Science Review of CABI

2015

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1. Executive Summary and Recommendations

The external review team was asked to assess CABI's progress and achievements in science since the last review in 2009 and to recommend action to help ensure its science remains strong, of high quality and focussed on priority issues. The review was carried out by a team of 8 reviewers who between them visited most of the Centres in the regions where CABI works and then met in Egham for two days to agree on the overall outline of the report and the main observations and recommendations. Staff and a small number of key partners were surveyed to solicit their views on CABI's current and future scientific work.

The world in which CABI operates today is very different from that of 2009, presenting new challenges and opportunities. These result from, *inter alia*, the anticipated agreement on the Sustainable Development Goals; the impact of the financial crisis on donor funding; further moves towards a new world economic order; a greater acceptance of the reality of climate change; a growing appreciation of the importance of agriculture and the ways in which it underpins nutritional security; a better awareness of the importance of invasive pests, diseases and weeds and a renewed interest in biological control and IPM.

Science permeates and underpins all CABI does, whether in research or in knowledge management and publishing. Its mission statement underlines this: "*CABI improves people's lives worldwide by providing information and applying scientific expertise to solve problems in agriculture and the environment*." CABI's science comprises research (the generation of new knowledge), its delivery together with other evidence-based knowledge, as well as research on the delivery systems themselves. CABI works across a wide range of subjects and, in spite of having in-house scientific depth in relatively few areas (such as plant health and ICT), is able to 'punch above its weight' as a result of its broad experience and credibility as an international convenor and knowledge broker. It is crucial if CABI is to continue to play this important international convening role, that strong scientific credibility be maintained. Without this it will become increasingly difficult to recruit and retain good scientists and partner with leading scientific institutions worldwide.

> **Recommendation 1: In continuing to play its important international leadership role in applying science to development, it is imperative that the individuals CABI assigns to lead and coordinate collaborative activities have sound scientific credentials.**

Since the last review, CABI has made excellent progress in many areas, especially in the development of Plantwise, but also in its stronger financial situation, the move towards 'one CABI', the initiation of the Big Push on invasives and the strengthening of the Centres in India, China and Brazil. The overwhelming majority of comments received through the partner survey were very supportive and appreciative of CABI and its role in the world.

Given CABI's expertise and global reputation in biological control (BC), it is important that it continue to maintain and invest in competence in this area. CABI should also consider ways to extend and strengthen its biological control expertise across all regions, giving special attention to Africa. Even given CABI's strengths it cannot do everything but is well placed to build on its international leadership role in this area.

> **Recommendation 2: We recommend that CABI consider working towards further innovative international initiatives in biological control, building on its**

acknowledged international scientific leadership in this field and its strong relationships with member countries and others.

There has been relatively little uptake of BC systems in many parts of the world in spite of its potential to contribute significantly to human health, food security, environmental safety and ecosystem services, as well as some notable successes in the past.

<u>Recommendation 3</u>: CABI should consider exploring why so many promising biological control systems have remained on the shelf and what might be needed for their wide-scale implementation.

Recognizing the general reluctance of the private sector to invest in developing new BC products, CABI could usefully devote more attention to exploring the potential of Private-Public Partnerships.

<u>Recommendation 4</u>: CABI should consider further developing its capacity to identify, develop and manage private-public partnerships across all of its Centres.

CABI is well positioned for global leadership in the management of alien invasive species. There are very few other institutions operating internationally with the capacity and experience to develop and mount effective BC programmes targeting invasives. We strongly support CABI's efforts to develop a major thrust in this area and agree that in order to gain the support of donors and partners, there is an urgent need for a very strong, evidence-based case statement that highlights the social as well as economic impacts of invasives, from both an environmental and development perspective.

While we recognize that Plantwise, the highly successful flagship project of CABI, is primarily concerned with the delivery of plant health knowledge to farmers and has already been extensively reviewed, we offer a few suggestions from the perspective of CABI's science. The Plantwise Knowledge Bank, for example, is potentially a very powerful resource for further research. Although CABI is already thinking creatively as to how it can be further used, for example for pest and disease surveillance, we feel that more can be done in this direction – especially if CABI's efforts to improve data quality are successful, e.g. through greater use of digital imaging processing.

<u>Recommendation 5</u>: CABI should give greater attention to defining the kind of data needed for significant research on pest and diseases and how collecting such data can best be integrated into Plantwise. Technological advances that would facilitate the collection and validation of research-relevant data should also be further explored.

Research is needed to test the Theory of Change and impact pathways underlying Plantwise, as well to examine the extent of 'ownership' of the initiative by governments. Such research is important for improving the design and sustainability of Plantwise. CABI's is in an excellent position to lead such research, which, if done well, is likely to be highly publishable but will need additional social science and economics expertise.

<u>Recommendation 6</u>: CABI, through Plantwise, Farmer Field Schools etc. should seek to gain a better understanding of the adoption of management practices by farmers, their scalability and impact.

The Nagoya Protocol influences CABI's ability to access and distribute living material including plants, plant parts, insects and pathogens. CABI is currently working with member countries to try to develop mutually acceptable and effective access and benefit sharing (ABS) mechanisms that are in line with the Protocol. If successful, such mechanisms are likely to be of global relevance and impact.

> **Recommendation 7: Continued efforts should be made to develop mechanisms for the efficient and effective implementation of the Nagoya Protocol, for the benefit of all countries.**

CABI is obliged to provide member countries with identification services for microorganisms and demand for this is increasing. The services are underpinned by the microbial genetic resources collection that houses, in addition to project and type strains, the UK National Fungal Collection as well as strains that are held in trust on behalf of member countries. The creation of Bioservices was, in large part, an attempt to offset the costs of maintaining the genetic resources collection. The future of Bioservices in general and the collection in particular is currently being explored within CABI with separate reviews underway to look at CABI's global microbiology requirements and appraise appropriate new technologies in which CABI might invest.

> **Recommendation 8: We agree with CABI's approach to exploring options for the future of Bioservices and the microbial genetic resources collection, and recommend that CABI explore in detail the cost/benefits of out-sourcing or partnership options before deciding whether or not to invest further in building in-house capacity. Furthermore, we believe that it is important that this be addressed in the proposed Science Strategy.**

In spite of the rapid development of molecular genetic identification techniques, there is a continuing need for taxonomic back-up to interpret and validate results. However, taxonomy and identification services are becoming weaker and more fragmented around the world and while initiatives like BioNET have not proven sustainable, the problem remains as a challenge for CABI.

> **Recommendation 9: CABI should continue to explore mechanisms for international support to taxonomy and identification of plant pests and diseases, in partnership with other institutions such as Fera, the Royal Botanical Gardens, Kew and the Natural History Museum in UK as well as partners overseas**

Both internal and external stakeholders are concerned by science quality. While one key measure of scientific quality and originality is the number of publications in high impact factor journals, not all stakeholders regard this as being the most important indicator for an organization like CABI. Publishing in respected national and international peer-reviewed journals and well as citation analyses are arguably more important as evidence of the relevance and utility of science. We note that the scientists in Delémont and to a lesser extent Egham have strong scientific publications records but that the regional Centres may need additional assistance in this respect.

> **Recommendation 10: CABI should establish appropriate targets for the number and/or percentage of papers to be published in various classes of journal and should invest in achieving these targets.**

Many scientists consulted saw the lack of ready access to scientific literature as a problem in their work and an anomaly for an organization that is a world leader in knowledge management. For copyright reasons, scientists do not have access to many of the journals provided to CABI for abstracting. However, we recognize the high cost of providing access and beyond urging management to continue to try to find a solution to this anomaly we feel unable to offer any specific solutions. A number of staff members also indicated that they would like additional support for preparing scientific publications in terms of time allocation and funding.

> **<u>Recommendation 11</u>: The costs associated with publishing research should be included in funding proposals to donors whenever possible; both staff time and the cost of publishing in open access journals should be included.**

There are few specific incentives for scientists to publish in scientific journals beyond their consideration for promotion and for small 'above and beyond' awards.

> **<u>Recommendation 12</u>: CABI should consider providing additional incentives to reward and promote scientific excellence such as bonuses, special awards of recognition, opportunities to attend scientific meetings and short-term sabbaticals.**

CABI is widely respected as a development-focused organization having a deep understanding of scientific research. This should be maintained.

> **<u>Recommendation 13</u>: CABI should continue to strengthen its "science culture", making sure all staff are well-informed through such means as regular live and virtual seminars, internal publications and increased opportunities for staff to attend relevant scientific events and courses**.

> **<u>Recommendation 14</u>: We encourage CABI to seize opportunities, wherever possible, to build specific research activities into development projects.**

CABI's dependence on, and commitment to science highlight the need for a specific science strategy that maps out the broad focal areas for CABI's scientific activities and indicates how it will address them. It should be based on a theory of change that explains how CABI's scientific research will aid the achievement of its goals and should identify CABI's approach and commitment to ensuring scientific quality.

> **<u>Recommendation 15</u>: The review team strongly recommends that a specific Science Strategy be developed that addresses how CABI will operate as a science-led organization.**

CABI is to be complimented on the considerable progress made in monitoring and evaluation (M&E) since the last review, particularly in Plantwise. However, the systems in place are largely aimed at monitoring, to ensure delivery on project targets, rather than on evaluating intermediate or ultimate impacts. The latter is arguably a more important activity from a scientific perspective and is a research exercise in its own right.

> **<u>Recommendation 16</u>: CABI should further develop its skills relevant to programme design and evaluation, including in such areas as the design of projects based on convincing theories of change and impact pathways, the use of *ex ante* modelling to predict outcomes of interventions, and the wide range of quantitative, qualitative methods available for *ex post* evaluation.**

With respect to future investment, the review team recommends:

> **<u>Recommendation 17</u>: Investment is needed in the maintenance and further development of the areas of CABI's core competence in plant health: IPM, Biological Control, invasives, SPS, quarantine etc., not only in Europe but also in the regions. New areas for possible investment include strengthening capacity to manage 'Big Data' and to make greater use of geographic information systems (GIS).**

In order to address a number of the earlier recommendations (e.g. 3, 6 and 17) additional strength is needed in economics and social sciences. Investing in these disciplines is considered a high priority.

> **<u>Recommendation 18</u>: CABI should seek expert advice to (1) help identify the research opportunities and needs in social science and economics across its programmes and (2) identify the most appropriate mix of staff investment and supporting partnerships to address these opportunities and needs.**

CABI is to be congratulated on its high degree of staff continuity. However, a substantial number of scientific staff, especially in Egham, will soon retire. Recent recruiting has tended to be more broadly based, with a higher proportion of staff lacking PhD-level science training than in the past.

> **<u>Recommendation 19</u>: It is important that CABI keep its staff succession plans under regular review, taking into account the proposed science strategy and making it clear which positions require high-level scientists and which can be filled by 'generalists'.**

The Delémont Centre, in particular, makes excellent use of PhD research students as well as summer students in its research programme.

> **<u>Recommendation 20</u>: All CABI Centres should look into the possibility of involving more research students in their science activities and try to secure the resources needed for this.**

The review team congratulates CABI on the considerable progress made in integrating its work across the various Centres and recognizes the high level of support this receives from staff. Science is, in many different ways, a unifying force in CABI.

