Darwin Plus Main & Strategic: Final Report

To be completed with reference to the "Project Reporting Information Note":
(https://darwinplus.org.uk/resources/information-notes/).

It is expected that this report will be a **maximum of 20 pages** in length, excluding Annexes.

Submission Deadline: no later than 3 months after agreed end date.

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Darwin Plus Project Information

Scheme (Main or Strategic)	Main
Project reference	DPLUS157
Project title	Managing the pathogens threatening St Helena's biodiversity and food security
Territory(ies)	St Helena
Lead Organisation	CABI
Project partner(s)	St Helena Research Institute (SHRI), Environment, Natural Resources and Planning Directorate (ENRP)
Darwin Plus Grant value	£ 265,440
Start/end date of project	16/09/2021- 31/03/2025
Project Leader name	Rob Reeder
Project website/Twitter/blog etc.	https://blog.cabi.org/2021/09/27/cabi-to-work-in-partnership-to-help-protect-st-helenas-biodiversity-and-enhance-its-agriculture/
Report author(s) and date	Rob Reeder, Norbert Maczey, Phil Taylor, Jayne Crozier, with contributions from Zac Bargo, Rebecca Cairns-Wicks, Elizabeth Clingham and Lisa Offord; 30 June 2025

1 Project Summary

This project aimed to investigate and identify pathogens contributing to the decline of St Helena's endemic tree species, reduced crop yields, and declines in endemic insect populations. Methods developed through CABI's Plantwise initiative were used to build capacity in plant health diagnostics and management, supporting growers, conservationists, and foresters. Identifying pathogens threatening keystone cloud forest species helped to understand and address the decline of the endemic ecosystem, reducing the risk of extinction for St Helena's unique flora and fauna. Identifying pathogens affecting crops has improved understanding of threats to food security and informed management practices that help boost self-sufficiency and reduce the need for food imports, particularly through better management of protected horticulture. The findings also contribute to biodiversity conservation and greater resilience to climate change. A key aspect of the project was building local capacity in disease identification and management through training and improved laboratory facilities. Extensive surveys revealed the scale of tree dieback, and one causal agent (Phytophthora kelmanii) responsible for the loss of at least one, and likely other, endemic tree species was identified. Additional surveys mapped the pathogen's current distribution on St Helena, which in turn informed an updated conservation strategy covering activities within St Helena's Peaks National Park and included training to improve production of disease-free tree seedlings, vital for future conservation efforts.

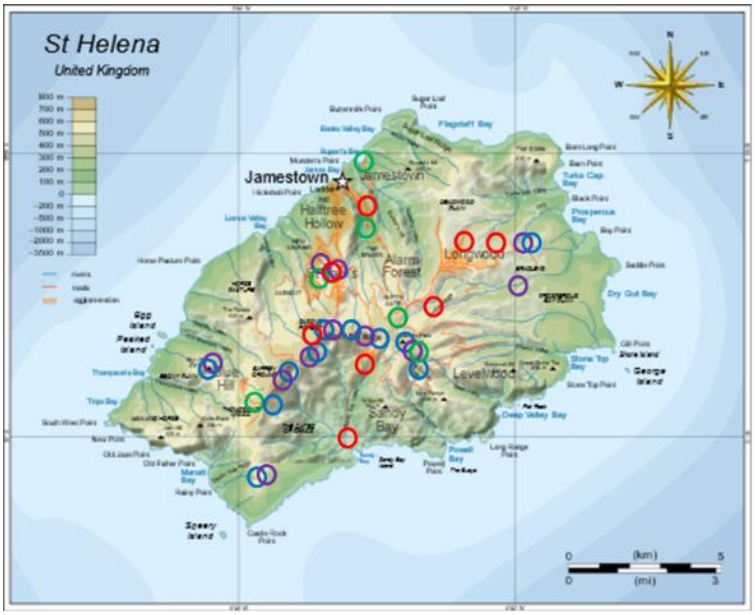


Figure 1: Map of St Helena showing the field sites visited by the project team between February 2022 and March 2025.

2 Project Partnerships

The main project partners were CABI (overall administrative management), Environment, Natural Resources and Planning Directorate (ENRP), St Helena Research Institute (SHRI) (coordination on St Helena) and the Birmingham Institute for Forest Research (BiFoR). Due to the island's remote location and limited accessibility, close collaboration between partners was crucial and was carried out remotely via e-mail and videoconferencing. These meetings were held on a 'needs' basis (20 zoom meetings undertaken during the project, plus briefings and debriefings in person during each site visit). The project team provided regular updates on the project, reviewed progress, addressed problems and developed solutions. The CABI team carried out 9 separate field trips to the island, providing an overall presence of CABI scientists for a total of 31 weeks. When CABI was off the island, it relied on partners to take forward activities, including monitoring progress and reporting back on results. Notably, staff from ENRP had, from an early stage in the project, taken the lead in monitoring disease incidence in the PNP and providing test plants for the pathogenicity experiments. One example of this collaboration was the establishment of a 'quarantine' shadehouse where the pathogenicity screenings could take place (Annexe 5.15). CABI outlined the necessary plans; ENRP facilitated the procurement of materials and oversaw the construction of the facility. The shadehouse allowed the pathogenicity testing and helped form a blueprint for improving protocols for the propagation facilities, to minimise the risk of pathogen spread in the nursery facilities. A major focus was the training of ENRP staff in various aspects of plant disease diagnosis and management. Staff from ENRP received training on isolation of pathogens and using the LAMP Genie II molecular tool for identifying *Phytophthora* species in infected plant materials and pure culture. In addition, project team members and those of the associated FCDO-funded Cloud Forest project based on St Helena (Rebecca Cairns-Wicks, Vanessa Thomas-Williams, Natasha Stevens, Liza Fowler), attended conferences in the UK and visited CEH, RSPB, BiFoR and CABI during their visits to the UK. The stakeholders included organizations involved in biodiversity conservation on St Helena. Other projects that complement the present one include 'Conserving St Helena's endemic invertebrates through invasive invertebrate control' (DPLUS104) and the FCDO-funded St Helena Cloud Forest Project (SHCFP), with the St Helena National Trust and RSPB being the main project partners. Collaboration between these projects began during the first visit and continued during the project. A joint task force, which met regularly (and included GBNNSS), was established as soon as it became clear that urgent phytosanitary measures were necessary to address the emerging threat from tree pathogens. Other important stakeholders were the local farmers and growers, as well as the wider public in St Helena. Field site visits and discussions with growers took place during five team visits. In 2022/23 the focus was on pathogen identification, but then shifted, in 2023/24, to disease management. The project consistently shared its results as widely as possible and actively encouraged all stakeholders to take part in planning and decision-making.

3 Project Achievements

3.1 Outputs

Output 1 Pathogens at the heart of emerging threats identified for the agricultural, forestry and environmental sectors.

There is surprisingly little public information available regarding existing records of plant pathogens on St Helena, including their pathways and impact. A review of existing literature including the digitised fungal records from the former 'International Mycological Institute' (IMI; now part of CABI) and CABI's 'Crop Protection Compendium' (CPC), yielded just 40 records but served as the starting point for the development of a database of St Helenian plant pathogens. During the project's first visit, the libraries of ENRP and Plantation House (seat of the governor) were searched for useful information. However, most information was in the form of advisory leaflets on pests and diseases, and, in general, this information was insufficiently specific (e.g. 'blight on tomato') to be added to the database. The first indicator, that at least 50 searchable records of pathogens and their hosts became accessible in a newly developed database, was achieved within the first year. The second indicator was that the number of records held in the database increased year on year, exceeding 300, by Y4 Q3. With a total of 431 records, at the time of writing, this target has been significantly exceeded. The visits to the island during the project have generated more than 60 samples identified from crop plants and more than 270 from endemic vegetation. Notable inclusions were an undescribed *Ramulariopsis* species on the endemic Jellico (*Berula bracteatum*) and a rust pathogen on Whitewood (*Petrobium arboreum*), which in all likelihood will turn out to be a previously undescribed new species co-evolved with, and specific to, its host. Numerous entomopathogenic fungi (EPF) have been collected and identified from endemic and introduced insects and spiders during two surveys. This includes 6 newly discovered species and brings the total of recorded EPF to 24 (details in Annexe 5.3). Due to the large number and variety of samples collected, it was not feasible to identify all isolates. Nonetheless, pure cultures of fungi are being deposited for long-term storage in the cryopreservation unit of the Genetic Resource Collection at CABI, ensuring they are accessible for future research. Representative isolates from known pathogenic genera were selected for molecular identification
The St Helena plant pathogen database (SHPPDB) greatly enhances our understanding of the pathogens present on the island. As a dynamic and ongoing resource, it will continue to evolve and expand after this project as new findings are made and documented. In addition to the original scope, a new tool introduced to the project in 2023 is a second database allowing precise mapping of individual endemic trees, their state of health and linkages to any pathogen isolated (Annexe 5.17). This new resource will be instrumental in monitoring the spread of pathogens in the coming years; it is hosted by the SHRI. Both databases will remain open for further records to be added, in case further historic/existing records are uncovered or additional ones are discovered in the future. Below (Figure 2) is a breakdown of the samples held in the database at the time of writing. The complete database is attached to this report as Annexe 5.1.

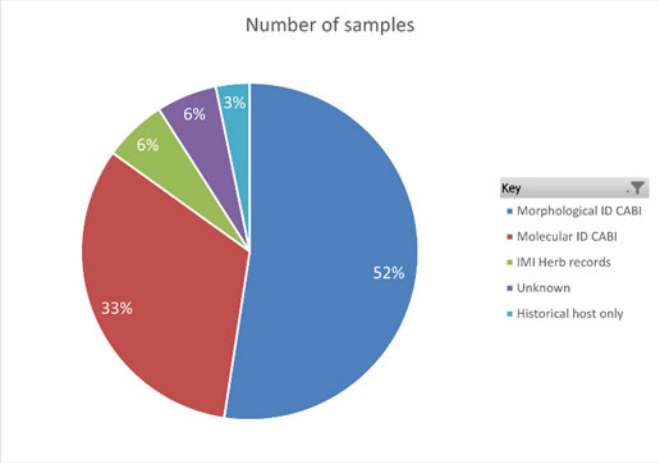


Figure2: Breakdown of plant and insect pathogens recorded from St Helena

Output 2. Current and future impact of plant pathogens on the peaks' cloud forest species and economically important crops assessed

2.1 Tree dieback. The situation for the dieback of endemic trees turned out to be rather complicated and, for reasons of clarity, we divide up our assessment into: *Tree and pathogen survey*, *pathogenicity testing*, *soil and water reservoir surveys* and *drone training*.

