co-designed and delivered three new, innovative interdisciplinary training courses for ECRs to prepare and empower the next generation of plant VBD researchers. CONNECTED has also worked in partnership to enable network members to access existing training courses that fill key

skills gaps. To date, CONNECTED has awarded over 100 places on training courses, almost all of which were to ECRs, with 32% to women. Delegates were from 18 different countries: Benin, Burundi, Cameroon, Democratic Republic of Congo, Ghana, India, Kenya, Mali, Nepal, Nigeria, Pakistan, Rwanda, South Africa, Tanzania, Uganda, UK, Zambia, Zimbabwe. The outcomes of these activities are new research capacities, skills, and practices are being applied by ECRs and network members in new and existing plant VBD research projects in Africa, and increased ECR career development and professional networking in the field of plant VBD. The impacts of these are enhanced Africa-based research capabilities in plant VBD results in more effective plant VBD research, contributing to better agricultural methods, products, and services that improve crop yield and reduce crop losses.

From January 2018 onwards CONNECTED awards places on training courses in a gender balanced way wherever possible.

Multi-disciplinary international partnerships

CONNECTED delivers added value by working within mutually beneficial, respectful multi-disciplinary international partnerships. Although based at University of Bristol, CONNECTED is a strong partnership with Newcastle University, synergising the experience and expertise of Network Directors [Prof Gary Foster](#) and [Prof Neil Boonham](#). CONNECTED is additionally guided by leadership from University of Bristol Cabot Institute. Through our expert Management Board, CONNECTED partners with the Biosciences East and Central Africa International Livestock Research Institute Hub (BecA-ILRI Hub) and the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria for the co-production and delivery of innovative interdisciplinary training courses for CONNECTED Network members. We also partner with the Swedish University of Agricultural Sciences (SLU) to award places to network members on their 9-week residential Bioinformatics course.