> **<u>Recommendation 21</u>: In further strengthening programmatic integration we recommend that senior management:**
> - **Take additional measures to promote staff exchanges among Centres;**
> - **Create greater incentives for collaboration, particularly to develop larger, more integrated projects that involve more than one Centre;**
> - **Make additional investments in the regions;**
> - **Locate additional cross-CABI leadership positions in the regions.**

CABI currently has no single person with overall line management responsibility for science. The task is divided between the Executive Director, Global Operations and the Executive

Director, International Development. While these arrangements have served CABI well up to now, with the many impending retirements, intended decentralisation and growing diversification of CABI's programmes, this may not be optimal for the future.

> **<u>Recommendation 22</u>: Senior management should explore the possibility of having a senior position with global executive responsibility for CABI's science.**

Science policy, strategy, quality and strategic oversight are among the key responsibilities of the CABI Board. Without in any way belittling the excellent scientists currently on the Board, we feel it is important for the Board to be able to call upon the breadth of scientific strength it needs to make wise decisions across the full range of CABI's scientific work.

> **<u>Recommendation 23</u>: the Board should consider ways and means to strengthen its science oversight capacity.**

The review team's recommendations regarding the various individual regions and Centres are covered briefly in section 20 of the main report and more fully in Annexes 6 to 12.

2. **<u>Acknowledgements</u>**

The review team wishes to thank the Board and senior management of CABI for inviting us to review their wonderful organization. We are very grateful for the support and assistance we received throughout the process from staff at all levels and in all regions. Everyone we encountered was enthusiastic, open and helpful and we thank them for this. We would particularly like to thank the Director General, Trevor Nicholls, for his advice and encouragement as well as the Executive Director, Global Operations, Joan Kelly and the Chief Scientist, Mathew Cock, who guided us through the process, making available key documents, providing important information and tirelessly explaining CABI's complexities. We would like to thank all those who responded to the staff and partner surveys – the feedback provided was extremely helpful. To Emma Thompson and Trinity Pearce: many thanks for the logistical support you provided for our travel, meetings, contacts and not least in helping to prepare this report, your efforts were greatly appreciated. And finally we would like to express our thanks to Andrew Bennett, who so ably represented the Board in the review process, attending many of the meetings and providing valuable comments on the draft reports. While the report is entirely the responsibility of the review team, it has benefitted immeasurably from Andrew's wisdom and insights.

3. <u>Introduction</u>

In 2009 CABI's Board and Management commissioned an external review of the organisation's scientific activities. A number of key recommendations were made that were followed up over the following years; see section 6. This current external science review was commissioned in 2015 with a view to taking stock of developments since 2009, and to recommend specific action to help ensure that CABI's science remains strong, of high quality and focussed on relevant, priority issues. The full Terms of Reference of the review are given in Annex 1.

A team of 8 reviewers was put together with one of them, Geoff Hawtin, acting as chairman; a brief c.v. of each reviewer is given in Annex 2. A preliminary face-to-face/video conference was held on 12th December 2014 to discuss the terms of reference and finalize the workplan. It was agreed that most of the CABI Centres would be visited by one or more reviewers, who would submit reports outlining their main observations and recommendations for inclusion in the final,

overall report. A summary of each of these reports is given in section 20 below and the full reports are provided in Annexes 6-12.

Following the individual visits, the full review team (with the exception of Christian Borgemeister and John Lynam) met for two days in Egham, UK at the beginning of April 2015 to agree on the overall outline of the report and the key observations and recommendations to be included. Various drafts were then prepared and circulated for comment and revision, with the result that all of the reviewers are pleased to endorse this, the final version of the report.

To assist in the review process, CABI set up a series of shared folders in Dropbox to make available a wide range of relevant documents. In addition Matthew Cock kindly provided an analysis of recent staff publications, and a staff survey was carried out, the results of which were summarized and made available to the review team by Matthew Cock and Emma Thompson (see section 7.1). A small sample of CABI's key partners was also surveyed using a short questionnaire and the main results of this are presented in section 7.2.

The team spent some time considering the overall scope of the review, in particular addressing the question: "What is science in the CABI context"? As a scientifically based organization, science permeates and underpins all CABI does, whether in research or in knowledge management and publishing. CABI science comprises research (the generation of new knowledge), the delivery of that – and other evidence-based knowledge – plus research on the delivery systems themselves. Increasingly, and as highlighted in this report, assessing the impact of CABI's overall programme is also a scientific research exercise in its own right. While recognizing the ubiquity of science within CABI, we were aware that we were not expected to address the totality of CABI's activities, and have thus confined ourselves primarily to those areas that result in the generation of new knowledge, and the interface between these and the delivery of knowledge. We point out the need for CABI to continue strengthening its overall "science culture" across the organisation, and indicate ways in which even development-oriented activities can be designed such that they generate important new knowledge.

The report makes a large number of suggestions and recommendations throughout. Those that the review team feel are particularly important have been underlined in the report and the most important of these are listed in the Summary and Recommendations.

4. The Global Context

The world in which CABI operates today is very different from that of 2009, presenting many new and different challenges and opportunities. These include:

- In 2009, the economic crisis was just beginning. Although there are now good signs of economic recovery, the impact of the recession on research and overseas aid was significant throughout the period under review.
- While the OECD countries have generally stagnated, economic and other power has continued to shift towards the emerging economies such as the BRIC countries, S. Africa, Mexico, S. Korea and others.
- Africa too has seen a decade of significant growth in *per capita* GDP, however problems of poverty remain pervasive. There has been a continuing focus on Africa by most development assistance agencies with the African Union countries pledging to support agriculture and food security in their countries.
- The 'Arab Spring' and subsequent upsurge in wars and terrorism have resulted in many countries and regions becoming less accessible and in increased global controls on the

movement of people and money. The situation has been exacerbated in West Africa by Ebola.

- There is now greater acceptance of the reality of climate change and increasing signs of its apparent impact. This, coupled with improved capacity for modelling and prediction has led to optimism that a significant global climate agreement can be reached in Paris in December 2015.
- It is likely that the UN General Assembly will adopt the Sustainable Development Goals in September 2015. However, their expected broad, all-encompassing nature may limit the extent to which they actually focus donor funding on a few top priority issues in areas of interest to CABI.
- The Nagoya Protocol of the Convention on Biological Diversity came into force in October 2014. It aims to facilitate access to genetic resources and ensure the equitable sharing of benefits arising from their use. Whether or not the Protocol results in greater movement of biological materials of interest to CABI remains to be seen.
- Fuelled at least in part by the food crisis of 2007/8, there has been a growing recognition of the importance of agriculture and agricultural research by development assistance agencies. In particular, there is a growing focus of research on the sustainability of agriculture, in light of its likely intensification and its demands on increasingly limited natural resources.
- Within the context of overall food security, there has been an increased appreciation of the importance of the nutritional quality of food.
- Awareness has increased of the importance of invasive pests, diseases and weeds, and how this is exacerbated by climate change and expanding globalization. However, invasives are still largely seen as an environmental security issue rather than one of food security.
- High pre- and postharvest pest and disease losses are increasingly recognized as an unacceptable burden on productivity targets, and a continuing concern about pesticide use and growing interest in organic production have generated a renewed interest in biological control and IPM.
- Technological advances continue apace in almost all areas of interest to CABI. For example, molecular technologies for genome sequencing and gene editing have continued to become faster, less expensive and more precise; new systems have been developed for managing and using 'big data'; GIS and image processing systems have become more accurate and powerful; and ICT systems are becoming cheaper, more widespread and of greater utility.

5. CABI's vision, mission and *modus operandi*

CABIs vision, as endorsed by the 2013 Review Conference, highlights the importance of science in its work: "*To deliver high impact development projects with world class information, skills and a solid science base"*. Its mission statement also indicates the important role science plays in its work: "*CABI improves people's lives worldwide by providing information and applying scientific expertise to solve problems in agriculture and the environment*." Science clearly permeates everything CABI does.

As pointed out in the introduction, CABI both generates new knowledge and disseminates it, frequently packaged with knowledge generated by others. Research and dissemination often take place through collaborative 'networking' arrangements (broadly defined) built around specific commodities, value chains, agricultural management systems, factors of production etc. CABI was described to the review team as having a 'T' configuration, with scientific depth in just a few areas (such as plant health and ICT) but with the experience, capacity and respect to act as a convenor, facilitator and knowledge broker across a broad range of disciplines. The team notes that in continuing to play this important international leadership role in applying science to

development, it is imperative that the individuals CABI assigns to lead and coordinate collaborative activities have sound scientific rather than just development credentials. Without strong scientific credibility it will become increasingly difficult for CABI to recruit and retain good scientists and to be respected as a science-based organisation.

6. CABI since the 2009 Review

Annex 3 lists the 19 key recommendations of the 2009 Science Review, together with Management's comments at the time and their assessment of where CABI now stands, in 2015, on each recommendation. CABI has responded well to most of the recommendations and is to be congratulated on making excellent progress in many areas over the past 6 years, and in particular in the creation of Plantwise. This we see as an outstanding achievement. CABI's financial position has continued to strengthen and progress towards 'One CABI' and the creation of CABI Core are both very commendable. There have also been some important developments in the regions such as in India, China and Brazil. However, there is still much to be done and several of the 2009 recommendations resurface again in this review report. For example, while good progress has been made in these areas since 2009, the need for greater attention to the social and economic impacts of pests, diseases and invasives is again highlighted, as is the continuing need for further attention to *ex post* impact assessment and to exploring additional opportunities for outsourcing.

7. Staff and Partner surveys

7.1 Staff Survey:

In the last quarter of 2014, 142 CABI scientists were surveyed to solicit their views on a range of topics of interest to the review team and management. The questionnaire used was similar to that of the 2009 Science Review. A total of 62 staff members completed the survey and the review team was provided with an extensive compilation of the results including all written comments. Considerable use was made of the survey results in the review process and while the full set of results will not be included in this report for reasons of length and complexity, senior management is urged to consider the many helpful suggestions made in the survey and take appropriate action. It is also important that staff be informed by management of the main outcomes of the survey in an appropriate form.

7.2 Partner Survey:

A short survey was carried out to solicit the views of some of CABI's key partners and donors with respect to the focus, quality and future of CABI's scientific work. Twenty-four individuals from around the world, familiar with CABI's science, were invited to provide feedback. A total of 15 responses were received. In addition to questions about the nature of the relationship between the respondent and CABI, the following five questions were asked:

- How do you rate the quality of CABI's scientific work in the different areas with which you are familiar? Based on what information?
- Do you see any major gaps in CABI's current scientific work programme?
- What would you miss if CABI no longer existed?
- What do you see as CABI's main role in the national and international agricultural research systems?
- What shifts, if any, would you see in CABI's scientific focus going forward?