Tree and pathogen survey

The team visited the cloud forest in the PNP numerous times to assess and take samples from trees showing new signs of diseases and to cover areas where dieback had been newly observed. Throughout the project, more trees have started to decline or have died inside the PNP; Whitewood and She Cabbage (*Lachanodes arborea*) trees seemed to be particularly badly affected (see maps showing the assessed trees and associations with pathogens in Annexe 4.6). Sampling was extended to areas with occurrences of endemic trees, but which were outside the national park, including Peak Dale, the Millennium Forest and various living gene banks. Additional sampling focused on the 'George Benjamin's Arboretum' (GBA), where a significant number of trees have now succumbed to disease. A huge diversity of organisms has been isolated from the diseased plants, the vast majority of which are saprophytes or weak/opportunistic pathogens. The challenge was to identify, from this diverse assemblage, the primary pathogens responsible for disease. A good first indicator for a likely pathogen is a consistent association with diseased plants, and this can only be established through systematic sampling, which requires repeated isolation of the putative pathogen(s) from the same host(s). Identification of isolated pathogens at CABI revealed strains belonging to several potential pathogenic genera, including *Phytophthora*, *Pythium*, *Fusarium*, *Ilyonectria*, and *Phomopsis.* In addition, we discovered bacterial infections associated with a tip dieback, on He Cabbage (*Pladaroxylon leucodendron*) and Black Cabbage (*Melanodendron integrifolium*), caused by *Xanthomonas* and *Erwinia* spp., respectively. One oomycete, a *Phytophthora* species belonging to clade 8a of this genus, emerged as a prime candidate behind the demise of at least some of the endemic trees and was later identified to be *P. kelmanii*. This pathogen was first isolated from Whitewood in the PNP. Several She Cabbage and Whitewood trees in GBA also tested positive for *P. kelmanii,* and this site also provided the first record of this species being associated with the endemic Black Cabbage tree. In January 2024, using additional matched funding from Defra, new diagnostic equipment (Optigene Genie II LAMP system) was installed in ENRP's diagnostic lab at Scotland, St Helena. The new molecular equipment facilitated a rapid screening of isolates from diseased trees for the presence of the main putative causal agent of tree decline: *Phytophthora kelmanii.* Commercially available, *Phytophthora*-specific, rapid diagnostic kits were used in parallel to get indications for the presence of Oomycete pathogens while doing survey work in the field. All isolates collected during the tree surveys were taken to CABI, UK, under Defra licence for identification. In addition, several shipments of samples isolated and cultured by the team based in St Helena were sent to the CABI's facilities in Egham, UK, for identification.

Figure 3: Dying trees at Black Gate field gene bank in January 2024

Figure 4: Internal discolouration in dying Whitewood at Black Gate field gene bank in January 2024

Figure 5: Dead Whitewoods (*Petrobium arboretum*) in the George Benjamin Arboretum in January 2024

Figure 6: Taking samples from a diseased Whitewood at Bellflower Ridge in the PNP, January 2024

Pathogenicity testing

The association of an organism with a diseased plant is not definitive proof of pathogenicity, as many organisms are capable of colonising dead plant tissue but cannot initiate disease in healthy plant tissues. To confirm pathogenicity, Koch's postulates must be fulfilled, which involves inoculating healthy plants with the suspected pathogen and subsequently recovering it from diseased plants. Pathogenicity testing began in 2024 after the construction of a purpose-built quarantine shade house (provided with matched funding by Defra). To test the suitability of different inoculation methods of the potential pathogens, pre-trials were carried out in the UK using *P. kelmanii* and *Ilyonectria* sp. and garden plants related to the target tree species on St Helena (details in Annexe 5.7). The first in-country pathogenicity trial began in Feb-24 followed by three further trials conducted until March-25 (protocols provided in Annexe 5.8). The experiments confirmed that *P. kelmanii* is the causal agent behind Whitewood dieback and is likely responsible for She Cabbage decline as well. When exposed to additional stress, other endemic species — including Gumwood, Ebony, Rosemary, Lobelia, and Brown Scale Fern — also succumbed to the pathogen, indicating a degree of susceptibility. This was a significant breakthrough as *P. kelmanii* had been suspected to be one of the main causes of the tree dieback in St Helena, if not the most important one, from the project's early stages. This progress was possible through the availability of a sufficient number of disease-free seedlings, which only became available for pathogenicity testing in 2024. We also expanded our efforts to encompass a broader spectrum of target tree species, both native and non-native plants. This provided critical insights into the severity and range of the disease threats posed by *P. kelmanii* and has informed a disease management plan. Some pathogens isolated in this project are poorly described or are new (or even unknown) to science, such as *P. kelmanii*, which was only formally described in 2021, and limited literature exists regarding its biology. Therefore, some of the necessary information to assess its impact may need to be inferred from knowledge of closely related species, as the extensive testing required to gain this knowledge is beyond the scope of this project. However, our results add valuable information in profiling this pathogen for future attempts at managing this species on a global scale. Overall, despite delays in pathogenicity testing, our research succeeded to deliver on the output indicators, Unfortunately, given the complex nature of the tree decline there is no guarantee that the project has determined a definitive identification of all organisms and interactions involved in the decline of the endemic species. Indeed, it is likely that further pathogens, such as *Fusarium* spp., require more detailed investigation.

Figure 7: Whitewood inoculated with *Phytophthora kelmanii* showing symptoms of wilting and root rot one month after the start of the experiment.

Figure 8: Whitewood control inoculated with sterilised rice granules showing no signs of a diseases one month after the start of the experiment.

Soil and water catchment survey (additional activity)

Once *P. kelmanii* was identified as the cause of dieback in Whitewood trees and possibly other endemic plant species, it became crucial to determine the current distribution of the pathogen throughout the PNP and other sites. This information is vital for the conservation of the endemic trees. This was beyond the scope of DPLUS157 but became possible through additional funding provided by Defra. Preliminary work on different methodologies for isolating and detecting *P. kelmanii* in soil was carried out at CABI. DNA extraction from soil (using proprietary kits) proved too unreliable due to the limited amount of soil that could be used (<5g). Cost and availability of reagents was also an

issue for future work on island after the project was finished. Therefore, the approach chosen was: leaf baiting from soil (followed by confirmation by LAMP analysis) to detect *P. kelmanii* as larger amounts (>100g) of soil could be used for the analysis, increasing the probability of detecting the pathogen. Soil baiting can also be carried out with basic materials which are available locally and it proved considerably more cost-effective and reliable (protocols Annexes 5.9 and 5.13). The soil testing protocol developed in the UK was validated during a visit to St Helena in Sep-24. During the next visit (Oct-Nov 24) CABI, SHRI and ENRP conducted a large-scale survey to collect soil samples from several areas in, and around, the PNP: the paths; restoration sites; historic tree plantings; field gene banks inside and outside the national park; two nurseries and sites earmarked for future restoration efforts (the so called "no regret" sites). Sampling sites were tagged with durable metal tags and the location, soil condition and the health of the tagged tree (and those nearby) was recorded. This, combined with site descriptions, ensured that precise, repeat sampling from the same locations can take place. A total of 441 samples were taken in Sept/Nov-24, of which 59 (13.4%) tested positive for *Phytophthora* clade 8a. Of 53 positive samples taken during the main survey in Oct/Nov-24, 52.3% came from wet and waterlogged soils, with only 5.7% from dry soil. *Phytophthora* clade 8a was detected from numerous sites inside the PNP (see map, below, for latest results). Outside the Park, it was also found in the grounds of the nursery at Scotland, at a site called 'The Dell' at High Peaks, and inside the field gene banks at Casons and GBA. Following the soil sample survey distribution maps have been developed showing the sampling locations inside the PNP and whether individual samples have tested positive or negative for the presence of *P. kelmanii*. In addition, the designated geographical compartments inside the PNP have been highlighted for any confirmed presence of the pathogen (fig. 9). Maps from each sampling site outside the PNP have also been produced (Annexe 5.10). *P. kelmanni* seems to be highly associated with diseased or dead Whitewood and She Cabbage trees. Although *P. kelmanii* could not be confirmed as a causal agent behind the dieback of Black Cabbage trees during this project (due to a lack of test plants), the soil sample results show an association of this pathogen with this tree species (table 1). Whether this is because the pathogen does attack this species or because it is only due to a similar habitat preference (both pathogen and tree prefer wet soil conditions), remains unknown at this stage.

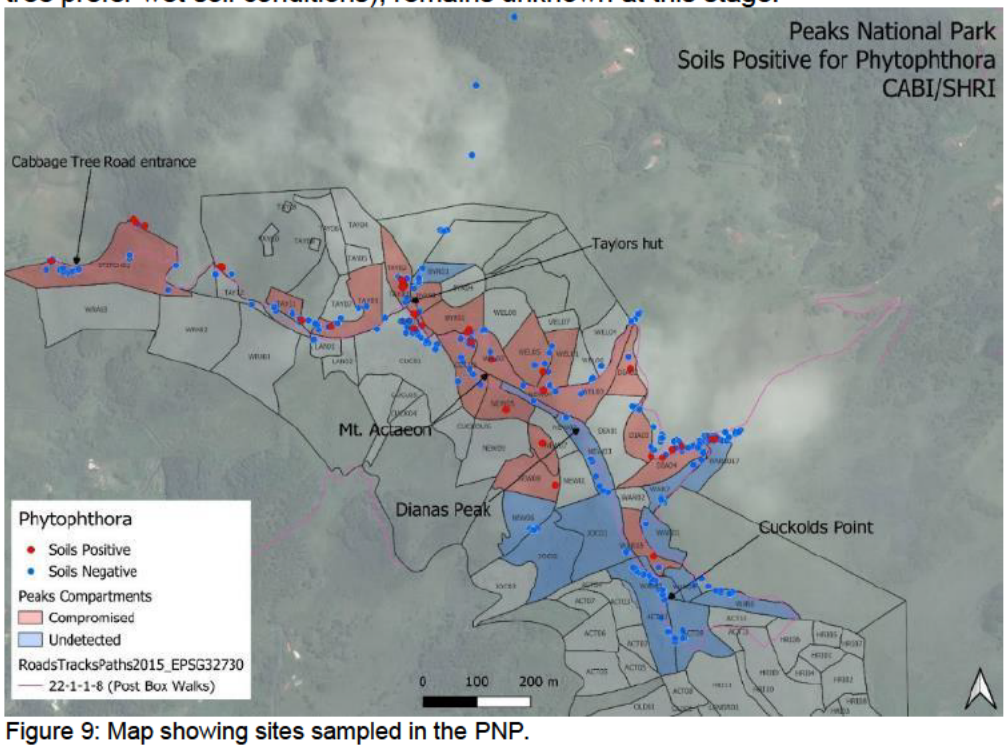


Figure 9: Map showing sites sampled in the PNP.

Table 1: Overall number of samples and percentage of positives in relation status of plant health.

host species	No. samples	No. positive	% positive	healthy trees	healthy trees positives	diseased /dead trees	diseased /dead trees positives	% positive healthy trees	% positive unhealthy trees
Whitewood	121	19	15.7	32	2	88	17	6.25	19.32
Black Cabbage Tree	62	9	14.5	28	4	29	5	14.29	17.24
Flax	59	3	5.1	59	3	0	0	5.08	-
Tree Fern	41	3	7.3	41	3	0	0	7.32	-
She Cabbage Tree	37	6	16.2	13	1	21	5	7.69	23.81

The implications of these findings are significant for the reopening of the PNP, as *Phythophthora* was repeatedly isolated from some of the main paths in the park. Most concerning was the finding of the pathogen at the “no regret sites”. These are areas of flax that have not been disturbed for many years and were earmarked for the continued planting of disease-free seedlings. Discovering *P. kelmanii* in soil from the PNP “no regret sites” led to the hypothesis that the pathogen may be moving in water runoff from infected to clean areas. To test this, leaf bait experiments (Annexe 5.16) were set up in water catchments from the PNP in Feb-25. The DNA from infected leaf pieces was analysed using LAMP with Clade 8a primers. Six of the 14 water catchments tested gave a positive result for *P. kelmanii* (Grapevine, Lower Wells, Lower Leggs, Jimmy Lots, Perkin’s Gut and the stream under Grape Juice). None of the reservoirs used to supply water for agricultural purposes tested positive but this demonstrates that the pathogen is more widespread on the island than initially thought, on both sides of the PNP.

Drone training (additional work package)

Monitoring and mapping of trees along with an assessment of their health is difficult due to the steepness of the PNP. Not all restoration sites or trees are visible from the main footpaths, preventing the collection of soil or even the assessment of tree health. Aerial surveillance provides a methodology to support future work which will be required to monitor tree health, identify symptomatic trees and track progression of disease symptoms. The development of aerial surveillance capabilities and capacity was carried out in conjunction with the (SHCFP). The SHRI team, Zac Bargo, Research Assistance and Data Manager, Selene Gough successfully completed the General Visual Line of Sight Drone Course with the UAV Academy in November, together with staff from the terrestrial conservation team of ENRP. The course, facilitated by the St Helena Government Civil Aviation Authority and UAV Academy, involved several weeks of theory coursework and an online examination and practical training conducted by a visiting drone trainer from UAV Academy. The SHCFP has purchased a drone with multi-spectral data capture and with ENRP and the SHRI seek to build on this first stage training to monitor tree health and track progression of tree disease.