Theory of change, and evaluating the success and impact of CONNECTED

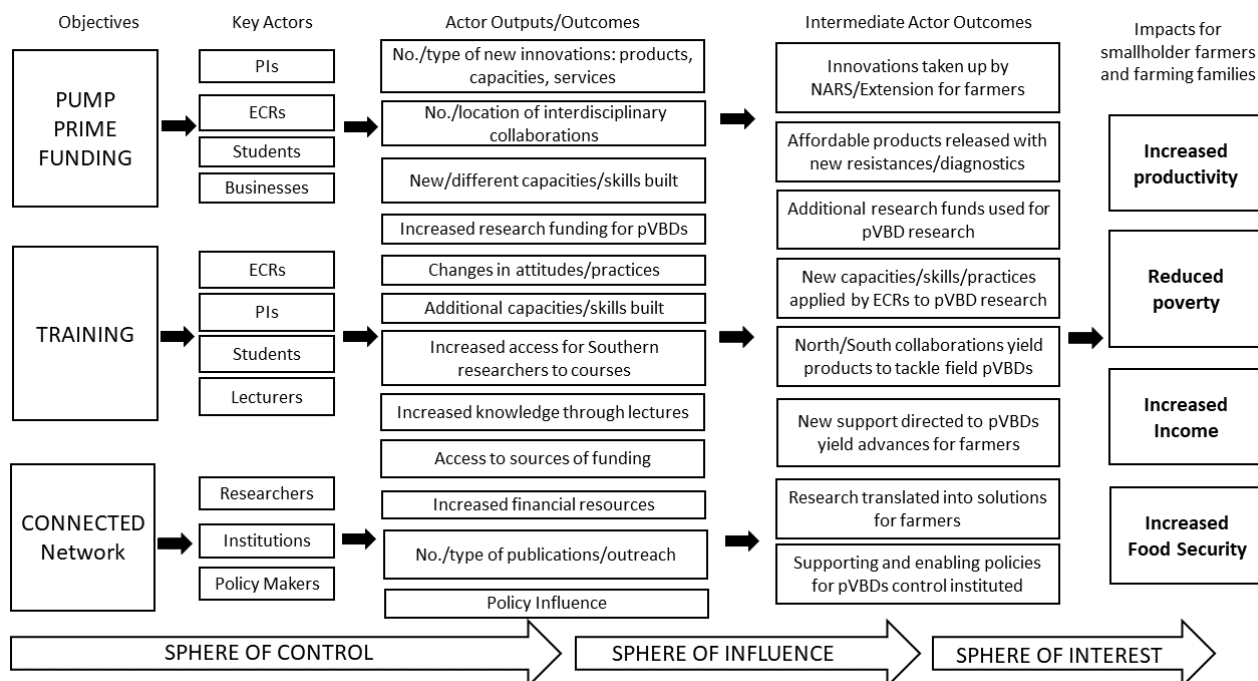


Figure 1: Actor Centered Linear Theory of Change for the CONNECTED Network

CONNECTED is guided by a theory of change that links core network activities with outputs and outcomes that lead to influence and ultimately impact for farmers and farming families in developing economies (Figure 1). Our theory of change utilises a monitoring, learning, and evaluation (MLE) system to track progress against objectives, ensuring our activities are fit for purpose and that they achieve influence and impact. The MLE system was developed harnessing expertise from our Management Board and from University of Bristol RED, and allows measurement of key performance indicators for delivering impact. Data is gathered through surveys for all training

activities/networking events: before a course, upon completion, and as a 6-month follow-up. We construct case studies of Network members who have benefitted significantly from CONNECTED resources. For PPF projects, MLE includes questionnaires to guide teams in capturing the benefits realized by their projects. For all PPF applications, we track who the investigators are: ECRs, country of origin, gender. We use network analysis to understand and respond to network composition, engagement and integration, e.g. how are ECRs, DAC-list, and female researchers integrated across our PPFs projects and how is our training supporting these individuals and project teams.

We integrate achieving impact into everything we do: we clearly link our objectives to activities to generate defined outputs and outcomes that will lead to influence and impact, evaluating progress as we go to refine our approaches. CONNECTED will continue to harness expertise from our MB, and University of Bristol RED and Cabot Institute to refine and enhance our MLE system.

Additional funding leveraged by the network

- *University of Bristol RED Global Impact Accelerator Account grant funding for BecA-ILRI: £23, 924*
- *BecA-ILRI waived lab access and various hospitality fees for Introduction to Virus and Vector Diagnostics course \$8,925 (£6,928)*
- *IITA Ibadan waived bench fees for Introduction to Virus and Vector Diagnostics \$5,000 (£3,975)*
- *Reduced course fees for 9-week bioinformatics course at Swedish Agricultural University for 2 Network members to attend in 2019 and 2020 £8,000*

Appendix

CONNECTED deliverables options for future funders

£100,000

- A 12 month* innovative research project pump prime funded, novel collaboration between the UK and Sub-Saharan Africa, and/or other DAC list and non-DAC list countries
- A cohort of 30+ individuals visiting UK research groups for educational visits, learning excellent techniques in plant VBD
- A full international conference
- Fully badged sponsorship of a two-week international residential training programme for early career researchers, including course fees, accommodation, travel and subsistence

£50,000

- A six month* innovative research project pump prime funded, novel collaboration between the UK and Sub-Saharan Africa, and/or other DAC list and non-DAC list countries
- A cohort of 15+ individuals visiting UK research groups for educational visits, learning excellent techniques in plant VBD
- Fully badged sponsorship of a 1-week residential training course for a cohort of 20 Early Career Researchers at one of our partner institutions in Africa (Beca-ILRI or IITA Ibadan)

£10,000

- Three individuals funded to conduct educational visits to UK research groups to further their career development and develop excellent skills in plant VBD research
- Two participants fully funded (travel, accommodation, subsistence, course fees) to attend field-leading bioinformatics course at the Swedish University of Agricultural Sciences (SLU) - a unique CONNECTED/SLU partnership
- Creation of two to three short educational videos, for use in presentations and lobbying, explaining elements of vector-borne plant disease to non-expert audiences, including decision-makers in the UK and Africa
- Creation of one novel, innovative online training offering for Early Career Researchers

£5,000

- Creation of a series of five infographics, highlighting key facts about crops, viruses & vectors, for use online (web, social media & video channels) and full-colour print for circulation at key plant science conferences
- Creation of one short educational animation in partnership with University of West of England
- Badged sponsorship of three stakeholder engagement workshops

*typical project duration, cost/duration varies according to research objectives