The responses to these questions are given in Annex 4 in such a way as to preserve the anonymity of the respondent. Comments received were unanimous in their support for, and appreciative of CABI and its role in the world. The quality of CABI's science was also rated highly. Although the questions focussed on CABI's science, many chose to also highlight the invaluable role CABI plays in providing information and in knowledge management – including its leadership in open access data. CABI is widely seen as a world leader in issues relating to plant health, biological control and invasive species and its role as a leader in ICT relating to agriculture is also highly appreciated.

8. CABI in the regions

As indicated in the introduction, the review team visited most of the Centres, including Egham, Delémont and Wallingford, the main exception being Latin America and the Caribbean. The majority of the observations and suggestion contained in this report arose from these visits, for example those relating to Plantwise, invasives, the need for a science strategy, the future of Bioservices and science management issues. A number of these issues were identified independently in different Centre visits. Key issues of broad CABI concern are covered in the following sections of this report with issues that are more relevant to specific Centres and regions being covered in Section 20. The full set of regional reports produced by the review team are attached as Annexes 6 to 12; no specific reports were produced for Latin America/Caribbean and Wallingford. It should be noted that the regional/Centre reports were written before the main meeting of the review team took place in Egham in April. Thus, whereas efforts have been made to make ensure there are no conflicts between the Centre/regional reports and the main report, they may not fully accord in all cases. It should be noted that while the review team as a whole have signed off on the main report, individual Annexes remain the responsibility of the authors concerned.

9. Trade and Commodities

This, and the following three sections consider the work of CABI within the four main thematic areas: Trade and Commodities; Invasive Species; Development Communications and Extension (previously Knowledge for Development); and Bioservices.

The work on specific commodities has declined somewhat in recent years, at least partly as a result of changes in the way the Common Fund for Commodities (CFC) funds R&D activities. As a result the work tends to be somewhat fragmented and piece-meal.

The choice of commodity upon which to work seems to be largely determined opportunistically, based on donor interests. However, if CABI is to play a more significant role as a global leader on a particular commodity (coffee, cacao, cotton, sugar cane etc.), consolidated, longer-term financial support is needed. It is unclear, however, where such funding is likely to come from as the public sector is increasingly unwilling to fund areas it considers of primary concern to the private sector, and the latter is generally reluctant to invest in longer-term programmatic arrangements. However, it might be worth devoting attention to developing private-public partnerships (PPP) in cases where private investment is involved in securing supply chains, especially when they are dependent on smallholder production systems, such as cocoa in West Africa or coffee in East Africa. Such PPPs are likely to be of particular mutual interest in cases where the supply chain is especially susceptible to pest and disease attack.

9.1. Sanitary and phyto-sanitary measures (SPS) and trade

SPS is a very important area for CABI, with high demand from developing country national governments for support and advice. This is clearly an area where CABI has an important global comparative advantage and one that should be maintained in the future. CABI could usefully carry out research on the cost-effectiveness of different SPS systems.

Expertise in SPS and related plant health issues underpins much of CABI's desire and credentials for expanding further into issues of international trade and value chains. However, its capacity to support the complementary areas required for a fully integrated programme is generally weak or lacking. These areas include non-pest related non-tariff barriers, consumer demand, market development, transport systems, post-production processing and packaging, etc. While CABI's 'T' *modus operandi* (see section 5) enables it to play a useful convening and facilitating role within commodity-based consortia, its scientific depth and credibility in plant health alone is not, in general, sufficient to support the scientific needs of such networks and additional scientific expertise is required, either on staff or through strong partnerships. The question arises as to whether CABI has adequate internal expertise to identify and recruit the best possible partners to expand its work further into these areas?

9.2 Nutrition and food safety

Once highly neglected, human nutrition has become an increasingly popular topic over recent years for researchers, development practitioners and donors with many new entrants into the field. CABI does not have extensive expertise in human nutrition on its staff and it is hard to see what it can bring to this already somewhat crowded field except in two specific areas: fungal contaminants in food chains and building nutritional information into its farmer-focused information delivery systems. The review team suggests that before adding any additional nutritional expertise to its staff, CABI should consider exploring appropriate outsourcing and partnership arrangements.

9.2.1 Fungal contaminants: CABI has well recognized experience in fungal toxin contaminants of foods, and in particular aflatoxin. These toxins are increasingly recognized as a major problem in many parts of the world. CABI could make a significant contribution through expanding its scientific work on aflatoxins in specific areas related to its strengths, for example through a) the further development and application of diagnostics and testing systems and b) understanding the cause of fungal infection and spread and developing appropriate counter-measures. This could build on the experience that will hopefully be gained through the proposed Nestlé project on the contamination of dairy products through feeding aflatoxin contaminated cotton seed cake to dairy animals.

10. Invasive Species

Biological control (BC) is one of CABI's key strengths and comparative advantage. However, it is important for the control of many pests and diseases and not only invasives. The review team thus questions whether this theme should be called Invasive Species or instead a more generic name (e.g. Pest Management) with Biological Control, IPM and Invasives as sub-themes.

10.1 Biological Control (BC)

Given CABI's expertise and global reputation in biological control, the review team believes it is important that the organization continue to maintain and invest in its competence in this area. This is important not only in Europe but CABI should also consider ways of extending and strengthening its biological control expertise more widely across the regions. Particular attention should be given to this in Africa. However, CABI can never hope to cover all subject areas important to the work on biological control and should continue to work in partnership with, and help to develop, complementary competence in other institutions. We recommend that CABI consider working towards further innovative international initiatives in biological control, building on its acknowledged international scientific leadership in this field and its strong relationships with member countries and others. We recognize the "Big Push" as one such initiative, focusing particularly on invasive plants, and recommend exploration of others within the scope of biological control.

Over recent years, growing problems with chemical pesticides have stimulated renewed interest in biological control. We were informed that this has translated into increased demand from member governments – and others - for assistance from CABI. However, capacity for BC work has declined in many countries and CABI now has to provide support for building – or rebuilding - national capacity. Demand for this is likely to increase over the coming years.

In spite of this renewed interest and the evident potential of BC to contribute to food security, human health and environmental safety, apart from a few noteworthy successes there has been relatively little uptake of BC systems in the past in many parts of the world. The review team consider that it would be useful and appropriate for CABI to undertake research to explore why promising solutions have remained on the shelf and what might be needed for their wide-scale implementation.

While classical biological control tends to be of a national or international public goods nature, there are a number of other areas of BC that are appropriate for private investment. These include, for example, work on biological control products (predators, parasitoids, parasites, pathogens); an area that has resulted in some significant past successes such as the current application for a patent on a mycopesticide to control Japanese Knotweed. CABI is currently developing its work on biopesticides through the joint lab with ICAR in India and similar possibilities exist in collaboration with CAAS in China and possibly ICIPE in Nairobi. However, overall there appears to be relatively limited interest within the private sector to develop new products and substantial CABI investment in developing its own products is not advised. This makes partnerships with private companies essential if CABI is to pursue this area further and we thus recommend that CABI further develop its capacity to identify, develop and manage such partnerships across all of its regional centres.

10.2 Integrated Pest Management (IPM)

While CABI is especially known for its BC work, it is also widely recognised for its experience and expertise in wider aspects of integrated pest management. This is a clear area of institutional comparative advantage and we consider it important that CABI continue to build its expertise and expand its activities in this area, particularly in low- and middle-income countries. There is a strong demand from member governments for CABI to continue to provide support for the development and application of IPM systems. This includes not only the development of new systems themselves, but also helping strengthen relevant institutions and develop policy options to create an enabling environment. In order to adequately address IPM issues, CABI may need to increase its ability to access expertise in areas such as ecology and socio-

economics, either through developing appropriate skills in house or through partnership arrangements.

10.3 The 'Big Push' on Invasives

CABI is well positioned for global leadership in the management of alien invasive species. There are few, if any other institutions that operate internationally with the capacity and experience to analyse the problems of invasives and mount effective programmes for the exploration, screening, identification, introduction and evaluation of control agents. CABI has good contacts with the partners needed for all of these stages across many countries. We strongly support CABI's efforts to develop this important thrust, and agree that in order to gain the support of donors and partners, from both the environmental and development sectors, it will be essential to have a very strong, evidence-based case statement. Such a statement must highlight the social as well as economic impacts of invasives and make it clear that invasives are much more than just an environmental problem.

One way forward for CABI in the Big Push on Invasives might be to convene a Panel of Experts both to explore further the various programmatic options and approaches available, and to help draw attention to the extent and nature of the problem.

11. Development Communications and Extension (previously Knowledge for Development)

The Development Communications and Extension programme provides an interface between research and development and plays an important role in the move towards 'One CABI'. Given CABI's mix of research and development expertise, it is in a good position to make a major contribution to our understanding of how to most effectively deliver information and knowledge products so as to maximize their use. CABI is particularly well placed to lead the development of an international science agenda in this area. In addition to increasing our understanding of farmer adoption identified as a topic for CABI below, there is also innovative work to be done on information/knowledge delivery mechanisms drawing on advances in ICT.

11.1 Plantwise

Plantwise, the flagship project of CABI, is primarily concerned with the delivery of knowledge to farmers on the management of pests and diseases. As such it generally falls outside the TORs and scope of this review. We also recognise that the programme has already been extensively reviewed and that more reviews are in the pipeline. Nevertheless, given the importance of Plantwise and its intimate linkage with CABI science, we would like to raise a few issues that we feel are pertinent to our remit.

11.1.1 Integration within CABI: We congratulate CABI for creating Plantwise, in many respects as a direct response to the 2009 Science Review. It is a highly successful initiative that has had the important effect of helping to integrate CABI's science and development work across the various Centres.

11.1.2 Knowledge Bank: the Plantwise Knowledge Bank is potentially a very powerful resource for further research and CABI is already thinking creatively about how it could best be used. This might include, for example, providing data for pest and disease surveillance, identifying farmers' perceptions of the importance of different pests and diseases, studying gender differences in such perceptions, discovering local control measures, and identifying areas for

new research. We feel that the value of the Knowledge Bank could be substantially enhanced if CABI's efforts to improve data quality are successful and we recommend that CABI carefully consider what kind of data are needed for significant and valuable research on pest and diseases in Plantwise systems, and how collecting both quantitative and qualitative data can best be integrated into the Plantwise programme. Technological advances that could facilitate the collecting of research-relevant data should also be explored, including automated digital collection and validation systems. The use of digital image recognition, for example, would appear to offer a good potential for improving data quality as well as the effectiveness and accuracy of the diagnoses made by the Plant Clinics.

Unfortunately, given the political sensitivity of much of the data – fuelled largely by concerns about potential impacts on international trade - not all the information in the databases is currently publicly available. This significantly curtails the potential use of the Knowledge Bank especially for regional and global analyses, and further efforts are needed to address and overcome these concerns. CABI is a global leader in open access data and Plantwise offers an important opportunity to promote this.