Survey of crop pathogens including farmer interviews

A comprehensive survey of crop pathogens was carried out across several key agricultural areas on St Helena. Local staff accompanied the team to major production and trial sites, including Plantation Square, Longwood, Bottom Woods, Scotland, Sandy Bay, Clifford Arboretum, the polytunnel facility at Harpers, Maldivia (Jamestown), Horse Ridge, and SHAPE in Sandy Bay.

Due to the island’s mountainous terrain, flat land suitable for crop production is limited. Most cultivation occurs in gardens and small allotments, with crop areas rarely exceeding 100 square metres, aside from coffee plantations. The survey included a broad range of crops:

- **Fruit trees**: peach, apple, plum, lemon, orange, avocado, banana, mango, grapes, melon
- **Vegetables**: potato, sweet corn, aubergine (brinjal), carrot, cabbage, onion, green bean, cucumber
- **Other plants**: taro, canna, nasturtium, and ornamentals such as New Zealand flax and geraniums

Crop pathogen assessments were largely completed within the first two years of the project. While some diseases could be diagnosed based on distinctive symptoms, the limited prior research on plant pathogens on the island meant laboratory confirmation was necessary to ensure accurate identification. Crop surveys revealed that many common pathogens appeared to be absent from the island. This disease-free status was particularly noted for major outdoor crops like coffee and bananas, which appeared free of many common diseases despite extremely limited control measures being implemented. In contrast, significant issues were observed in indoor lettuce and tomato production, primarily due to oomycete and bacterial infections. Here, *Pythium dissotocum* on tomato and *Pseudomonas cichorii* on lettuce significantly impacted yield. (see case study below). A range of pathogens affecting fruit, vegetables, and ornamental plants was recorded during the surveys, including a new, undescribed *Ramulariopsis* species isolated from *Jellico*. Symptoms resembling *Verticillium* wilt on brinjal were seen in Maldivia (Jamestown) and *Alternaria solani* was observed on potato at ‘Horse Ridge’. *Puccinia pelargonii-zonalis* was widespread on ornamental geraniums however this species appears to be host-specific and does not pose a threat to *Pelargonium cotyledonis* endemic to St Helena.

Harpers Polytunnel Case Study

CABI was requested to make a site visit to the hydroponic facility in Harpers due to concerns regarding the health of the crops. Martin Joshua, the grower specialising in hydroponically produced tomatoes and lettuce, reported that the tomato plants were significantly stunted. The plants exhibited poor root

development and did not produce any yield. In the laboratory, sampled roots were examined and tested positive for *Phytophthora* using a lateral flow device (LFD). The root tissue was then surface-sterilised and plated onto *Phytophthora* selective media before being sent for molecular identification in Egham. *Pythium dissotocum*, a root pathogen related to *Phytophthora*, was identified as the likely causal agent. Lettuce crops at the same facility also showed symptoms of basal rot. A bacterial pathogen was suspected, and isolations were conducted in the local laboratory. Samples taken back to the UK were identified using MALDI-ToF and found to be *Pseudomonas cichorii*, a recognised pathogen of lettuce. A management plan including a wide range of recommendations to address these problems was developed for the grower and implemented in early 2023. By October 2023, the production of tomatoes had recovered, and the improved production system will avoid future yield losses. The management plan for tomato and lettuce production on St Helena is attached to this report as Annexe 5.4.

Figure 10: Tomato production at 'Harpers' showing heavily diseased plants

Figure 11: Positive oomycete test on tomato at 'Harpers', shown by the positive 'T' line

Figure 12: Diseased lettuce at 'Harpers' *caused by Pseudomonas cichorii*

Figure 13: Potato crops at 'Horse Ridge'

2.2 *Forestry*

Diseased forestry trees, primarily silky oak (*Grevillea robusta*) and maritime pine (*Pinus pinaster*), were assessed at several sites, including Jamestown (moat), Plantation, and Thompson's Wood. The main concern was the recent arrival of wood-boring insects such as the wood wasp *Sirex noctilio* and the powder-post beetle *Xylopsocus capucinus*, which target weakened trees. The wood wasp has also been reported to act as a vector for fungal pathogens. In Jamestown, silky oaks showed signs of insect damage and potential fungal infection. Two notable fungal species were identified: *Neofusicoccum parvum/ribis* complex, and *Xenoacremonium recifei.* (the most frequently isolated species). The former is known to cause cankers and dieback on trees in Africa, whereas the latter is reported to be a tree pathogen associated with wood-boring beetle vectors. Although concerning, pathogenicity testing is required to confirm whether these fungi cause disease on St Helena. Tunnelling by the beetles may enable infection, especially in trees already weakened by termite damage, which was also observed. The false powder-post beetle has been attacking silky oaks and may threaten endemic trees by facilitating fungal infections. At Plantation Square, pine trees exhibited dieback, browning needles, and insect exit holes attributed to the introduced wood wasp. Some trees had died and fallen, while others showed fungal stroma breaking through the bark, likely a Basidiomycete, possibly *Amylostereum,* a known wood wasp-vectored pathogen. Fungal samples were sent to CABI for culturing and molecular identification, but tests were inconclusive due to

Trichoderma contamination, which outgrew the Basidiomycete. Three additional pathogens were recorded: a rust (*Melampsora* sp.) on *Populus alba,* an ascomycete (*Corynelia uberata*) on Cape yew (*Afrocarpus falcatus*) and a further ascomycete (*Mycosphaerella* sp.) on Spoor (*Pittosporium undulatum*). Further details are provided in Annexe 5.2. These findings underscore the vulnerability of St Helena's forestry species to a complex of emerging threats involving invasive insect pests and associated fungal pathogens. While evidence points to a link between insect activity and pathogen introduction, more research is needed to confirm causal relationships and assess the risks to native and endemic species. In the meantime, strengthening forest health through improved management, early detection, and biosecurity measures will help to mitigate further decline. Nevertheless, other pests, especially termites, continue to weaken trees, which may facilitate the establishment of these invasive beetles.

Figure 14: Silky oak stump in Jamestown, St Helena, showing termite infestation.

Figure 15: Basidiomycete (probably *Amylostereum* sp.) fungus growing through the bark of a dead pine tree near plantation. The trees were affected by *S. noctilio*.

2.3 EPF surveys

The surveys of entomopathogenic pathogens were conducted in Nov-22 and Jan-24 by Harry Evans, although ad hoc collections – also covered in this report - had been made earlier during the Mar-22 plant-disease survey. During the surveys, Zac Bargo of the SHRI assisted with some of the collections as part of a mentoring exercise. The surveys focused on the PNP where the highest diversity in EPF was suspected to be found in the cloud forest. The second survey included revisiting sites likely to yield discoveries during a different season. Due to access restrictions in place for the PNP, every group of scientists had to be always accompanied by an ENRP officer. Sites covered outside the PNP included the Millennium Forest, Plantation Forest, Blue Hill, Cason's, Fisher's Valley, High Hill and Napoleon's Tomb. Specimens, together with the substrate to which the diseased arthropods were attached, were collected in sterile plastic tubes and examined in the laboratory for a provisional identification and, where appropriate, for isolation in culture. After further examination at CABI-UK, the specimens were assigned temporary codes until final accession in the CABI fungarium ('Herb IMI', housed at RBG Kew). Fungal isolates from the survey were sub-cultured and then transferred to storage tubes for deposit in the CABI (living) Culture Collection. Each of these accessions has received IMI codes as official deposits. An annotated list of the EPF collected during the project, including figures, is provided in Annexe 5.3. The two surveys conducted during the project remain only a snapshot of the EPF present on St Helena. Their occurrence will vary during the year, according to the season and prevalent weather conditions. However, as shown here, more new records – and, potentially, new species – continue to be discovered. The surveys indicate that, like the flora and fauna, the mycobiota of St Helena is also highly diverse with a richness of species, some of which could also be critically endangered and at risk of extinction, along with their arthropod and plant hosts. The interactions of these fungi with their hosts and their roles in ecosystem functioning remain to be determined.

The main — and most concerning — finding is that some endemic leafhopper species are under threat from an apparently exotic species of Beauveria, likely *B. malawiensis*. *Sanctahelenia insularis*, a critically endangered species found only on the False Gumwood (*Commidendrum spurium*), which has just six trees left in the wild, and *Atlantocella leleupi*, a vulnerable species are both at risk. This Beauveria species was also found multiple times on the introduced flax weevil (*Scobious tottus*). This EPF was first described on a beetle host from Malawi and later reported from Thailand on stink bugs (Hemiptera). A more recent finding is on the invasive paper wasp (*Polistes chinensis)* in New Zealand. Therefore, unusually, this EPF would appear to have an eclectic host range with a pantropical distribution. There remain some puzzling questions to answer:

- Why has this EPF not been found on other leafhopper species, notably, *Sanctahelenia decellei*, which is 'out-of-control' and causing significant damage to its gumwood host, especially in the Millennium Forest?
- Why has it only been found on the flax weevil and not on other beetle hosts; and does it pose a threat to endemic species of Coleoptera, as well as, the two endemic leafhoppers?
- How and when did it arrive? This EPF has never been produced as a commercial mycoinsecticide and, therefore, it must have arrived accidentally on St Helena.

As populations of the endemic leafhopper *Sanctahelenia insularis* were being monitored regularly at the Mt. Vessey site, it was recommended that diseased insects should also be included within the counts – it was estimated that approximately 30 per cent of the population was infected – and that these cadavers should be removed from the site to reduce inoculum pressure. Another focus was on *Aschersonia*-whitefly associations on two, as-yet undescribed and possibly endemic, whitefly species from Whitewood and Dogwood – and their mycoparasite complexes – to establish both host and pathogen identifications. It is posited that these EPF, and their mycoparasites, constitute a natural control balance: without the EPF, the whitefly populations could explode – damaging their hosts directly and indirectly (sooty moulds); without the mycoparasites, the EPF could impact negatively on these, potentially, endemic whitefly species. Molecular assessments are still ongoing to ascertain whether two separate EPF are involved in this St Helena specific host-pathogen system.