11.1.3. Research on knowledge transfer: Plantwise provides an excellent opportunity for research on the dissemination of knowledge to farmers, particularly through comparing Plantwise with other mechanisms such as conventional extension services, Farmer Field Schools and through agricultural input providers. A better understanding of the adoption of management practices by farmers, their scalability and impact are important for improving the design and sustainability of Plantwise. Research is needed to test the Theory of Change and impact pathways underlying Plantwise, as well to examine the extent of 'ownership' of the initiative by governments. CABI's is in an excellent position to lead such research, which, if done well, is likely to be highly publishable in peer-reviewed journals. However, in order to carry out this research, greater expertise in both economics and social science is needed, and ideally through a combination of additional in-house recruitments as well as stronger partnership arrangements

11.1.4. Future of Plantwise: there are currently several areas where CABI's in-house scientific expertise may not be fully adequate to serve the needs of Plantwise. These may include, for example, phytoplasma diseases, nutrient deficiencies and other physiological disorders. CABI should aim to put in place effective systems for tapping relevant expertise in such subject areas, where possible in country.

11.2 Other Areas – Integrated Crop Management (ICM), soil management and seed systems:

While CABI is well recognized for its expertise in plant health and related topics, there is a strong push to expand from this core expertise into related areas such as from IPM into integrated crop management, from soil health to soil management, and from seed health to seed systems. Recognizing the demand for CABI's involvement in such areas, and the important opportunities they present, we regard the 'T' *modus operandi* (see section 5) as highly appropriate in such cases as it builds on both CABI's depth in plant health and its credibility as an international convenor to work across a broad range of issues – extending beyond areas of in-house expertise. While much of the work foreseen in these areas involves packaging and repackaging knowledge (developed in house and by others), in many cases it also involves research. It is thus important that CABI continue to maintain rigorous scientific quality across these programmes by ensuring that convenors have appropriate scientific credentials and that CABI forms partnerships with leading scientists and scientific institutions in the fields concerned. Thus, in the case of ICM for example, CABI should partner with the

leading scientific institutions involved in such areas a soil fertility management, water management and agronomy, and in the case of seed systems with institutions with recognized expertise in such areas as small scale commercialization, intellectual property rights, seed regulations etc. Success will, to a large extent, be determined by the quality of these partnerships. CABI has a particular opportunity to build these partnerships in those member countries that have a strong science base, e.g. India, Brazil and China, and to coordinate such partnerships through its regional centres.

11.3 Policy:
CABI has an important role to play in informing the development of policies through the provision of evidence relating to its core areas of competence: plant health, IPM, BC, SPS, quarantine, pest and disease surveillance etc. One particular area where CABI could play an important international role relates to the implementation of the Nagoya Protocol of the Convention on Biological Diversity. The protocol, which came into force in October 2014, greatly influences countries' ability to access living materials; their ability to move them across national boundaries. This applies equally to plant materials, insects and pathogens for research (including identification) as well as actual and potential biological control agents. CABI is currently working with member countries to try to develop mutually acceptable and effective access and benefit sharing protocols that are in line with Nagoya (and where appropriate, the International Treaty on Plant Genetic Resources for Food and Agriculture). While this effort is to be applauded, the Review Team is not overly confident that it will be possible to reach a satisfactory solution with all member countries in the short-medium term. Nevertheless, continued efforts should be made, especially in association with the Protocol/Treaty Secretariats and others, and ideally going beyond just developing effective mechanisms with member countries but contributing to a workable implementation of the Nagoya Protocol appropriate for all countries. A significant breakthrough in this area would be of major benefit to countries around the world.

12. Bioservices

CABI has a treaty obligation to member countries to provide identification services for microorganisms. Demand for these services is increasing, in part as a result of Plantwise. Identification services and diagnosis are core areas of CABI's competence and are underpinned by the microbial genetic resources collection that houses, in addition to project and type strains, the UK National Fungal Collection and strains that are held in trust on behalf of CABI member countries. However, CABI has lost capacity in identification and diagnosis over recent years and already out-sources virus and phytoplasma diagnosis and identifications to Fera. Several impending retirements risk CABI losing more capacity in microbial identification. A decision will have to be made regarding the extent to which CABI will maintain its in-house expertise, and if so how much should be retained centrally and how much should be devolved to the regions. Quarantine requirements are likely to be an important factor in any decision on the devolution of services.

The future of the microbial genetic resources collection is, in particular, a key issue for CABI. While we recognize that this is in many ways a unique resource, the question remains as to whether to invest further in its maintenance and use or whether to divest it, like the fungarium, to a third party. This is an important decision for CABI. We note that the repatriation of duplicate samples to member countries is already going ahead but that any attempt to divest the full collection may be hampered by the requirement for approval by the Member countries.

The creation of Bioservices was, in large part, an attempt to offset the costs of maintaining the genetic resources collection, and with the divestment of the Fungarium and staff to Kew coupled with an increase in commercial activities, CABI has succeeded in making the maintenance of the collection cost-neutral. CABI is currently looking into the future of Bioservices and the collection and has two separate reviews underway to a) look at CABI's global microbiology requirements and b) appraise appropriate new technologies in which CABI might invest.

We agree with CABI's approach to exploring options for the future of Bioservices and the microbial genetic resources collection, and recommend that CABI explore further the cost/benefits of out-sourcing or partnership options (e.g. with other bioservice organisations such a Fera) before deciding whether or not to invest additional resources in building in-house capacity. We believe that it is important that this be addressed in the proposed Science Strategy**.**

In spite of the rapid development of molecular genetic identification techniques, there is a continuing need for taxonomic back-up to interpret and validate results. However, taxonomy and identification services are becoming weaker and more fragmented around the world and while initiatives like BioNET have not proven sustainable, the problem remains as a challenge for CABI. CABI should continue to explore mechanisms for international support to taxonomy and identification of plant pests and diseases, in partnership with other institutions such as Fera, the Royal Botanical Gardens, Kew and the Natural History Museum in UK as well as partners overseas.

13. Science quality and relevance

As a science based organization, CABI is committed to high quality science. Where CABI *does* science, through research led by its staff, this should be of high quality. Where it *uses* science done by others in its research, development or information activities, CABI should be able to identify, select and use only high quality scientific evidence. Finally, CABI's impact evaluation work, addressed in the next section, is fundamentally a scientific activity and this too needs to be of high quality.

13.1 Science quality in CABI

Both internal and external stakeholders are concerned with science quality. CABI researchers care about the quality of their work as it influences their reputations and careers. CABI's partners and sponsors also want to be assured that CABI's scientific outputs are of high quality; e.g. in studies on the safety of potential biological control agents for North American partners.

Some development donors require CABI to demonstrate scientific excellence. DFID, for example, requires CABI to provide information annually on its most significant scientific outputs. Donors also increasingly expect institutions like CABI to design and evaluate their programmes in a scientifically rigorous manner. Science quality is often judged by the number of articles published in international refereed journals – and especially those with a high impact factor (IF). Such indicators might be especially important to CABI's partners in joint research facilities such as the Chinese Institute of Plant Protection, as well as to research partners on competitive research grant proposals, particularly for UK or European research funding. The relatively low number of articles in high IF journals might be one reason why CABI seems to struggle, for instance, in securing UK Research Council funding.

However, not all stakeholders regard publication in high IF journals as being the most important indicator. Many are satisfied to see CABI science quality measured by publications in lower IF

but well respected national and international peer-reviewed journals, and give more importance to citation analyses as evidence for the relevance and utility of the science.

The helpful analysis of recent CABI publications prepared by Matthew Cock, showed that over recent years CABI has not published extensively in international high impact journals, but has contributed to a broad range of international and national peer-reviewed journals and books. The great majority of publications came from the Swiss and UK Centres and focused on invasive species (including biological control). It was noteworthy that in terms of citation, review papers, reference books and guides are particularly highly rated; the highest cited CABI publication, for example, is the *Dictionary of Fungi*, followed by *Alien Invasive Species: a Toolkit of Best Prevention and Management Practices.*

We recommend, therefore, that CABI establish appropriate standards or targets that it wishes to achieve in terms of the number and/or percentage of papers published in various classes of journal, and that it invest specifically in achieving higher, more international levels of scientific quality where this is strategically important to the programme and funding of particular Centres. This approach should be embedded in the Science Strategy (see below).

13.2 Supporting science quality

The review team felt that the dedicated effort CABI is making to help staff develop their skills in writing scientific papers, to provide better access to scientific information and in mentoring should be continued and extended. We note the appreciation that staff expressed for this in the staff survey. That survey also revealed that many staff expressed the desire to see a greater science content to their work and would like more time to prepare publications; priority work time has to go to project reporting while writing research papers is ofter done in personal time. Although to a certain extent this is acceptable and expected in a scientific institution, we believe CABI should continue to try to find ways for staff to have more time available for preparing research papers. We see the provision of assistance and incentives for staff to publish more and higher quality research papers as an important means of strengthening CABI's research reputation and culture (see below). Thus we believe that greater efforts should be made to cover the cost of publishing research in funding proposal budgets; both staff time and the cost of publishing in open access journals should be included. While many donors may be reluctant to cover such costs, we believe a strong argument can be made that publishing research papers in appropriate journals is critical to a broad communication of project results and provides a useful project evaluation mechanism.

Access to the scientific literature was raised as an issue by a number of CABI scientists and was considered to be a particular anomaly for an organization that is a world leader in knowledge management and agricultural communications. Special, often individual arrangements have to be made to access literature e.g. via local universities. For copyright reasons, scientists do not have access to many of the journals provided to CABI for abstracting, even though they are on the server in Wallingford. However, we recognize the large cost of providing access to the scientific literature and beyond urging management to continue to try to find a solution to this anomaly we are unable to offer any specific suggestions.

Developing and maintaining science quality in CABI may also require giving greater attention to specific subject areas. We note, for example, a need for greater support for biometrics and statistics and that this could be provided in-house and/or through partnerships. Elsewhere we recommend strengthening CABI's economic and social science research capacity, and scientific quality will be a particular issue here. CABI has little in-house capability to judge the quality of

science in these areas and while it thus needs to build its in-house expertise, it will also be important to establish strong external partnerships for mentoring and providing support for what are relatively isolated research areas.

At present, one of the main ways that CABI encourages greater scientific output and quality is through publication targets set for Regional Directors, which in turn filter down to the scientific staff. For individual scientists, however, there are few specific incentives for publishing or achieving other scientific outcomes (such as keynote presentations, scientific society awards or patents) beyond their consideration in cases of promotion and the small 'above and beyond' awards that are under the control of the regional directors. CABI might wish to consider providing additional incentives to reward and promote scientific excellence including bonuses, special awards of recognition, opportunities to attend scientific meetings, short-term sabbaticals etc.

13.3 A CABI science culture and science strategy

The review team noted that only a fraction of CABI staff members actually engage in scientific research and that scientific output and its quality should be performance criteria only for those who are. However, CABI's as a whole depends on the scientific credibility of its programme and it is important that CABI maintain its credibility as a development-focused organization having a deep understanding of scientific research.

Therefore, CABI should ensure that it continues to strengthen its "science culture", making sure all staff are well-informed on science and science quality. We suggest that a major contribution to this could be made by ensuring that science is widely communicated and discussed in CABI, through regular live and virtual seminars from CABI and external scientists, internal publications, and increased opportunities for staff, both scientific and non-scientific, to attend relevant scientific events and courses, etc.

Elsewhere in this report, we recommend the strengthening of the research programme linked to Plantwise. We also believe there are opportunities to build specific research activities into many development projects and recommend that CABI take advantage of such opportunities whenever possible. Even in cases where donors are reluctant to support research, it can often be included under different guises. This, along with a more scientific approach to evaluation recommended in the next section, will help to build a CABI "science culture" by bringing together CABI's current science and development communities around a commitment to scientific rigour in the design and evaluation of its programmes.

While CABI has a relatively modest science programme, its broader dependence on science and its commitment to science partnerships internationally highlight the need for a strategy for how it will act as a science-for-development organization. The review team noted that, while CABI has an overall strategy and a regional strategy, and that elements of a science strategy are embedded in the business plan, it does not have a specific science strategy. *The review team thus strongly recommends that a Science Strategy be developed that addresses how CABI will operate as a science-led organization*.

The strategy should analyse the market demand for CABI's science, indicating who are its main clients, what are its key areas of comparative advantages and who are its main competitors. It needs to describe the broad focal areas of CABI's scientific activities and how it will address them. It should be based on a theory of change that explains how the development and application of scientific research will aid the achievement of CABI's goals and should identify

CABI's approach and commitment to ensuring scientific quality in its own work and to using science of high quality in all of its activities. It should also indicate how it will measure the relevance, quality and impact of its scientific work and how it will build the scientific skills of its staff and contribute to building science quality with partners and member countries. Finally it should describe in general terms how CABI intends to secure the necessary resources to implement the strategy. We are not suggesting that it should include a fine level detail on exactly what science CABI will do and at what centres. This we foresee as one of the roles of a senior member of management who will be given the brief and authority to develop and implement the CABI science strategy in cooperation with other members of senior management (see section 19). We provide a possible outline of a science strategy for CABI in Annex 5

14. Monitoring and evaluation

The Terms of Reference ask the review team to pay particular attention to CABI's monitoring and evaluation (M&E). The team would like to compliment CABI on the considerable progress it has made recently in developing and implementing an M&E strategy, particularly focussed on the Plantwise programme. Our contribution relates to the specific relationship between M&E and CABI's scientific activity.

The systems of M&E that CABI has currently established are aimed strongly and deliberately at monitoring, in order to ensure delivery on project targets and milestones. From a science perspective, however, evaluation is a different and arguably more important activity. Evaluating the intermediate or ultimate impacts of any CABI project, be it focused on science, development or information, is an increasingly scientific exercise with clear and rigorous methods. Further, the social science and economic tools used in project impact evaluation generate original research in their own right, as we note elsewhere in this review in the context of building the science research programme of Plantwise. The science of impact evaluation is particularly championed and encouraged today by donor agencies like DFID.

The review team believes that CABI needs to further develop its skills relevant to programme design and evaluation. Relevant areas might include, for instance the design of projects based on convincing theories of change and impact pathways, systematic and rigorous reviews of literature, the use of *ex ante* modelling to predict outcomes of interventions, the creation of counterfactuals and randomized controlled trials, and the wide range of quantitative, qualitative and mixed methods approaches available for *ex post* evaluation of projects. How it should do this, e.g. through building in-house capacity in economics and social sciences, and/or through out-sourcing or partnerships, is an important issue that needs to be addressed.

CABI's development programmes offer particular and exciting opportunities for using these methods, for example in the design of future Plantwise projects as controlled trials to measure changes in agricultural performance and livelihoods that can be attributed to project participation. Donors are increasingly demanding such evaluations, and it is to CABI's advantage to understand them and to show donors that it has the capacity to design appropriate evaluation procedures for its own projects.

We recognize that many CABI projects provide just one component of a larger effort, and that this may sometimes prevent CABI from designing and measuring ultimate impacts. In the selection and screening of biological control agents, for example, CABI may not be involved in their final multiplication and release. However, we suggest that even in such cases, an in house capability that allows CABI to evaluate the potential contribution of its projects will help in the

selection of what CABI does research on, how it does that research, and how it could engage with later, downstream stages to ensure that impact is measured and reflects CABI achievements.

More generally, a culture of designing projects for impact, and developing evaluation as well as monitoring tools for project execution is a key part of building a CABI science culture and should be a key component of the proposed CABI Science Strategy.

15. Priority areas for new science investment

This and the next section highlight the areas that we see as top priority for future investment in relation to CABI's future science work. Clearly of vital importance to CABI's future is the maintenance and further development of its core competence in plant health; IPM, Biological Control, invasives, SPS, quarantine and the like as well as in ITC. Additional investment is needed in these areas not only in the European Centres where much of the work is currently concentrated, but also – arguably especially - in the regions.

Another priority area for future investment is in economics and the social sciences. These should not be conflated, as they are different disciplines that use different tools and languages; both disciplines often work better with natural scientists than with each other. CABI needs social science expertise for research on the way people make use of and benefit from agricultural knowledge and interventions and how this affects their decisions and livelihoods at the farm level, and the policies they make at a political level. CABI needs economics research for predicting (*ex ante*) and measuring (*ex post*) the economic costs and benefits of its projects, be they extension related (like Plantwise) or scientific (like biological control). In the staff survey, several staff members highlighted the need for greater economics and social science expertise. The review team suggests the following approach as a way forward: CABI should engage leading social scientists and economists, possibly through a consultation or workshop to (1) help the institute identify the research opportunities and needs in social science and economics across its programmes and (2) identify the most appropriate mix of staff investment and supporting partnerships in order to achieve this. CABI should make an effort to get the very best minds involved in this process if it wants to develop a high quality research programme.

Other priority areas that should be considered for possible future investment include strengthening capacity in statistics and data handling, in the management of 'Big Data' and in greater exploitation of geographic information systems (GIS). Increased capacity in these areas would enable the Plantwise Knowledge Bank to be further improved, explored and exploited, as well as provide greater assistance to staff in experimental design and statistical analyses more generally.

Investment needs and opportunities in other areas will depend on management's response to suggestions elsewhere in this report, as well, of course, as those of the separate reviews of CABI's microbiology requirements and appropriate new technologies.

16. Staffing

CABI is to be congratulated on its excellent staff continuity. However, a substantial number of scientific staff, especially in Egham, will reach retirement age over the next few years and recent recruiting has tended to be more broadly based, with a higher proportion of staff lacking PhD-

level science training than in the past. Furthermore, with senior scientific staff tending to be concentrated in just a few Centres, those Centres with relatively few staff members involved in scientific research, particularly the newer ones, are likely to find it increasingly difficult to get the scientific support and backstopping they need. Both of these issues can be addressed, at least in part, by extending existing efforts to mentor younger scientific staff and through encouraging greater staff mobility and exchanges between Centres. Allowing younger staff to work in joint laboratory or other partnering arrangements with competent science teams, such as the CABI-IPP partnership in China, will also contribute to developing science capacity in younger staff and should be explored in all Centres.

Given the impending increase in staff turnover, it remains of critical importance that CABI keep its staff succession plans, some of which have been developed only recently, under regular review, taking into account the proposed science strategy. The succession plans should make it clear which positions require high-level scientists and which can be filled by 'generalists'.

In all relevant areas of science, CABI will need to decide whether to recruit its own in-house expertise, to employ consultants, or to outsource to other institutions and partners. Clearly the availability of resources will be a critical determinant of this decision. While outsourcing and working through partnerships is, in many cases, likely to be the preferred option, it is important that CABI has sufficient in-house scientific strength to be able to identify the most appropriate partners and to attract them to collaborate. A single CABI staff member, or even a small team cannot, in any case, provide the breadth of expertise needed in many areas such as in the social sciences and economics. Strong external partnerships will be absolutely necessary to allow CABI to access skills that it does not have and to the get the mentorship and disciplinary support needed. In looking for high quality external partners, CABI should look broadly and in particular seek partners in China, India, Kenya and other CABI member countries.

The Delémont Centre, in particular, makes very good use of students in its research programme. PhD research students as well as summer students both contribute greatly to the Centre's research output. We recommend that all CABI Centres look into the possibility of involving more research students in their science activities and try to secure the resources needed to do this. However, in order to attract good students it will be important for CABI to be able to offer high quality research supervision and a conducive research environment.

17. Partnerships

The importance of partnerships to CABI has been highlighted in several places in this report. They are critical for impact and reach, and need to be kept under regular review. Partnerships are important both in the generation of knowledge (research partners) as well as in the dissemination of knowledge (development partners). We see excellent opportunities for expanding the science capacity available to CABI, through continuing to forge and strengthen the long-term partnerships it has with many institutions around the world and particularly those in member countries such as ICAR in India, CAAS in China, ICIPE, KALRO and other institutions in Kenya, MARDI in Malaysia, EMBRAPA in Brazil and Fera in UK.

Partnerships with sister AIRCA Centres are proceeding – albeit somewhat slowly and hesitantly - and offer an area of future potential across a range of subjects including ICM, soil management, and nutrition. The potential for partnering with ICBA in the Gulf Countries, for example was highlighted in the CWA report. It is unfortunate that collaboration with the CGIAR Centres has proven to be less easy than expected in spite of the creation of the CGIAR

Research Programmes (CRP). Nevertheless it is hoped that the next round of CRPs, to begin in 2017, will offer more substantial collaborative opportunities and we encourage CABI to actively explore its possible participation during the programme preparations to be carried out over the next year or so.

While we recognize CABI's interest in private-public partnerships (PPP), as a review team we were unable to identify many exciting opportunities at the present time. Some projects, like the proposed project on aflatoxin that will hopefully be supported by Nestlé, may give rise to significant resources, but such possibilities appear to be relatively few and far between. The provision of paid services, such as microbial identification, may offer opportunities for income generation that should be taken into account in looking into the cost-benefits of setting up or strengthening such services. However, overall perhaps the best PPP opportunities lie in working with small and medium companies in the delivery of the results of CABI's research, especially in IPM, biological control systems and seeds.

18. One CABI

The review team congratulate CABI on the considerable progress it has made to date in integrating the work on research and development across the various Centres, and we recognize the high level of support from staff for this as expressed through the staff survey. Science is, in many ways, a unifying force in CABI and we believe the development and implementation of a CABI-wide science strategy will help to reinforce this.

A number of staff members, however, indicated the (real or perceived) need to meet a local bottom line, with locally led projects tends to restrict collaborative fundraising and can lead to competition rather than cooperation among Centres.

In further strengthening programmatic integration we recommend that senior management consider:

- Taking additional measures to promote staff exchanges among the Centres;
- Creating greater incentives for collaboration, with the particular aim of developing larger, more integrated projects that involve more than one Centre;
- Making additional investments in the regions;
- Locating additional cross-CABI research leadership positions in the regions.

19. Science Management and Governance

19.1 Science Management:

CABI is a scientific organization and as such science must remain central to its programme; it cannot be relegated to a supporting role. Good science is the lifeblood of the organisation. We were informed that, largely as a result of more funding becoming available for international development, recent years have seen a relative decline in the proportion of funds devoted specifically to scientific research. While we were unable to examine this issue in any depth, we believe that it is important that CABI monitor this balance and ensure that sufficient resources are available to underwrite the science strategy.