Figure 16: Searching for leafhoppers with EPF infection on False Gumwood (*Commidendrum spurium*) on 'Mount Vesey'

Figure 17: *Beauveria cf. malawiensis* on False Gumwood leafhopper (*Sanctahelenia insularis*) *Commidendrum spurium* on 'Mount Vesey'

Figure 18: *Aschersonia* sp. on whitefly nymphs (*Aleuroplatus* sp.), on Whitewood. Stromata of *Aschersonia* colonised by black mycoparasites; inset a healthy *Aschersonia* stroma exuding spore tendrils

Figure 19: *Beauveria cf. malawiensis* on Flax weevil (*Sciobius tottus*) at 'High Peak'

Output 3. Action plan to mitigate identified threats developed with, and made available to, all stakeholders (this will include different chapters addressing the identified threats for each sector and a strategy for future management)

This output aimed to identify management options to address the impacts of the most important plant pathogens on crop production and those affecting the endemic trees in the PNP. The verification indicator for this is the adoption of improved management practices for at least 4 priority threats to cloud forest species and/or economically important crops. The objective has been successfully accomplished regarding both economically significant crops cultivated on St. Helena and the risks posed by pathogens to native tree species. A management plan has been developed and implemented by the appropriate grower to enhance phytosanitation practices for the indoor cultivation of tomatoes

and lettuce. The problem was noted during the first year of the project and once the candidate pathogens were confirmed, a management plan (including a wide range of recommendations to address this problem) was developed in 2022 and subsequently implemented in early 2023. By October 2023, the yield of tomatoes had recovered, and the improved production system will prevent future losses caused by these diseases. A report on this is attached as Annexe 5.4.
A phytosanitary regime was proposed early in the project to minimise the potential for the accidental transfer of pathogens from one region to another. This regime has been adopted by ENRP. The discovery of a range of serious soilborne plant pathogens within the PNP has led to the formation of the task force involving all major stakeholders active in St Helena. In 2022 the task force implemented emergency measures to restrict access to infected sites or sites particularly sensitive for conservation. Other measures include detailed phytosanitary protocols, to which all personnel working in the vicinity of infected or sensitive sites are required to adhere (annex 5.6). Access restrictions were widened in 2023 to include public access to the entirety of the PNP. Exemptions from these restrictions are only granted for essential activities, contingent upon a substantiated request to SHG. This has become applicable also to the team working on this project. Based on advice given by CABI pathologists, the Cloud Forest Project team have developed a management protocol to produce disease-free tree seedlings, urgently needed for efforts to restore the cloud forest on St Helena. They are also essential for the conduct of the remaining pathogenicity experiments, which are required to confirm if the pathogens discovered during our surveys are causal agents for the ongoing tree dieback.
The confirmation of *P. kelmanii* as a causal agent of the dieback of Whitewood and potentially She Cabbage has allowed the development of a management plan (Annexe 5.5) to mitigate the impact of this devastating plant disease in the PNP, which contributes to a wider strategy under the SHCFP (Annexe 5.5). As the causes of the diseases in other endemic tree species remain unconfirmed there remain some gaps to be filled in by future research to provide detailed information on comprehensive mitigation strategies for threats to the cloud forest. The current management plan will undoubtedly have to be updated in coming years. However, there are principles of phytosanitation based on our current knowledge that can already be applied which will already mitigate and reduce the overall threats. The recommendations made in the current draft have been made available to ENRP for their consideration and pave the way for a decision on the tentative reopening of the PNP to the public, providing a range of safeguarding procedures and regulations are put in place.

Output 4. Capacity for St Helena to address threats caused by pathogens independently increased

Training in diagnostics and crop management was provided to a wide range of audiences in St Helena. Devised by CABI as part of the Plantwise program, the training has been widely tested in many countries. The material was modified to fit shorter timeframes and cater to the needs and abilities of participants on St Helena. Originally intended for crop production, the training was adjusted to also suit the requirements of both forestry and extension/conservation staff. Training was provided in two tranches: 2022 (disease diagnostics) and 2023 (disease management). The training sessions took place at various venues, the largest of which was the main diagnostic session, which took place at Kingshurst Community Centre and was attended by 24 staff from forestry and conservation. Two training sessions were also provided at the facilities of SHAPE, an organisation providing occupational therapy for those with learning difficulties through horticulture reaching 9 participants. In both 2022 and 2023 training was also provided to 16 students from Prince Andrew secondary school at the agricultural education centre at ‘Harpers’ within the school grounds. The training comprised a mix of seminars and interactive sessions centered around crop diagnostics. This training was developed specifically for this age group, in order to be inspirational, educating the students in methods of disease and pest control and revealing the true extent of natural biological control that takes place under field conditions. A more technical training was provided to the staff of ENRP. This training was provided within the Scotland laboratory complex. The training investigated aspects of pest management, the economics of pest management as well as the various options and timings with regard to pest and disease control. Biological control and cultural methods were promoted along with relevant safety approaches when considering chemical control. Literature pertaining to chemical use to ensure efficacy and prevent the development of resistance was supplied along with information on the appropriate phytosanitary methods to use when dealing with the various pathogen and pest groups. A reduced version of the course was given to farmers and agro input importers/suppliers at an evening event. The literature on chemical resistance groups and regimes to reduce the development of resistance in insect pests and pathogens was of particular interest to this group.

Figure 20: Setting up of the Optigene GenieII LAMP system at Scotland, St Helena.

Figure 21: Onsite training on *Phytophthora* phytosanitary measures.

Due to the practical nature of the courses, all training sessions were well received by the participants. On each occasion feedback was requested through a course questionnaire provided at the end. This comprised both tick boxes and free text options, with considerable praise received for the material and presentation. Based on these returns it was clear that the participants felt they could use the information in their professional and private lives e.g.: "The whole of the course was very useful particularly in my job an also being a part time farmer; I find the course very useful and interesting an also learnt a lot did broaden my knowledge" [sic]. The training at Prince Andrew School may have inspired some students to become interested in crop protection and may take up a career in that discipline accordingly. The two training sessions have undoubtedly increased the capacity for local people to diagnose and to manage pests and diseases in a timely and appropriate manner, whilst fulfilling the indicator "4.1 Details on training sessions and questionnaires are provided in Annexe 5.12.

Figure 22: Participants having received certificates after completing training in plant disease diagnostics.

In addition to the formal training, a great deal of informal training/mentoring/capacity building took place with the scientific staff of ENRP. Basic microbiology and plant pathology were taught alongside more complex molecular methods, extracting DNA and using taxon-specific diagnostics through LAMP amplification. Secured matched-funding facilitated the establishment of additional capital equipment in the renovated laboratory at Scotland, enhancing its capabilities. The new equipment included an Optigene GenieII LAMP system for molecular diagnostics work. This became necessary to enable a rapid diagnosis of tree pathogens by the team on St Helena replacing the time-consuming and costly shipment of samples to the UK for identification. The new system will enable the St Helena team to verify the identity of pathogens isolated from roots in the pathogenicity experiments, thus enabling Koch's postulates to be tested. Moreover, this development is crucial as it will enable newly produced tree seedlings to undergo disease testing before their transplantation to restoration sites. Altogether, seven staff from ENRP have been trained in the use of the equipment for processing samples of crop and tree diseases (covering indicator 4.3). A major step towards this output has been achieved through the refurbishment of the pathology lab at ENRP (St Helena; Scotland site) with a comprehensive set of equipment necessary for the isolation and morphological identification of pathogens. The list of equipment and consumables as outlined in the proposal was agreed by all project partners and, as most of the equipment was already installed and ready for use by March 2022, training could start earlier than originally planned. Although training was formally completed in the second project year, significant advancements were still achieved later. On the job training took up considerable time but was essential to allow independent pathogen surveys and assessments to be conducted by the team based on St Helena. In addition to the laboratory training, the nursery staff were trained in the best phytosanitary practices for plant propagation. Protocols were drafted based

on observations made during previous visits to the Peaks and Nursery facilities. These draft protocols were reviewed and discussed with the head of the conservation nursery, V. Thomas Williams, and revised to reflect the practicalities of implementing the activities on the ground. Training was then provided to six team members from the Peaks and nursery staff. This involved walking them through each protocol and gathering their feedback on the practicality and feasibility of each task. In total, 10 protocols were developed and implemented (see Annexe 5.6).

Output 5. Pathogen treatments implemented.

This output has been achieved regarding the crop production sector, as described further above, with significant advancements in phytosanitary procedures observed in indoor vegetable production. Consequently, food security for high-value salad vegetables like tomato and lettuce has been notably enhanced. These achievements align with indicators '5.1 At least one new treatment measure was developed and tested during Y3Q2 to Y4Q2' and '5.2 At least one new treatment practice(s) demonstrates a quantifiable reduction in the spread and/or severity of disease, by Y4Q3', demonstrating the development and successful testing of new treatment measures, as well as the quantifiable reduction in disease spread and severity (for details see Annexe 5.4). Despite the complex causes of the problems on the endemic trees, we were also able to provide comprehensive recommendations for pathogen management in the PNP. Protocols have been implemented and adequate training provided for improving the phytosanitation and growth conditions of the seedlings in the nursery in Scotland and in the Peaks, and a full action plan concerning activities conducted within the National Park has been drawn up (for details see Annexe 5.5).

3.2 Outcome

Outcome: *St Helena will have an increased local capacity to manage plant and insect pathogens reducing the risk of biodiversity loss and increasing economic prosperity.*

During the project, the CABI team made nine visits to the island and collected and identified samples from endemic, forestry and agricultural plants found in a range of habitats. In addition, a pathology lab has been set up and training given to local staff for the identification of plant pathogens. Training was also provided to an extremely wide range of stakeholders covering the diagnosis and management of plant disease. Eight workshops were held in 2022 and 2023. A further focus was to implement emergency measures to prevent the further spread of potentially serious pathogens belonging to the oomycetes after their initial detection in 2022. In April 2023 the SHG introduced new legislative powers to legally prohibit access to some areas of the PNP to protect the endemics from pathogens that could cause irreparable damage to St Helena's biodiversity. The urgent need for improved phytosanitation in the PNP led to the closure of the Peaks to the public and the development of a *Phytophthora* taskforce led by local stakeholders, but with scientific inputs from CABI. The closure of the PNP has had significant knock-on effects on other research projects and conservation activities currently ongoing on St Helena. The detection of pathogens in the nursery production site in Scotland has led to the implementation of improved Phytosanitary practices and the development and implementation of new procedures produced jointly by ENRP and CABI. This protocol now allows the production of healthy nursery stock and limits the further spread of disease on the island. The newly built quarantine shade house constructed with matched funding by Defra provides a blueprint for how plants should be grown and maintained going forward. The pathogenicity of one of the putative agents, *P. kelmanii*, was confirmed for the endemic Whitewood and potentially She Cabbage, the tree species most affected by the tree dieback. This allowed the development of a management plan and the putting in place of precautionary phytosanitary measures. These interventions have had a significant impact on the production of nursery stock and will inform future restoration efforts. Taken together, they directly address the first indicator 1.1 'Changes to habitat management practices in cloud forest, and afforestation's based on best practice recommendations. Healthier nursery stock in production by the end of the project'. The introduction of molecular methods (LAMP system), development of suitable sampling and testing protocols and taxon-specific primers, along with extensive training of local researchers, has created sufficient capacity for St Helena to proceed with the detection and monitoring of invasive *Phytophthora* species such as *P. kelmanii*.

The assessment of pathogens affecting crop production in St Helena was completed during the project. Management plans for combating pathogens affecting the indoor production of lettuce and tomato were written and significant improvements were observed due to their implementation. These plans directly address the second outcome indicator 2.1, which is the reduction in reported crop failures due to disease. However, the focus of project activities moved away from the assessment

of crop pathogens towards the detection and management of diseases affecting the endemic vegetation of the PNP. This had become a priority given the continued death of endemic trees and the fragile nature of the unique vegetation of St Helena. Without the appropriate phytosanitation, conservation and management practices being put in place, there is a significant risk of the further decline or even extinction of already endangered species as well as the communities they support.

The surveys undertaken on the island by CABI, SHRI and ENRP staff and the laboratory isolations and identifications will contribute greatly to the knowledge of fungi on the island. The indicator linked to this work was 1.3 'Increased lab diagnosed diseases from the current level, 3, to 15 by the end of the project'. It is anticipated that by the end of the project, the number of lab-diagnosed plant pathogens on St Helena will have increased. The indicators broadly capture the desired outcome. It is important to note, however, that it is still too early to provide evidence of the full delivery of the outcome. A slowed or reversed loss of trees due to the measures put in place will only become apparent years after the termination of the project.

3.3 Monitoring of assumptions

Assumption 1: Sufficient baseline data on crop losses due to pathogens is available to allow comparison of changes due to improved management practices. This assumption was incorrect, as there was virtually no data in the literature, or on the island relating to losses incurred due to pathogens. To address this, key informant interviews were conducted with growers to get baseline data for comparison. This assumption remained a challenge as growers were unable to provide figures regarding yield or potential losses. However, Improved yields in tomato and lettuce production after management changes can be compared to the initial production levels.