CABI's current structure has no single person having overall line management responsibility for science. The task is divided between the Executive Director, Global Operations and the Executive Director, International Development. The Chief Scientist, who reports directly to the Executive Director, Global Operations, has no line authority for science. CABI's theme leaders, who might be considered those in management most responsible for developing and delivering a high quality international science programme, do not have executive authority. The Portfolio Management Group (comprising the CEO, EDGO, CFO and CIO) has responsibility for assessing new larger project proposals for quality, relevance and adherence to CABI strategy. Responsibility for implementation rests with the Regional/Country/Centre Directors.

While these arrangements have served CABI well in the past, we note that there are many impending retirements, further decentralisation to the regions is planned and there is a growing diversification of CABI's programmes. In these circumstances, for science to maintain its status as a core pillar of CABI we recommend that senior management explore the possibility of assigning to a senior position, global executive responsibility for CABI's science. The person in such a position must have the international skills and scientific reputation commensurate with the task and must have sufficient authority and tools to carry out the job effectively. We foresee a unique opportunity to readjust job descriptions and create such a position as a result of the staff retirements that are due to take place over the next couple of years.

19.2 CABI Board:

As we have argued throughout this report, science underpins the whole of CABI. We believe that it is important that adequate attention be given to the direction and quality of science at all levels within the organization. Science policy, strategy, quality and strategic oversight are among the key responsibilities of the CABI Board. We feel it is important that the Board has adequate scientific strength to be able to make wise decisions concerning the full breadth of science of the institute. While this is in no way to belittle the excellent scientists currently on the Board, we feel that their relatively small number does not allow for an adequate coverage of the wide range of scientific disciplines required by CABI or for sufficient debate on matters of critical importance or contention. We would thus urge the Board to consider ways and means by which it can strengthen its science oversight capacity. Possibilities that could be considered include: the assignment of specific responsibility to an individual Board member act as a focal point for the Boards deliberation on science; the creation of a Science Committee; bringing additional scientists onto the Board over time; convening *ad hoc* expert panels; and/or creating a dedicated Science Advisory Group, perhaps comprising Board and non-Board members,

20. Regional Reports

The individual reports in Annexes 6 to 12 present the main findings and recommendations arising from the individual Centre/region reviews. The reports are summarized below.

20.1 Sub-Saharan Africa (*Ruth Oniang'o and John Lynam. Full report: Annex 6*)
CABI's African programme is concentrated mainly in East Africa where there are 41 staff members based in Nairobi. There are also 7 staff members in West Africa, but the work there is currently constrained by insecurity and Ebola. The work in sub-Saharan Africa has been growing slowly, and is very important CABI as a whole. We were impressed by the enthusiasm of the staff and their willingness to participate in this study. The context within which CABI works in Africa is well described in the 2014-16 Medium Term Strategy: "*A key challenge … is the degraded capacity of extension systems and supporting institutions, coupled with out-dated or*

inappropriate policies and regulations." CABI sees its role as providing *"… integrated ("one CABI") solutions for delivery of knowledge to solve problems in agriculture and the environment*". The staff emphasized that they do not undertake research but package and disseminate the research findings of others. Many lamented their inability to carry out 'real research' and indicated that determining the validity and quality of research carried out by others was not always easy. Nevertheless, CABI values its image as a science based organization.

While the cost of disseminating information has decreased exponentially over recent years through rural radio, the internet, and increasingly mobile telephones, agricultural extension has remained generally ineffective. New information technologies are increasingly seen as a way forward, through generating and analysing 'big data' both for the creation of new knowledge and for targeting that knowledge to particular farmers. This would seem to be central to CABI's competitive niche. This review suggested three potential areas for new program development building on Plantwise: a) evolving a regional surveillance capacity from the plant clinic network; b) building social science rigor into the understanding of farmer adoption, diffusion and scaling, and c) building a capacity to deliver food based nutritional information. While all three represent unexploited niches in the region, each requires quite different capacity, and hence strategic choices must be made.

Africa has the lowest publishing record within CABI, especially with regard to high impact articles. Finding time to publish is clearly a challenge and it was felt that greater incentives could be provided for this, e.g. through including publications in annual workplans and through linking publishing to a scientist's career path. There was, however, a good appreciation of the support CABI has provided to staff to develop their writing and other skills. Increasing the number of post-graduate research students would also contribute to CABI's overall publications record.

The reviewers do not consider that CABI needs its own laboratories, but should rather help upgrade and use KALRO's facilities. The on-going discussions with ICIPE on the possible sharing of labs need to be finalized.

Key recommendations include: a) the need for CABI to further enhance its image as a scientific institutions, e.g. through increasing the number of publication in high impact factor journals; b) the need for CABI to strengthen its partnerships to support is work in areas of growing importance such as the social sciences, SPS, food safety, postharvest technology, nutrition, policy and monitoring and evaluation; c) revisiting the approach to influencing policy; and d) make more effort to showcase Plantwise, highlighting it as a scientific endeavour.

20.2 East Asia (*Jeff Waage and Benchaphun Ekasingh. Full report: Annex 7*)

The East Asia Centre has considerable potential for the development of CABI's science programme. China provides strong support for both CABI and its scientific role, the latter through the Joint Lab with IPP, which is a model for how CABI can work with member country agricultural research systems. China expects CABI to be a strong science partner, and links with other CABI Centres have been and will be important to achieving this. Growth and sustainability of the science programme should involve development across the three current types of project; a) donor funded development projects b) projects on biological control for NA and Europe, and c) projects specifically for China. In the case of donor funded development projects, the applied research projects in DPR Korea and Rwanda provide models that should be emulated elsewhere in Asia and also in Africa, making full use of the potential to engage Chinese research partners and facilitate their South-South scientific research contribution.

Projects on biological control for North America and Europe offer particular opportunities for building Centre science quality and publications. Projects for China are challenging but should be developed, with a particular focus on research projects linked to the design and evaluation of extension programmes like Plantwise.

To achieve these aims, the Centre will need a) close, equitable collaboration on the development and execution of new projects with other CABI Centres, b) support to build scientific skills and careers of local staff and incentivize staff and students through scientific exchange with other Centres and training, and c) an imaginative programme of collaboration with Chinese partners to apply CABI expertise to Chinese problems and engage Chinese partners in CABI activities in other countries. CABI should also recognize the East Asia Centre as a resource for member country expertise and fully involve it in developing CABI's activities in new areas like economics and social science.

20.3 South East Asia (*Benchaphun Ekasingh. Full report: Annex 8*)

The majority of activities in this region are development projects undertaken for and requested by a wide variety of partners. Some research activities are undertaken although their funding is relatively small compared to that of development projects. Both development and research projects involve bringing science to solve problems and building partners' human resources capacity. The work focuses on integrated pest management, biological control, invasive species and biodiversity management for major crops as well as for forest environments.

The centre, in collaboration with CABI UK, has started innovative work on trade related sanitary and phytosanitary measures and it has also initiated work in climate-related pest risks. Both areas, as well as other integrated pest and disease management projects, present opportunities for CABI to build on its comparative advantage in the region. The Asia Pacific Economic Cooperation (APEC), Australia and Myanmar are all windows of opportunity for this regional centre.

Maintaining the quality of science is essential for all these projects and is expected by donors/partners. The centre's senior staff members, with their solid scientific reputation and network of partners, have been instrumental in successfully obtaining project funding and donor support. However, it is important that the centre further develop its cadre of mid-career scientists.

As the centre primarily conducts development work, socio-economic research to evaluate the application and impact of science in the field could improve the effectiveness and credibility of CABI's work. Research, both socio-economic and biological, can and should be embedded/integrated in newly funded development projects so that CABI retains its competitive advantage in its core fields of pest/disease management, even at the regional centre level. Cross-centre collaboration should be enhanced to improve staff's international experience, project development and science quality. Strategic succession planning and inputs of economists and/or social scientists should add value and bring sustainability to the centre's existing good work.

20.4 South Asia (*Krishna Kumar. Full report: Annex 9*)

The main activities of the region include: a) biological control of invasive *Rubus* spp *and* Hydychium spp. in Hawaii, using insect and pathogen natural enemies from Kullu and Sikkim (India); b) the development of a road map for sustainable tea production in India; c) a

proposed ICAR-CABI joint microbiology laboratory; d) Plantwise; e) Direct to Farm (D2F), a mobile telephone-based advisory service; and f) direct publishing/sales.

In the 21st century, enhancing crop productivity in the face of declining factors of production is only possible through science led agriculture, especially in the area of IPM/Biocontrol/invasives that is of concern to CABI. This requires a scientific understanding of ecological events at both the micro and macro levels, involving the organism, ecosystem, and region as a whole, as well as the impact of human intervention. There is a definite place for science in these activities; however, for this to happen fully effectively there is a need for CABI-Delhi to enhance its scientific staff strength.

Where effective local extension services do exist, such as in India, CABI should make special efforts through Plantwise and other information networks, to make use of the vast HR available for the benefit of other countries of South Asia.

A key challenge is to integrate South Asia as one block for the purpose of addressing plant protection. It is very important to address the issue of invasives for the region as a whole and not through isolated, individual country attempts. An excellent opportunity exists to collectively address the issue of invasives through forming a South Asian network, or grid, of scientists working on the systematics of insect pests, predators and parasitoids. Such a network, in which scientists pool their information, would greatly facilitate the development of relevant basic and strategic research and would help build trust. South Asia is in need of good scientific literature on various aspects of agriculture that truly reflect the regions needs, and this represents a golden opportunity for CABI. Similarly ICAR scientific publications could be marketed across the globe by CABI under an appropriate MOU.

Major recommendations include: a) there is a need to evaluate economically, and to document the benefits accrued as a result of CABI's projects; b) CABI should consider establishing a South Asian regional/international grid or network on the systematics of pests and insect biocontrol agents, focussed on invasives; c) CABI-Delhi should make more use of the vast human resources available in India for the Plantwise and D2F programmes as well as in research collaboration; and d) CABI should collaborate with ICAR to publish new scientific books and market them across the region.

20.5 Central and West Asia (*Geoff Hawtin. Full report: Annex 10*)

The CABI-CWA office covers Pakistan, to West Asia and the Arabian Peninsula. From its early focus on biological control (BC), the work has expanded to include IPM/ICM; agricultural development (through Farmer Field Schools, Plantwise and ICT); strengthening SPS systems; and promoting skills in business and marketing. Recently there has been a significant expansion into Afghanistan and CABI is now looking to extend its activities elsewhere in the region.

CWA's main focus is on providing knowledge for development, including advice on laboratory infrastructure, with research in the region directed at problem solving rather than primary research. Research, especially on BC was stronger in the past but remains significant today. Overall it is of high quality and has made an impact. All Pakistani officials interviewed greatly appreciated CABI's work in both development and research.

BC remains a major area of interest with demand from both N. America and locally. The Government of Pakistan is seeking CABI's support to reduce pesticide use, build on past

success with fruit flies and mealy bugs, and to move into new areas e.g. the control of Khapra beetle, Parthenium and paper mulberry. The Big Push on invasives has the potential to bring important extra scientific strength to CWA's work. Expanding the work in ICM, food safety, international trade and seed systems will require additional scientific support, whether from expanding staff numbers, outsourcing or new partnerships.