Assumption 2: There are no outbreaks of Covid on St Helena that will cause significant disruption/delay to project delivery. Covid-19 has impacted the project work plan significantly with an initial delay of 3 months. As a result, we had extended the project by a year in a cost neutral way through a change request granted in January 2022. Forward planning allowed to turn a 10-day quarantine period of the visiting team on St Helena in February 2022 into a productive period (access to a limited number of crops, makeshift lab facilities, provision with field samples by St Helena team).

Fig. 23: Makeshift lab at Teutonic Hall during quarantining

Assumption 3: Identified stakeholders, including women, are available to participate in project activities. At all times, stakeholders have been committed to the project activities. The project managed to ensure that activities including any training are conducted flexibly to accommodate the commitments of stakeholders.

Assumption 4: All partners and their staff deliver timely on their commitments to the project. Interactions with the partners have been very good and the project team meetings and Project Governance according to Prince 2 methodology helped to ensure that engagement was maintained.

Assumption 5: Applied research is approved by the St Helena Research Council. The project was developed with local authorities and reflects locally identified needs and priorities. We always had good support from the St Helena Research Council and did not encounter any significant problems.

Assumption 6: Archived literature exists that describes the plant pathogens of St Helena. This assumption was found to be inaccurate. Unlike the botany and insects of St Helena which have been widely studied and documented, there is very little literature, paid for or otherwise on microbial life on the island. This makes the new pathogen database we created even more important and relevant.

Assumption 7: Export licenses for pathogen samples in place to allow identification at CABI & UoB facilities. This was a problem, but export licences were applied for in a timely fashion.

Assumption 8: Access to the infected parts of the infected trees is easily possible. Given the protected nature of the endemic trees, destructive sampling has been kept to a minimum. The recording of potentially pathogenic Fungi and oomycetes during this project has led to restricted access to sensitive areas. Further surveys in the PNP in the second half of the project required approval of the

St Helenian authorities before every field site visit. However, this turned out to be non-problematic as the project involved all relevant stakeholders of the management of the national park.

Assumption 9: Local farmers are willing and keen to engage and share their local knowledge. Farmers have always been willing to share information with the research team. This has been facilitated by efforts made to communicate with them about the project and the potential benefits.

Assumption 10: Timing of travel to and from St Helena is not disrupted by adverse weather conditions. Adverse weather did cause travel disruption however this was anticipated and a flexible working schedule allowed to fully compensate for this.

Assumption 11 Standard diagnostic procedures do not allow for the measurement of the current spread of pathogens. The major causal agent proved very challenging to identify using molecular means. To assist with identification support has been sought from external *Phytophthora* experts and eventually the pathogen was identified as *P. kelmanii*. The acquired LAMP GENIEII allowed for the rapid identification of *Phytophthora* belonging to SubClade 8a but is yet unable to distinguish between species within this clade. This was addressed by culturing samples that tested positive for clade 8a and exporting them to the UK for species-level identification. We were then able to develop taxon-specific LAMP primers for Phytophthora clade 8a, which we tested against available Phytophthora species.

Assumption 12 Treatments and best practice procedures are available or can be developed based on existing knowledge of the pathogens recorded for St Helena. Suitable treatments were available to deal with the outbreaks of plant diseases within the indoor production of vegetables, and these have already been implemented. Regarding the tree dieback in the PNP, recommendations for best practices became possible only once a clearer understanding of the pathogenicity and spread of *P. kelmanii* was gained towards the end of the project. Given the urgent need to manage the disease on the island, several measures were implemented in consultation with the Phytophthora Action Group. These included restricting access to the PNP, providing sanitation stations, and halting seedling production in the Peaks nursery. Restrictions also apply to some new areas initially earmarked for replanting, which were found to be already infected by the pathogen.

Assumption 13 Timely availability of facilities to hold a workshop on St Helena. Stakeholders were keen and available to engage. There have been eight stakeholder meetings on the island, and these included both training for growers and extension staff held at various facilities throughout the island. In addition, four presentations explaining the purpose and initial results of the project were hosted at the ENRP facility and by the museum in Jamestown, which were open to staff on site and to the general public.

4 Contribution to Darwin Plus Programme Objectives

4.1 Project support to environmental and/or climate outcomes in the UKOTs

The project discovered *Phytophthora* killing endemic trees in the PNP and, concomitant with that, the necessity to follow good phytosanitary procedures in the production of trees for transplantation. Disease was identified as a possible feature influencing management of the PNP (The Peaks National Park Conservation Management Plan (2019-2024). The phytosanitary procedures established as a result of this project, to reduce the spread of disease and establish disease free planting material, support the objectives of the Peaks National Park Management Plan (2019) and its associated action plan “Restoring St Helena’s Internationally Important Cloud Forest for Water Security & Wildlife Implementing the Peaks Management Plan (2021-2026)” to protect the remaining cloud forest fragments and increase habitat for biodiversity. This requires significant scaling up of nursery plant production, planting and invasive weed control. Furthermore, the project legacy will have a long-term significant impact on reducing the threat of extinction of St Helena’s critically endangered and endangered cabbage trees and their associated plants and invertebrates. The cabbage trees of the PNP cloud forest at keystone species and play a vital role in mist capture and soil formation that sustains island water supplies. The reduction in tree loss, and associated canopy cover, together with improved survival rates that can now be achieved with disease-free planting material and known locations of presence of *P. kelmanii* in the soil will contribute to successful habitat restoration and improved resilience to climate change directly contributing to “A Climate Change Action Plan for St Helena 2020-2027”, SHG that identifies “Supporting cloud forest restoration and the Peaks Management Plan will enable the Island to improve water supplies, be climate change resilient and protect habitats for the Island’s endemic plants and invertebrates”. As a result of the project, the spread of plant pathogens in the PNP will be reduced, and only disease-free planting material will be

produced and taken for transplantation. The education provided on crop production will increase the amount of locally grown food and will reduce imports, and lessen the carbon footprint of St Helena. “The carbon emissions associated with imports are larger than the total carbon emissions generated on the island” (St Helena Net Zero Carbon Emissions Scoping Study, March 2021). The training given to the pupils at Prince Andrews school may have inspired some of them to become more interested in and involved in crop production.

4.2 Gender Equality and Social Inclusion (GESI)

GESI Scale	Description	Put X where you think your project is on the scale
Sensitive	The GESI context has been considered and project activities take this into account in their design and implementation. The project addresses basic needs and vulnerabilities of women and marginalised groups and the project will not contribute to or create further inequalities.	X

Society on St Helena is an extremely equitable one and women are in positions of authority in all areas of ENRP. Most of the management positions are filled by women, and the labouring positions are filled by men. The project worked with partners inclusively. Both training activities were provided to those attending SHAPE (St Helena Active Participation in Enterprise) and were adjusted to accommodate any learning difficulties. This has enabled the SHAPE members to become more involved in the onsite plant production. We learned that there was some hesitancy by ENRP staff to attend our training, but the work done at SHAPE reduced these concerns.

5 Monitoring and evaluation

Covid-19 impacted the project work plan significantly, with an initial delay of 3 months to the project start date. This had knock-on effects on the schedule (seasonality of sampling) and, as a result, we extended the project by a year in a cost-neutral way through a change request, which was granted in January 2022. This allowed a more flexible approach regarding the planning of field site visits to St Helena. The initial change in the timeline required some adjustments to the log frame. Reviewers of the first annual report also requested that the indicators be made SMARTer. This has led to the approved changes highlighted in yellow in the log frame, but did not require a formal change in the project design. Evaluation during the project took place through the reviewing of the annual reports, which did not lead to any significant changes, but, at some stages, reviewers asked for more details on the methodological approaches and how the project addresses specific St Helena strategic biodiversity and environmental priorities, which were provided. Fine-tuning of activities and methods applied were regularly discussed with the whole team and with the *Phytophthora* task force, which was established from an early stage of the project. The early results prompted a shift in focus from managing crop and forestry pathogens to conserving endemic trees. This change was feasible because it turned out that fewer pathogens than initially assumed were causing problems in agriculture and forestry, which could be addressed relatively easily. However, the realization that urgent research was needed on the newly discovered pathogens threatening the survival of endemic trees led to efforts to secure additional funding. As a result, Defra provided complementary funding for the financial years 2023/24 and 2024/25.

Isolation of pathogens from dying trees does not prove that these organisms are also the causes of the respective tree’s death and decline. Therefore, an important part of the project was to provide experimental proof of pathogeny by replicating disease symptoms on healthy tree seedlings through inoculation with the pathogen. Initially, this step had been delayed due to the lack of seedlings for inoculation purposes and was addressed by a change request, approved in Jan-23, to undertake testing only in 2024/25. In addition, this was complemented by experiments conducted in CABI’s UK quarantine facilities. These experiments were designed to help refine the methodology in preparation for experiments on the island. Regular project monitoring has been conducted through meetings and briefings between project partners via audio/video links, and these meetings have been productive and effective. The progress towards project outputs has been regularly checked against the ‘Implementation timetable’ during the online meetings and ‘in person’ during visits to the island. Towards the end of each activity an evaluation, with regards to any necessary corrective adjustments, was undertaken during the regular team meetings. Project reports, being part of the monitoring were

generated as collaborative activities, with responsibility shared equally between all project partners and progress achieved has been reviewed jointly by all teams.

6 Lessons learnt

The project team worked extremely well together, despite the difficulties due to extreme distances between partners and their respective remote locations. Initially, we purchased laboratory equipment cautiously due to uncertainties surrounding the research, although some omissions and duplications did occur. As the project progressed, additional equipment was acquired as needed. There was good collaboration with other projects working on similar subjects on St Helena (DPLUS104 'Conserving St Helena's endemic invertebrates through invasive invertebrate control' and the FCDO funded SHCFP, and this has led to very useful synergistic activities, such as coordinated purchasing of equipment, joint invertebrate and tree health monitoring and adaptive management strategies under the SHCFP. Through the sharing of experiences and knowledge, all collaborative partner projects will benefit from this synergy. ENRP took the findings extremely seriously, and a task force and other committees were developed to respond to the results once the implications became clear and quickly led to the imposition of a ban on entry to the PNP. As a result of the first two surveys conducted in 2022, it became evident that comprehensively addressing the dieback of all endemic tree species was beyond the project's scope. Fortunately, we secured additional matched funding from Defra, which allowed us to work much more intensively on pathogen detection and pathogenicity testing. The combination of the relatively basic laboratory in St Helena and CABI's considerably more technical facilities in Egham worked well together. The initial shortage of tree material for inoculation was frustrating. The discovery of *Phytophthora* itself further hindered tree production, necessitating a stricter phytosanitary regime, additional equipment, and upgrades to existing St Helena facilities. Planning remained flexible to coordinate seedling availability with CABI visits. All training sessions were well received and contributed significantly to advancing the project's key objectives.

7 Actions taken in response to Annual Report reviews

Initially, indicators in the log frame were deemed not to be sufficiently 'SMART' and had to be amended. Updated indicators were submitted in the following 'half-year project report' as a new Annexe but were not visible for reviewers of the next annual report, and subsequently, the amended log frame was resubmitted via a change request. Other requests from reviewers concerned details on the methodological approaches and how the project addresses specific St Helena strategic biodiversity and environmental priorities, which were subsequently provided.

8 Risk Management

This project started before risk registers were introduced for the Darwin Plus programme, but one was added in 2024, nonetheless. The most significant risk to the project occurred in 2023 because of the delay in the pathogenicity testing on St Helena. A combination of the lack of suitable test plants and delays to the construction of the quarantine shade house meant that this activity was pushed back to 2024/25. However, improved nursery facilities and production protocols resulted in the production of healthier plants for testing purposes. The rapid decline of numerous trees, coupled with the identification of likely causal agents, has created an urgent need to expand monitoring of pathogen spread, confirm host species, and intensify ecological studies of these poorly understood pathogens. The scale of this issue turned out to be significantly beyond the scope of the present project; hence, complementary funding was sought from Defra and granted in August 2023 to cover additional work until March 2025.

9 Scalability and Durability

The profile of the project has been promoted at several levels. Locally, through public announcement of the arrival of visiting teams of scientists and radio interviews in 2022 and 2024, one of which was conducted by the Minister for ENRP, Christine Scipio at South Atlantic Media Services (SAMS). Updates on project developments were also given through an article in the local newspaper "The Sentinel" and a public talk at the museum in Jamestown in February 2024, which was also recorded by the local media and made more widely available via YouTube. More generally, results and implications from our project were discussed during a private audience with the Governor of St Helena, a meeting with eight members of the St Helena Legislative Council and four government ministers in the Castle council chambers in January 2025, two receptions in the House of Commons, Westminster in May 2023 and April 2025 and through several blogs. Collaboration with other teams working on biodiversity conservation on St Helena has already led to further planned joint activities.

A core aim was to translate communications and training into new skill sets embedded at ENRP. This has been achieved through training and changes to the ENRP team structure, allowing Martina Leo to dedicate more time to pathogen work, supported by Lawanda and Theressa. Plantwise training and site visits better equipped growers, with practical changes—such as Martin Joshua's introduction of water sterilisation—enabling continued tomato production. Durability of impact is ensured through trained staff, while scalability is supported by ENRP, leveraging lab upgrades, additional funding, and staffing changes.

Sustainable procedures for seedling testing and production of disease-free plants are now in place, essential for future restoration efforts. Relevant staff have been trained in updated phytosanitary procedures, and ongoing technical support from ENRP ensures growers can apply improved management methods beyond the project's lifetime. These methods will become part of the continuous advisory service, with both farmers and advisory staff trained to use future developments from CABI's diagnostic and advisory online tools, enabling remote assistance on new pathogen outbreaks.

Open access to all project data and outputs—including reports, training materials, photographs, and videos—is a key policy of CABI. These resources are freely available digitally on the Darwin, CABI, and ENRP websites, with social media used to promote project stories and photos. Most data are annexed to this report, with additional materials available on CABI's website as needed. Lessons from this project apply across UK Overseas Territories (UKOTs), which face similar disease challenges affecting both the environment and agriculture. Findings have been presented at relevant conferences and workshops, with ongoing aims of publishing in peer-reviewed journals.

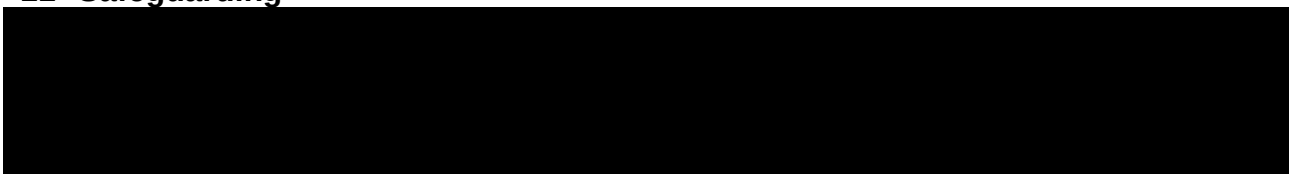
Evidence of changed practices in habitat restoration at the Peaks includes the introduction of access exemption requests, phytosanitary protocols, and enhanced site management. Funding secured through the new SHCFP will support monitoring to ensure procedures are effective, with CABI scheduled to return for soil testing. The project's exit plan includes the establishment of the pathogen laboratory and embedding new skills in pathogen identification, culturing, pathogenicity testing, soil baiting with LAMP, and tree health monitoring. Staff can now work remotely to continue testing for *P. kelmanii* and manage pathogenicity assessments.

Innovative, safe, and affordable field methods were developed and trialed to survey soilborne Phytophthora species, significantly increasing ecological knowledge of *P. kelmanii* and enabling cost-effective application across other UKOTs and similar environments. The project also introduced new phytosanitary procedures in tree nurseries and established nursery stock testing protocols before planting in conservation areas. These methods, affordable for low-income countries, have strong potential for global adoption.

10 Darwin Plus Identity

Although intensive collaboration with teams working on other projects took place, DPLUS157 was always promoted as a distinct project during all forms of public engagement. Almost every resident on St Helena is aware of the Darwin initiative as a vital donor to preserve biodiversity and support livelihoods in this UKOT. The Darwin logo was represented in all presentations covering the project during several visits to St Helena between 2022 and 2025, to which many stakeholders and the public had been invited. The project was also presented during two radio interviews on St Helena subsequently resulting in coverage by a local newspaper article. During these events, the aim and purpose were explained, and the Darwin Initiative was specifically mentioned as the main funder of the overall project. The project was also presented in four talks given at the UKPD meetings in 2024 (RHS Wisley) and 2025 (JHI Dundee), and presentations were given at the International Mycological Congress 12-15 August 2024 in Maastricht, Netherlands. A further presentation will be given at the BSPP conference in September 2025. The funder was also acknowledged in three separate blogs and in a presentation given at: 'Terrestrial Restoration and Invasive Non-Native Species in the UK Overseas Territories and Crown Dependencies, 6th & 7th March 2023, webinar organised by UK Overseas Territories Conservation Forum' and also in an article dedicated to the project in the April 2025 issue of the Forum News.

11 Safeguarding



12 Finance and administration

12.1 Project expenditure

Project spend (indicative) since last Annual Report	2024/25 Grant (£)	2024/25 Total actual Darwin Plus Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs				
Consultancy costs				
Overhead Costs				
Travel and subsistence				
Operating Costs				
Capital items				
Others				
TOTAL	56,572	61851.64		

Staff employed (Name and position)	Cost (£)
Rob [redacted]	[redacted]
Norbert [redacted]	
Phil [redacted]	
Jayne [redacted]	
Lisa [redacted]	
Yuen [redacted]	
Thomasz [redacted]	
Vince [redacted]	
Rebecca [redacted]	
Zac [redacted]	
TOTAL	

Other items – description	Other items – cost (£)
Water cans Optigene strips for LAMP	[redacted]
TOTAL	

12.2 Additional funds or in-kind contributions secured

Matched funding leveraged by the partners to deliver the project	Total (£)
In kind contribution staff time ENRP, St Helena	[redacted]
CABI membership allowance	
CABI in-kind overhead reduction	
BIoFR PhD funding	
TOTAL	

Total additional finance mobilised for new activities occurring outside of the project, building on evidence, best practices and the project	Total (£)
C20108 Grant Funding Agreement for St Helena Phytophthora Outbreak, Defra 2023/24	[redacted]
C25062 Grant Funding Agreement for St Helena Phytophthora Outbreak, Defra 2024/25	
TOTAL	

12.3 Value for Money

Although cost implications caused by pathogens to the ecosystem, forestry and agriculture on St Helena are difficult to estimate, these are significant in relation to the population of this territory, and this project addressed an urgent, high-profile conservation issue. By aiding the preservation of key-stone species, we remain on track to prevent the extinction of many endemic taxa associated with said pathogens, thereby achieving significant impact. Although agriculture mostly supports domestic demand, effective production is vital to sustain livelihoods and maintain general health on the island. The fragility of the food security of St Helena has been exposed during the Covid crisis, where disruptions to food supply chains have resulted in shortages and contributed to high food prices. Local income through the recovery of tomato and lettuce production during the project is most likely to have already made the investment this project has made to this success, and will continue to do so in the coming years. Travel costs to St Helena are high, and a number of visits were required for this project. However, we provided high value for money by addressing a wide range of issues related to

pathogens, which under other circumstances would require several separate projects. During individual visits, we worked simultaneously on several strands (diseases of endemics, forest trees and crops; diagnostics and implementation of solutions). Value for money was also provided through significant contributions of all project partners, the matched PhD funding and complementary funding from Defra. CABI, as a not-for-profit organisation owned by member states, was able to provide the highest levels of expertise at competitive cost rates. Adopting cost-effective procedures to stay viable as an organisation has allowed CABI to keep overheads to a minimal level whilst maintaining efficient overseas work practices.

13 Other comments on progress not covered elsewhere

The design of the project remained the same. However, due to the significant threat posed by the highly invasive soilborne pathogen *Phytophthora kelmanii* that emerged early in the project, the overall focus had to shift toward assessing this specific pathogen. This required extra efforts put into identification, pathogenicity testing and monitoring of its the current distribution and spread on St Helena. It was only possible to cover these emerging and complementary activities, which were beyond the scope of this project, through additional matched funding. In particular the development of a suitable method of soil sampling (and pathogen screening) to monitor the spread of *P. kelmanii*, went significantly above and beyond what would have been possible under the initial budget (limit at time of application at £300k) and the necessity to do this could not have been predicted at the outset of the project.. The rate of ongoing loss of endemic trees remains alarming and unsustainable even over a short period. There is therefore still a significant risk of losing not only the tree species themselves but also their associated endemic deadwood invertebrates, if the essential work covered through this project cannot be continued through further funding during the next months and years. Similarly, on the level of methods used in the project to cover all objectives there had to be some adjustment made. Again, this did not change the design of the project as such but is part of a normal research procedure, which requires a constant refinement of procedures building year-on-year on the ongoing observations and results. To a small degree we also adjusted the format of some outputs to make them complementary to the outputs of the FCDO-funded Cloud Forest project, which took place during the same time period as DPLUS157.

14 OPTIONAL: Outstanding achievements of your project (300-400 words maximum). This section may be used for publicity purposes.

I agree for the Biodiversity Challenge Funds to edit and use the following for various promotional purposes (please leave this line in to indicate your agreement to use any material you provide here).

File Type (Image / Video / Graphic)	File Name or File Location	Caption, country and credit	Online accounts to be tagged	Consent of subjects received (delete as necessary)
Video	https://youtu.be/z_b-gxrg17Q	A Study of Tree Disease on St Helena - Amy Webster & Jayne Crozier		Yes / No
Audio-Radio interview	https://open.spotify.com/episode/7j52F8x3iOfAJ4PNghHrXx?si=b41275e1e4c948d1&nd=1&dlsi=9c23eb1c30c34c97	In Scope: Environment and Natural Resources and planning – Focus on update on Peaks National Park		Yes

Phytophthora kelmanii was only formally described in 2021, the year this project started (Crous et al. 2021). Just two years later it was already reported in the literature as being highly invasive; *"P. kelmanii is also predicted to be highly invasive, and this is supported by the re-evaluation of GenBank data, which shows this species can already be found in 21 countries"* (Marcot et al. 2023). Pathogenicity experiments conducted by DPLUS157 in 2024 and 2025 confirmed *Phytophthora kelmanii* as the causal agent behind the dieback of Whitewood (*Petrobium arboretum*) and potentially She Cabbage (*Lachanodes arborea*). The pathogen has been found in dying She Cabbage plants in the field and was recovered from diseased roots during pathogenicity tests, where plants were subjected to 72 hours of waterlogging. This suggests She Cabbage may be susceptible to infection under stress conditions, such as prolonged soil saturation, supporting its classification as a potential host. Both tree species are endemic to St Helena, and these findings provide important new insights into the host range of this invasive pathogen. Positively identifying the cause of the decline of these endemic tree species is a big step towards the long-term conservation of these critically endangered species.