Major recommendations include: a) CABI could capitalize more on opportunities to undertake research within development projects; b) digitization of the insect collection is an important objective; c) greater effort should be made to strengthen the research culture in CWA – with more attention to publishing in refereed, preferably high IF, journals; d) CWA should try to secure support for more PhD students to bolster its research capacity; e) attention should be given to strengthening strategic partnerships with sister institutions in the CWA region such as ICBA, ICARDA and the Regional Program for Sustainable Agriculture in Central Asia and the Caucasus; and f) CABI should consider including the somewhat neglected North Africa region within CWA rather than Africa, given the social, cultural and environmental affinities of these two regions, as well as the fact that the African office focuses – for very good reasons - almost exclusively on Sub-Saharan Africa.

20.6 Latin America and the Caribbean (*Geoff Hawtin*)

Unfortunately it was not possible for the Review Team to visit Latin America or the Caribbean and thus this brief summary report is based on CABI documents and information provided by Yelitza Colmenarez the Regional Representative for South America, as well as staff in Egham and through the staff and partner surveys.

Securing resources for CABI's work in the region is proving to be difficult, largely as a result of the low priority afforded by most development assistance donors to the majority of the countries in Latin America and the Caribbean, the main exceptions being Bolivia, Peru, Nicaragua and a few other Central American countries. As a result, apart from Plantwise CABI currently has relatively little scientific activity in the region. This is unfortunate since there is a strong need for CABI's support, e.g. for work on invasives, IPM and biological control, especially in those countries that lack strong agricultural research and support systems. Furthermore, CABI is under pressure to provide services to those of its member countries that currently receive little attention, including Guyana, Colombia and Chile.

Although the CABI regional office in Trinidad has a long history, it has had to be downgraded in recent years and is currently struggling to find a role, and the resources to support it in that role. The Regional Representative, however, sees significant opportunities for expanding the programme on invasives in the Caribbean, based on funding from the USA and Canada; the Caribbean being a gateway for many invasive species into North America.

CABI opened its Centre in Sao Paolo, Brazil in 2010 and this is now the main Centre of research for CABI in the region. The office partners with several institutions in Brazil (especially EMBRAPA) as well as in Bolivia and Peru. It is currently seeking stronger ties, through joint projects, with its host institution, Sao Paolo State University (UNESP), that in turn aims to play a larger international role. As in the rest of the region, lack of funding is a major issue but partnerships with strong institutions such as EMBRAPA offer a potential for important collaborative research.

While the long-standing links with CATIE continue, funding for activities there remains problematic. The CATIE staff consulted were very appreciative of CABI's work on biological

control, considering it to be of high quality. Likewise they recognized the potential value of data collected through Plantwise. They did, however, indicate that it would be helpful if CABI were to expand its social science work and although they consider CABI to be excellent at the molecular and plant levels, they feel it could usefully put more emphasis on system thinking within a larger territorial context.

While there are clearly opportunities for strengthening partnerships with other international research institutions in the region (not only CATIE but also CIAT, CIP, CIMMYT etc.), all too often they see each other as competitors rather than allies in the search for resources. Hopefully the second round of CGIAR Research Programmes, due to start in 2017, will offer better opportunities for CABI's participation than was the case in the first round.

Many countries in Latin America and the Caribbean have considerable scientific strength (e.g. Brazil, Argentina, Chile, Colombia, Costa Rica), and CABI should engage scientists in leading institutions in such countries to help design and execute CABI's programmes internationally, building links that could lead to new CABI programmes in the region.

20.7 Delémont, Switzerland (*Christian Borgemeister and Geoff Hawtin. Full report: Annex 11)*)

CABI's Swiss R&D Centre in Delémont, Switzerland has an outstanding track record in the use of biological control (BC) to control alien invasive (AI) pests and weeds. In the past this research was particularly targeted at AIs of economic significance in North America. However, in recent years the geographic focus was widened, with an increasing level of activities in Asia and Africa.

The Delémont team has gained an enviable reputation in the field of classical BC of AIs. It has a clear advantage over its few international competitors and enjoys widespread recognition by its peers, as exemplified, among others, by its impressive publication track record.

The funding and donor base for BC of AIs is relatively narrow with often relatively small projects, leading to high transaction costs in management and administration. However, expanding the geographic focus and closer collaboration with CABI Centres outside Europe, e.g. in Africa, would lead to multiple win-wins (more donors, bigger projects, new thematic challenges, introducing scientific 'spice' into otherwise purely development oriented projects, etc.). With regard to Plantwise, a key challenge and opportunity will be to embed more science into the operations by making greater use of the huge amount of data that is regularly generated by Plantwise's operations.

Major recommendations include: (a) to continue to strengthen collaboration of Delémont-based scientists with those in other CABI Centres (One CABI), providing enhanced opportunities to inject their scientific expertise into meaningful development-oriented projects; (b) to continue the successful work on BC of AIs, ideally through larger more integrated projects; (c) a greater scientific validation of Plantwise data preferably through automated digital processes, including digital image processing, would add tremendous additional value to this initiative and (d) explore ways to facilitate the access of researchers in Delémont to the scientific literature.

20.8 Egham, UK *(Nicola Spence, Jeff Waage and Geoff Hawtin. Full report: Annex 12)*

The UK centre focuses its scientific research mainly on the biological control of invasive non-native species and bioscience services including the diagnosis of plant clinic samples (fungal, bacterial and nematology identifications are done in house). It is also the operational centre for Plantwise and maintains a collection of 30,000 fungal and other microbial specimens. Science

underpins most of the activities at Egham, which has significant expertise in areas such as IPM, invasive species and biological control, for which it is recognized and respected globally.

The co-location of the CABI biological control and mycological research at the Egham site created a clash of science cultures that has taken some time to integrate. However, things have moved on and with the recruitment of new and talented young staff the consolidated UK programme appears to have considerable energy.

Partnerships with UK institutions are clearly important, particularly those with Royal Holloway University (situated near Egham) and Imperial College. Others include the Universities of Reading, Bristol and Bangor, Kew Gardens, NHM and Campden BRI. While there are doubtless more, it should still be possible to make greater use of the excellent UK science base, e.g. through a further outsourcing of specific areas of the work. Biometrics, molecular analyses and certain aspects of social science, for example, might all be candidates for greater outsourcing. Building the cadre of research students at Egham could both help strengthen CABI's research activity and help build partnerships.

Access to the scientific literature is an issue for many Egham scientists. For copyright reasons scientists do not have access to many of the journals provided to CABI for abstracting, even though they are on the server in Wallingford. Special, often individual arrangements have to be made to access literature e.g. through Royal Holloway and elsewhere, and this was considered a less than satisfactory solution by many of those consulted.

With a number of impending retirements of senior scientists and managers at Egham, succession planning is particularly important for this Centre. While we were informed that plans have already been drawn up, it will be important that they be kept under review as the proposed new global science strategy is developed and implemented.

Other key areas highlighted in the Egham review report are covered elsewhere including monitoring and evaluation, Plantwise, invasives, 'One CABI', publishing in open-access journals, social sciences, Bioservices and future of the genetic resources collection.

21. Conclusions

In conclusion, CABI is to be congratulated on the very good progress made since the last review in 2009, in spite of a difficult, but now improving financial situation. The establishment of Plantwise has provided an excellent focus and has contributed greatly to organizational integration - to building 'One CABI'. It is also offers a number of significant research opportunities.

Science pervades CABI and underpins every aspect of the organization from the generation of new knowledge to the dissemination of that knowledge, often packaged with knowledge created by others. CABI works with a wide variety of organizations that look to CABI for scientific support and partnership. It is thus critical that CABI's science remains of the highest quality.

CABI has performed well in terms of its publications record – although it could usefully aim at achieving a greater proportion of its scientific publications in high impact factor journals. Nevertheless, we recognize that for an institution such as CABI, scientific relevance and impact are arguably of equal, if not greater importance than originality as measured by articles in high IF journals.

We commend CABI for the progress made in developing its M&E system, but recognize that it is geared more to monitoring progress on achieving goals and milestones than evaluating impact. We recommend giving more attention to assessing impact in the future.

In terms of future investment, the top priority should be to maintain and further develop those areas in which CABI has a comparative advantage and in which it is already well recognized internationally as a global leader: plant health in general and IPM, biological control, invasive species, SPS systems etc. in particular as well as ITC. However, in order to have a greater impact – and the ability to assess that impact - it is important that CABI also invest in strengthening its expertise in social science and economics.

CABI is obliged to provide a microbial identification service to member countries. This is underpinned by the microbial collection maintained in Egham. Bioservices are currently being independently reviewed with respect to future needs and technical possibilities. We feel it is important for CABI to explore the cost/benefits of out-sourcing or partnership options before deciding if, how and where to invest further in building in-house capacity for microbial identification or for the use of the collection.

Given the centrality of science in CABI we feel it is important to develop and publish a specific Science Strategy that maps out the broad focal areas for CABI's scientific activities and indicates how it will address them. It should be based on a theory of change that explains how CABI's scientific research will aid the achievement of its goals and should identify CABI's approach and commitment to ensuring scientific quality.

Finally we believe that CABI should look into mechanisms for strengthening its management of science at its most senior levels and explore ways of reinforcing the Board's science oversight capacity.

ANNEX 1

CABI Science Review 2015
Brief and Terms of Reference

CABI's mission

CABI is an inter-governmental, not-for-profit organization that was set up by a United Nations treaty. Our mission and direction are influenced by our 48 member countries.

CABI's mission is to improve people's lives worldwide by providing information and applying scientific expertise to solve problems in agriculture and the environment. CABI has scientific research, international development, knowledge management and publishing at its core.

To achieve this mission we have set ourselves four goals: to contribute to greater food and nutritional security, to help smallholder farmers increase their incomes and improve their livelihoods, to protect the environment and preserve its biodiversity, and to provide the knowledge farmers need to improve agricultural practices. By generating and increasing access to scientific knowledge, and delivering change through development projects we work to improve crop yields, combat agricultural pests and microbial diseases, protect biodiversity and safeguard the environment, which enables the world's poorest communities to feed themselves. Put simply- producing more and losing less.

SR2015 team and overview

The 2015 Science Review team includes:

- A geographical, and gender balance
- A balance of science and development experience.
- Key expertise; IPM (entomology and/or pathology); development; research and applied science, social science.

Context of the review

- CABI's mission and existing themes
- Plantwise and planned new initiatives
- 2014 CABI Medium-Term Plan and 20:20 Vision
- Geographical spread of Regional Centres and Offices
- The new Sustainable Development Goals
- A review of the last 5 years but focus mainly on future opportunities and helping CABI to achieve vision and goals
- The need to maintain appropriate scientific expertise

Key assumptions to be tested

- CABI needs to maintain a strong science programme in order to remain a credible organisation in international development and publishing.
- CABI sees a clear need to focus in relatively few areas to maintain a world-leading position in one or two areas and to be world competitive elsewhere.