Annex 1

Project summary	Progress and achievements
Impact Biodiversity on St Helena will not be threatened with loss due to invasive non-native plant pathogens and livelihoods based on production and use of the Island's natural resources will be improved.	We have achieved what we set out to do during the project. Vegetable production—the only crop group severely affected by pathogens—has increased significantly by the project's end, thanks to new management practices introduced in 2022. A broad range of stakeholders now possess the capacity to independently diagnose and manage plant pests and diseases, developed through comprehensive training events. Pathogen identification capabilities have improved through laboratory training and the installation of new diagnostic equipment, as originally planned. Additionally, a new cost-effective detection system has been established, enabling St Helena staff to produce disease-free seedlings essential for conservation and forestry. This success is underpinned by updated protocols, upgraded facilities, and staff training. Current and future conservation efforts within the Peaks National Park are supported by a tailored phytosanitary protocol designed to mitigate the impact of invasive soilborne tree pathogens.
Outcome St Helena will have an increased local capacity to manage plant and insect pathogens, reducing the risk of biodiversity loss and increasing economic prosperity	
Outcome indicator 0.1 Changes to habitat management practices in the cloud forest, and afforestation areas based on best practice recommendations. Healthier nursery stock in production by end of project (please note: a slowed or reversed dieback due to the measures put in place will only become apparent within 10 years after termination of the project).	Confirmation of *Phytophthora kelmanii* as the causal agent behind the dieback of Whitewoods and potentially She Cabbages led to the development of a management plan for cloud forest habitats (Annexe 5.5). Research conducted during the project informed a new protocol for producing healthy nursery stock at ENRP facilities in Scotland and St Helena, in collaboration with the Cloud Forest Project team. This protocol was validated by the availability of disease-free seedlings used in multiple pathogenicity trials in 2024 and 2025. The new management plan, incorporating best-practice recommendations to mitigate the impact of *P. kelmanii*, will be integrated into the overall strategy for Peaks National Park and will also address other soilborne pathogens with similar ecologies.
Outcome indicator 0.2 Reduction in reported crop failures due to disease (currently the failures of at least 5 crops can mostly be attributed to pathogens or unknown causes that might be pathogens. More crops are not reaching full maturity due to disease)	Training for growers and extension staff included modules on disease diagnostics and management. Of all crop failures, only two were conclusively attributed to fungal or bacterial pathogens. After addressing plant disease issues in indoor vegetable production at St Helena's largest site, production has improved markedly, as shown by photos in Annexe 5.4. Since then, no tomato or lettuce crop failures have been reported. Continuous training of ENRP and SHRI staff in laboratory and plant pathology techniques throughout the project has enhanced their ability to support growers with accurate diagnostics and effective management recommendations. This progress has contributed to a reduction in crop failures due to disease.
Outcome indicator 0.3 Increased lab diagnosed diseases from current level, 3, to 15 by the end of the project	The project team on St Helena, (staff from ENRP and SHRI) have independently isolated numerous fungi from diseased plants, primarily from endemic trees, and sent four batches of isolates for further identification to CABI. These skills were complemented through further training in the use of the LAMP system for the identification of tree pathogens. Staff at ENRP and SHRI, using the new lab facilities and equipment, have shown that they can independently conduct pathogen isolation and identification. A testing regime for seedlings produced in St Helena, based on LAMP technology, enables close monitoring of *P. kelmanii* presence throughout the production process. The laboratory in Scotland currently holds sufficient

	consumables to sustain diagnostics for a period long enough to establish a contingency budget for replenishing any used materials.
Output 1 Pathogens at the heart of existing and emerging threats identified for the agricultural, forestry and environmental sectors.)	
Output indicator 1.1 At least 50 searchable records of pathogens and their hosts recorded in St Helena accessible in newly developed Excel database, by end of Y1 (The Y1 records create a baseline against which to assess new pathogen records. The database brings together, historical information on plant/insect pathogens as well as those newly identified through surveys undertaken during the project. Currently the small amount of published information on the presence of plant pathogens on St Helena is highly dispersed and not accessible in one place or searchable for specific taxa)	This output was achieved during the first project year. Surprisingly little data is available through public information resources regarding existing records of plant pathogens on St Helena (40 records) and almost nothing regarding pathways and impact. Some records were found through the digitised data from the old 'International Mycological Institute' (IMI) and a full text assessment of the literature in the CABI 'Crop Protection Compendium' (CPC). These few records are nevertheless important and are included in the first version of the project database now established and attached as Annexe 5.1 of this report. During the first visit to St Helena the library of ENRP and Plantation House (seat of the governor) were searched for useful information. However, there was little information, and what was available was not sufficiently technical to be of use.
Output indicator 1.2 Number of records held in database increased year on year exceeding 300, by Y4 Q3 (The database will be regularly updated with findings from the surveys undertaken on St Helena. It is anticipated that several revisions will be made to the database)	This output was accomplished by the end of year 3. The latest version of the database, including the results from the literature research and records collected during the nine visits, is attached as Annexe 5.1 to this report. The database will remain open after the termination of the project for further records to be included. The latest version of the database has 435 entries. It is important to mention that at least two new plant pathogens have been discovered, which are closely associated with endemic plants on St Helena. One is a *Ramulariopsis* species on Jellico and the second a new undescribed rust fungus on Whitewood (see Annexe 5.2). In addition, a new tree database has been established by SHRI (Annexe 5.17)
Output 2. Current and future impact of pathogens on the Peaks cloud forest species and economically important crops assessed.	
Output indicator 2.1. At least 1 plant pathogenic taxon each affecting endemic tree species and agricultural crops identified by Y3, Q3, which had not been recorded or managed before the start of the project (by the final year it will be known whether plant pathogens are the main causal agent, or at least contributing factors, to the tree dieback) Currently, the causes of the dieback of trees on St Helena are unknown)	A *Phytophthora* species belonging to clade 8a was isolated from dying Whitewood, dogwood, redwood and She Cabbage early in the project. This pathogen has now been identified as *P. kelmanii*. Several other pathogenic genera have been identified from dying plants and may be implicated in the decline. These include *Fusarium, Ilyonectria*, and *Pythium.* Due to the recognition that the endemic trees are difficult to propagate and that it takes longer to produce specimens of a sufficient size to conduct pathogenicity experiments the necessary experiments could only start in 2024. However, we have delivered this output but the end of the project, by confirming *P. kelmanii* as the causal agent for Whitewood and She Cabbage.

	A new plant rust, most likely co-evolved, has been discovered on Whitewood and is currently in the process of being described as a new species. No specific management measures are required for this native pathogen. *Pythium* and *Pseudomonas* were identified pathogens behind the yield losses in tomato and lettuce production respectively. We have also recorded a new pathogen associated with Cape yew, which is an important forestry species on St Helena.
Output indicator 2.2 Impact of the two most threatening pathogens quantified using a combination of disease severity and potential dispersal pathways by Y4Q4	Intensive survey work, most of it based on soil sampling, an additional time consuming and costly activity only possible through matched funding, has led to the production of a set up maps showing the spread of *P. kelmanii* and its association with endemic tree species and underlining the dramatic impact this species has got on endemic trees. A newly refined methodology targeted to the circumstances on St Helena and based on leave baiting in water reservoirs also significantly improved our knowledge on how easily soilborne pathogens can move downhill from infected sites, even when buffered large stretches of undisturbed vegetation. The high impact of *Pythium* and *Pseudomonas* on tomato and lettuce production became evident at the beginning of the project, but exact quantification was not possible to lack of baseline data. Work on these pathogens included assessing the risks of spreading the pathogens to other production sites.
Output indicator 2.3 All pathogenic taxa recorded during the project in association with economically important crops and endemic tree species profiled regarding their potential future impact by Y4Q3 (This will include, for the first time, identification of pathogens to species level (so far only generic diagnosis such as 'blight' etc. appear in island literature)	Samples were collected by CABI pathologists and the BiFoR team from all endemic tree species showing signs of pathogen infection, including soil samples taken from around diseased trees. Initial pathogen isolation from leaf, branch, and trunk tissue was conducted at the newly refurbished ENRP laboratory in Scotland, St Helena. These plates, along with frozen leaf and soil samples, were then transported to CABI facilities in Egham, UK, for further analysis. Most samples were identified to species level, with results compiled in the database presented in Annexe 5.1. Notably*, Phytophthora kelmanii*, a pathogen only recently described to science, has been extensively studied through this project, significantly advancing knowledge of its biology and impact. Additionally, several potential plant pathogenic genera have been identified and profiled, forming a valuable basis for further studies should additional funding become available.
Output indicator 2.4 All entomopathogenic fungi (EPF) recorded during the project profiled regarding threats and benefits for endemic invertebrates present on St Helena by Y4Q3 (For the first time EPF will be identified to species level)	Upon completion of comprehensive surveys for entomopathogenic fungi (EPF) identification and subsequent evaluation of the threats posed by these pathogens to endemic invertebrate species, a detailed profiling of several entomopathogenic fungi—currently awaiting formal taxonomic description—has been achieved, as documented in Indicator 2.3 (Annexe 5.3).
Output 3. Action plan to mitigate priority identified threats developed with and made available to all stakeholders	
Output indicator 3.1 Adoption of improved management practices for at least 4 priority threats to cloud forest species and/or economically important crops. by Y4Q2	From the beginning, the repeated isolation of a soilborne *Phytophthora* (*P. kelmanii)* from dying endemic plants made this pathogen a strong candidate for the tree dieback observed on St Helena and this pathogen has now been confirmed as a causal agent behind the dieback of Whitewoods and potentially She Cabbage trees. However, prior to this discovery and due to the perceived threat based on the experience of similar *Phytophthora* species elsewhere in the world a task force was initiated. The task force included a wide range of stakeholders and met on a regular basis. Recommendations from the taskforce include a range of

	phytosanitary measures, including significant restrictions on access of either already infected or very sensitive sites. Further conservation work will also be linked to recommendations made in a disease management plan (Annexe 5.5). In addition, new protocols for the disease-free production of tree seedlings have been introduced in collaboration with the Cloud Forest project team based on results from this project and including the development of new testing methods and protocols, making use of non-invasive baiting of leachate and assessment through the LAMP system installed during this project. Improved management procedures have also been adopted for the management of *Pythium* and *Pseudomonas* in vegetable production in St Helena.
Output 4 Capacity for St Helena to address threats caused by pathogens independently increased.	
Output indicator 4.1 At least 30 stakeholders (disaggregated by gender, age, etc.) proficient in the diagnosis of diseases and best practice for effective control by Y3Q4	Training of stakeholders in diagnostics and disease management has been finalised through five workshops held on St Helena in 2022 and 2023, targeting extension, research staff and commercial and other growers (see Annexe 5.12). Training primarily focused on disease diagnostics management, and all sessions received positive feedback from attendees, as documented through questionnaires. Training material based on CABI's Plantwise program had been developed prior to the workshops. Stakeholders covered through the training have been both commercial and private growers' staff of ENRP, trainees at SHAPE and pupils of the secondary school in St Helena.
Output indicator 4.2 At least 6 staff trained in the use of diagnostic facilities enabling them to independently isolate and diagnose plant diseases by Y4Q1	A significant milestone towards achieving this output was reached through the refurbishment of the pathology laboratory at ENRP (St Helena; Scotland site), equipping it comprehensively for the isolation and morphological identification of pathogens. This capability was further enhanced in 2023/24 with the installation of new equipment enabling staff on St Helena to perform DNA extractions for the detection of specific pathogens from diseased plant samples (see photos earlier in this report). Training on the use of this equipment has been provided to seven staff members from ENRP and SHRI. Jointly collected diseased plant samples served as practical material for on-the-job training, building capacity for independent sample processing in the future. The training covered the use of laminar flow cabinets, autoclaves, agar preparation, and pathogen isolation techniques. Although time-intensive, this hands-on training was essential to initiate the pathogen surveys collaboratively.
Output indicator 4.3 4.3 At least 300 records and information about known pathogens of St Helena available online by Y4Q4	Recording of pathogens continued throughout the project, and after initial training in diagnostics, was supported by the teams on St Helena, who have independently recorded a high volume of samples. The database in Annexe 5.2 shows currently 431 records and will be made available shortly. In addition, SHRI has started to put together a database linking pathogen records to individual trees within the PNP.
Output 5 Pathogen treatments implemented.	
Output indicator 5.1	

At least one new treatment measure developed and tested during Y3Q2 to Y4Q2	Pathogen management has been successfully implemented in the horticultural sector (Annexe 5.4). Comprehensive management recommendations have been provided for future conservation work to address and mitigate the impact of *P. kelmanii*, which, to a certain degree, also covers other soilborne pathogens with a similar ecology (Annexe 5.5). Advice was provided on the growth conditions of the seedlings in the nursery, which has led to an updated protocol allowing the production of disease-free seedlings.
Output indicator 5.2 At least one new treatment practice(s) demonstrates a quantifiable reduction in the spread and/or severity of disease, by Y4Q3	Assessing the situation scientifically has become challenging due to the lack of baseline data on yield, as previous records were not kept, and growers cannot provide precise measurements of current yield levels. However, the report in Annexe 5.4 clearly demonstrates a significant recovery from substantial yield losses following the implementation of adequate phytosanitary treatments.

Annex 2 Project's full current logframe as presented in the application form (unless changes have been agreed)

Project summary	SMART Indicators	Means of verification	Important Assumptions
• **Impact:** (Max 30 words) Biodiversity on St Helena will not be threatened with loss due to invasive non-native plant pathogens and livelihoods based on production and use of the Island's natural resources with be improved.			
• **Outcome:** St Helena will have an increased local capacity to manage plant and insect pathogens reducing the risk of biodiversity loss and increasing economic prosperity. • (Max 30 words)	Changes to habitat management practices in cloud forest, and afforestation's based on best practice recommendations. Healthier nursery stock in production by end of project (please note: a slowed or reversed dieback due to the measures put in place will only become apparent within 10 years after termination of the project). Reduction in reported crop failures due to disease (currently the failures of at least 5 crops can mostly be attributed to pathogens or unknown causes that might be pathogens. More crops are not reaching full maturity due to disease). Increased lab diagnosed diseases from current level, 3, to 15 by the end of the project.	1.1 Existing management plan updated to address dieback with new best practice guidelines; assessment report as Annexe to final project report comparing pathogen levels at start and end of project within nurseries (please note: a slow down or decrease of dieback resulting in higher survival rates of nursery stock can only be recorded by national park and forestry management in years after the termination of the project). 1.2 Survey results on yield improvement compared to levels at the start of the project conducted in Y3Q4 to Y4Q3 and provided as final report Annexe. (please note: yield improvement will also lead to decrease in expensive imports of horticultural produce. However, this is likely only to become apparent within 5 years after the termination of the project). 1.3 Lab protocols /records and publication of new disease records by the end of the project.	• Sufficient baseline data already available to allow comparison • Mitigation: In case of lack of baseline data, gathering of data at the start of the project. • There are no outbreaks of Covid on St Helena that will cause significant disruption/delay to project delivery and there are no new variants in the UK that will result in a change to the current quarantine restrictions. • Mitigation: The timing of travel will remain as flexible as possible so as to accommodate any changes in the Covid status of the countries. Training could be provided remotely so as to avoid quarantine restrictions if circumstances demand. • Identified stakeholders, including women, are available to participate in project activities. • Mitigation: Ensure training dates are flexible to accommodate the other commitments of stakeholders. • All partners and their staff deliver timely on their commitments to the

Project summary	SMART Indicators	Means of verification	Important Assumptions
			project. • Mitigation: Regular steering group meetings and Project Governance according to Prince 2 methodology. • Applied research approved by St Helena Research Council. Mitigation: Project has been designed and developed with local authorities and reflects locally identified needs and priorities.

Project summary	SMART Indicators	Means of verification	Important Assumptions
Outputs: **1.** Pathogens at the heart of existing and emerging threats identified for the agricultural, forestry and environmental sectors.	[redacted]	[redacted]	Archived data is freely accessible. Mitigation: Pay for literature not freely accessible from consumable budget. Export licenses for pathogen samples in place to allow identification at CABI & UoB facilities in the UK. Mitigation: Focus at the start of the project on getting licenses approved in time. Access to the infected parts of the infected trees is easily possible. Mitigation: Use telescopic tools to reach high branches. Local farmers willing and keen to engage and share their local knowledge. Mitigation: Share information about the project and potential benefits to them. Providing access to the resources produced as a result of the project. Timing of travel to and from St Helena not disrupted by COVID 19 or adverse weather conditions. Mitigation: Having within each financial year as much flexibility as practical in timing of activities so that the project can accommodate flight delays and quarantine requirements.
2. Current and future impact of pathogens on the Peaks cloud forest species and economically important crops assessed.	[redacted]	2.1 & 2.2 Preliminary observations and findings described in [redacted] survey reports and available in annual reports. First journal publication in case of discovery of a new disease by end of project.	Standard diagnostic procedures allow to measure current spread of pathogens Mitigation: Drawing in external specialist advice in case unusual methods have to be employed.

Project summary	SMART Indicators	Means of verification	Important Assumptions
	[redacted]	2.1 & 2.2 Draft assessment/impact reports on cloud forest species and economically important crops, including identification and prioritization of threats available by [redacted] [redacted]Preliminary findings and observations described in [redacted] field survey reports and included as an Annexe in the final project report.	Travel to and from St Helena not disrupted by COVID 19 or adverse weather conditions Mitigation: Having as much flexibility as practical in timing of activities so that if flights delayed or quarantine required it can be accommodated within the FY.
3. Action plan to mitigate priority identified threats developed with and made available to all stakeholders.		3.1 Action plans published and disseminated to stakeholders by [redacted] Plans included as Annexes to the final project report.	Treatments and best practice procedures are available or can be developed based on existing knowledge of the pathogens newly identified and recorded for St Helena. Mitigation: Drawing in specialist external advice in case unusual methods have to be employed

Project summary	SMART Indicators	Means of verification	Important Assumptions
4. Capacity for St Helena to address threats caused by pathogens independently increased.	[redacted]	4.1 Training Material; PPT presentations; list of workshop attendees, attendee feedback reports.	Timely availability of facilities to hold workshop on St Helena. Stakeholders are keen and available to engage Mitigation: Book early, early engagement, advertisement & timely invitations and venue/workshops timed to suit stakeholders.
	[redacted]	4.2 Before and after photos of improved facilities; press releases; first recorded diagnosis in new lab and the publication of new disease reports from St Helena (available as Annexe in second annual project report). 4.3. Test protocols available. Plantwise test results show an increase of knowledge in trainees by an increase in the score between the two tests. 4.4 DOI to pathogens of St Helena published and shared by the end of the project.	Travel to and from St Helena not disrupted by COVID 19 or adverse weather conditions Mitigation: Shift to virtual online training workshop.

Project summary	SMART Indicators	Means of verification	Important Assumptions
5. Pathogen treatments implemented.	[redacted]	5.1. Protocols of rollout added to final project report. 5.2. Report of results of survey in crops and nursery stock included as Annexe to final project report.	Internet connection will allow remote organisation and supervision of activities including the use of shared remote microscopy Mitigation: Use consumable budget for extensive telephone communication. Farmers amenable to implement changed farming practices. In case of pesticide requirement availability of products is guaranteed Mitigation: Starting public engagement with farmers at an early stage; explore the potential to use alternative products.

Table 1 Project Standard Indicators

DPLUS Indicator number	Name of indicator	Units	Disaggregation	Year 1 Total	Year 2 Total	Year 3 Total	Year 4 Total	Total achieved	Total planned
4.1	At least 30 stakeholders (disaggregated by gender, age, etc.) proficient in the diagnosis of diseases and best practice for effective control by Y3Q4	**people**	**women**		**7**	**8**		**9**	**15****
4.1	At least 30 stakeholders (disaggregated by gender, age, etc.) proficient in the diagnosis of diseases and best practice for effective control by Y3Q4	**people**	**men**		**38**	**28**		**45**	**15***
4.3	At least 6 staff trained in the use of diagnostic facilities and able to independently isolate and diagnose plant diseases by Y4Q1.	**people**	**women**		**6**	**8**		**9**	**3***
4.3	At least 6 staff trained in the use of diagnostic facilities and able to independently isolate and diagnose plant diseases by Y4Q1.	**people**	**men**		**7**	**2**		**7**	**3***

* There was no gender disaggregation for the total number of people to be traines, 30 in total for all stakeholders and 6 in total for staff

Table 2 Publications

Title	Type (e.g. journals, manual, CDs)	Detail (authors, year)	Gender of Lead Author	Nationality of Lead Author	Publishers (name, city)	Available from (e.g. weblink or publisher if not available online)
A Study of Tree Disease on St Helena	You tube video	Amy Webster & Jayne Crozier (2024)	female	British	SAMS, St Helena	https://youtu.be/z_b-gxrg17Q
In Scope: Environment and Natural Resources and planning – Focus on update on PNP	Radio interview	Anita Robbertse, SAMS (2024)	female	British	SAMS, St Helena	https://open.spotify.com/episode/7j52F8x3iOfAJ4PNghHrXx?si=b41275e1e4c948d1&nd=1&dlsi=9c23eb1c30c34c97
In Scope: Environmental. Natural Resources & planning	Newspaper article	Anita Robbertse, SAMS (2024)	female	British	SAMS, St Helena	Sentinel, St Helena

Title	Type (e.g. journals, manual, CDs)	Detail (authors, year)	Gender of Lead Author	Nationality of Lead Author	Publishers (name, city)	Available from (e.g. weblink or publisher if not available online)
Portfolio - Focus on update on PNP						
Mapping Phytophthora kelmanii, a plant pathogen threatening endemic trees in St Helena	Article	Norbert Maczey, Rebecca Cairns-Wicks, Elizabeth Clingham, Rob Reeder (2025	male	German	UK Overseas Territories Conservation Forum	https://www.ukotcf.org.uk/wp-content/uploads/2025/04/Forum62_April2025d.pdf
CABI to work in partnership to help protect St Helena's biodiversity and enhance its agriculture	Blog	Wayne Coles (2021)	male	British	CABI	https://blog.cabi.org/2021/09/27/cabi-to-work-in-partnership-to-help-protect-st-helenas-biodiversity-and-enhance-its-agriculture/
Project to investigate the microbial diseases of St Helena's crop plants takes root	Blog	Phil Taylor, Rob Reeder (2022)	male	British	CABI	https://blog.cabi.org/2022/03/14/project-to-investigate-the-microbial-diseases-of-st-helenas-crop-plants-takes-root/
Managing the pathogens threatening St Helena's biodiversity and food security	Blog	Phil Taylor, Rob Reeder (2025)	male	British	CABI	https://blog.cabi.org/2025/06/12/managing-the-pathogens-threatening-st-helenas-biodiversity-and-food-security/

Checklist for submission

	Check
Different reporting templates have different questions, and it is important you use the correct one. Have you checked you have used the **correct template** (checking fund, scheme type of report (i.e. Annual or Final), and year) and **deleted the blue guidance text** before submission?	
Is the report less than 10MB? If so, please email to BCF-Reports@niras.com putting the project number in the Subject line.	
Is your report more than 10MB? If so, please consider the best way to submit. One zipped file, or a download option, is recommended. We can work with most online options and will be in touch if we have a problem accessing material. If unsure, please discuss with BCF-Reports@niras.com about the best way to deliver the report, putting the project number in the Subject line.	
If you are submitting photos for publicity purposes, **do these meet the outlined requirements (see section 14)?**	
Have you included means of verification? You should not submit every project document, but the main outputs and a selection of the others would strengthen the report.	
Have you provided an updated risk register? If you have an existing risk register you should provide an updated version alongside your report. If your project was funded prior to this being a requirement, you are encouraged to develop a risk register.	
Have you involved your partners in preparation of the report and named the main contributors	
Have you completed the Project Expenditure table fully?	
Do not include claim forms or other communications with this report.	