Review Programme

It is anticipated that the review will be addressed as two work packages

Work Package 1- Retrospective

In light of the above context and assumptions, has CABI's science programme since the last review (2009) been fit for purpose? Have we delivered to stakeholder requirements and CABI strategic plans? Aspects to consider might include:

- Response to and implementation of recommendations from the prior review
- Publications and their impact
- Quality of science/resources/people in key areas
- Scientific aspects of project design, delivery and outputs
- Monitoring and evaluation of project outcomes and delivery
- Project relevance/responsiveness to member country priorities
- Project impacts
- Partnership management and development (how do our national and international partners feel about working with CABI).

Work package 2- The Future

- Assuming above assumptions are accepted, what should the focus areas be, building on current areas of actual (or perceived) strength?

- Based on the identified key areas to build on for the future, how do we optimise our science programme towards achieving CABI's mission and goals?

- Should we continue to focus our research efforts in E-UK and E-CH or should we broaden / replace them with activities in selected / all developing country Regional Centres?

- What additional technologies, facilities and skillsets should we consider in order to pursue the recommended focus areas?

- Who would be good strategic partners with whom we could pursue the recommended areas?

- How should we monitor and evaluate our science going forwards?

Tasks

- Select and review from the material that CABI makes available and identify any additional documentation or information that you would like to see, or like prepared.

- Discussions with Board members and senior managers (including Executive Management Team and International Development senior management group as far as practical), selected staff (self-selected and selected by team), key partners and donors. Site visits should include E-UK, E-CH, Africa and at least one other developing country Regional Centre (China, India, Pakistan, Malaysia). Site visits may be by subsets of the SR2015 team and should include a review of facilities, individual meetings with selected CABI scientists and key local partners, and a workshop with available CABI scientists.

- Review team discussions and drafting of report.

Outputs

- The Review team will provide a report together with a set of recommendations for investment in terms of staff, capital expenditure, partnerships and priority developments

for each region / theme. The content and format of this to be discussed and agreed by Executive Management Team (EMT) and the review team leader before commencement.

- Presentation and discussion of key findings to EMT and CABI Board.

- Presentation of key findings and recommendations at Town Hall meetings.

Time frame

- Confirmation of SR2015 leader.

- Selection and recruitment of SR2015 team; finalise ToRs, and materials that CABI will provide / prepare. By end Q3 2014.

- Initial meeting of team; agree report structure; schedule for visits and team responsibilities. By end Q4 2014.

- Programme of visits and meetings. Q1 2015.

- Draft report and discussion with CABI senior management. Early Q2, 2015

- Final report, Board meeting, Communication to staff. End Q2, 2015

Materials / resources to be provided

- Access to CABI's internet and intranet resources, including:
    - CABI's 2014 mid-term plan; 20:20 Vision document, ID strategy and business plan Plantwise documentation; relevant guidelines/policies (science, gender, others), Reports from Member Country regional consultations and review conference, etc.;
    - Science Review 2009;
    - List of staff publications for last five years;
    - CABI In Review 2013 and current centre annual reports;
    - Current staff profile pages;
    - Current and recent project pages;
    - Overview of centres.
    - Survey of staff views.
    - Survey of partner/donor/user views
- Videoconference or phone access to any CABI scientist(s).
- Administrative support

ANNEX 2 Science Review Team *Curricula vitae*

Christian Borgemeister

Professor Christian Borgemeister obtained his PhD in Horticulture from Leibniz Hannover University (LUH) in 1991. He lectured at HU before embarking on a research career in Africa in 1992. Until the end of 1997 he worked at the International Institute of Tropical Agriculture (IITA), in Benin, West Africa first as a Postdoctoral Fellow, then as an Associate and finally as a Senior Scientist coordinating a multi-country program on the integrated control of an invasive stored-product pest. He returned to Germany in 1998 working as an Assistant, then Associate and since 2003 as a Full Professor for Applied Entomology at HU. From 2000–2001, he was also a Visiting Professor for Applied Zoology at the Justus-Liebig-University Giessen, Germany. From 2005 to 2013 he was the Director General of icipe, the International Centre of Insect Physiology (www.icipe.org), a Nairobi, Kenya headquartered pan-African R&D centre.

He is a Fellow of the African Academy of Sciences, the Royal Entomological Society and the Entomological Society of America. Borgemeister was for >8 years Chief Editor of the *International Journal of Tropical Insect Science* (published by Cambridge University Press) and has affiliations with other distinguished scientific journals as reviewer. He has authored and co-authored over 130 papers in peer-reviewed scientific journals, has co-authored a book on biological control in Africa, and has written over 10 chapters for different scientific books.

Benchaphun Ekasingh

Dr Benchaphun Ekasingh is an Associate Professor in Chiang Mai University, Thailand, specializing in agricultural and natural resource economics, rural development and agricultural systems research. She was the head of Department of Agricultural Economics, Faculty of Agriculture, Chiang Mai University during 1999-2005 and head of the Multiple Cropping Center, Chiang Mai University during 2008-2014. She was during 2002-2005 serving as the Chair of the Board of the International Plant Genetic Resources Institute (IPGRI, now Bioversity International), based in Rome, Italy. During 2008-2011, she was serving as a Vice Chair of the Board of the Center for International Forestry Research (CIFOR), based in Bogor, Indonesia.

She engaged occasionally consultancy work for many agencies on various topics mostly related to agricultural/highland/rural development in Southeast Asian region e.g. the Canadian International Development and Research Center (IDRC), CIRAD (Centre de coopération internationale en recherche agronomique pour le développement), France, German Technical Assistance (GTZ), Germany, the United Nations Drug Control Program (UNDCP), the United States Agency for International Development (USAID) and the International Rice Research Institute (IRRI).

Benchaphun obtained her Bachelor of Commerce and Administration and Master of Public Policy in Victoria University of Wellington, New Zealand. Her Ph.D in agricultural and natural resource economics was from Michigan State University, U.S.A. She had authored or co-authored more than 150 scientific and technical publications. In 2005, she received an award for Biennial medal from the Modelling and Simulation Society of Australia and New Zealand Inc. In 1990 and 1994, she received a Best paper award from the Asian Farming Systems Association. She is currently based in Chiang Mai, Thailand.

Geoffrey Hawtin (Chair)
Dr Geoffrey Hawtin is an independent agricultural research consultant specializing in research management, agrobiodiversity, genetic resources, plant breeding and international development. He is also currently Senior Technical Advisor to the Secretariat of the International Treaty on Plant Genetic Resources, hosted by FAO, Rome, Italy; a member of the Board of Trustees of the Royal Botanical Gardens, Kew, UK; Vice-Chair of the Board of Trustees of the Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia; Advisor (previously Director) of the Global Crop Diversity Trust, Bonn, Germany and a member of the Expert Committee of the Defra/Dfid Darwin Initiative.

Geoff has headed two Centres of the CGIAR: from 1991 to 2003 he was Director General of the International Plant Genetic Resources Institute (IPGRI, now Bioversity International), based in Rome, Italy and in 2008 and 2009, he was interim Director General of CIAT in Colombia. He has lived and worked for 11 years in the West Asia–North Africa region, based in Lebanon, Egypt and Syria where he worked first as a programme leader and then Deputy Director General of the International Centre for Agricultural Research in the Dry Areas (ICARDA). During his career he has also headed the Agriculture, Food and Nutrition Sciences Division of the Canadian Government's International Development Research Centre (IDRC), living in Vancouver and Ottawa.

Geoff obtained both his first degree and Ph.D. from Magdalene College, Cambridge University, U.K., carrying out his doctoral thesis research at Makerere University in Uganda. He has been elected "correspondant étranger" of the Académie d'Agriculture of France and has been awarded the Frank Meyer Medal by the Crop Science Society of America. He has authored or co-authored more than 100 scientific and technical publications and writes a regular column on international agricultural research for the journal 'Agriculture for Development'. He is currently based in Dorset, UK.

N. K. Krishna Kumar

Dr Krishna Kumar, is a fellow of the Agricultural Research Service (ARS) of the Indian Council of Agricultural Research. He started his scientific pursuit as an ARS scientist (Agricultural Entomology) at the Indian Institute of Horticulture Research (IIHR), Bengaluru as Vegetable Entomologist. His experience include project leader; Head, Division of Entomology and Nematology; Chairman, Institute Technology Management Unit; Chairman, Project Management and Evaluation (PME); Chairman, Research Co-ordination and Management Unit and Director in-Charge, IIHR. He served as Director of National Bureau of Agriculturally Important Insects (NBAII), Bangalore (Formerly CIBC) prior to assuming the post of Deputy Director General (Horticulture Science), ICAR in August, 2012.

Kumar is a Ph. D from University of Hawaii and a Post-doc from U.C. Davis, California. His specialization is on insect vectors of plant viruses and host-plant resistance. He has guided several M.S. and Ph.D in Entomology. As a Director, NBAII he was instrumental in creating separate divisions of Insect Systemetics, Insect Ecology and Insect Molecular Biology. He was awarded by the ICAR for his outstanding contribution to successful biological control of papaya mealy bug. He is the National Director, Bioversity International and Vice-President, Indian Vegetable Science and has been associated with several national and international professional societies in various capacities, besides being the Founder Member of Entomology Academy of India. He is the first Entomologist to Head the Horticultural research of India under ICAR supervising 23 institutes and coordinating research projects.

Kumar was nominated to attend the Consultative Committee Meeting in the Planning Commission, Government of India and been the President, Association for Pest Management in Horticultural Ecosystems; Vice- President, Society for Promotion of Horticulture; Founder, Entomological Foundation of India and Member, Research Advisory Committee, NHRDF.

Kumar is a recipient of East-West Center pre-doctoral Award. His research work for doctoral work earned him Best Paper award, Entomological Society of America 1992; Award of Merit, Gamma Sigma Delta, Pacific Branch. He has over 150 scientific publications to his credit and has authored/co-authored 5 books/book chapters and 10 technical publications. He has organized several national meetings on varied topics.

John Lynam

Dr Lynam has over 30 years' experience in tropical agricultural research in Latin America, sub-Saharan Africa and Asia. His expertise centres on smallholder-led agricultural development in the tropics. Much of his work has focused directly on agricultural research in both national and international systems, working within commodity, farming system, and NRM programmes.

An independent consultant since mid-2000, Dr Lynam has worked with international development organizations such as The World Bank, FAO, ILRI, the World Fish Centre, the Bill and Melinda Gates Foundation, the World Vegetable Centre and the CGIAR. His previous employment has been with, among others, Kilimo Trust in Uganda; the Food Security Division of the Rockefeller Foundation in Kenya; the Cassava Program of Centro Internacional de Agricultura Tropical (CIAT) in Colombia, and visiting research fellow at the Institute for Development Studies, University of Nairobi, Kenya.

With an extensive publication history, Dr Lynam has authored or co-authored over 42 publication on agricultural research in the developing world. Among these, he has co-authored two major monographs relating to African agriculture and development.

Dr Lynam currently serves as chair of the board of trustees of the World Agroforestry Centre, and is on the board of CIFOR. Dr Lynam as well serves on the program oversight panel of Aquatic Agricultural Systems and the independent science advisory panel of Drylands. Dr. Lynam holds a Ph.D. and an M.A. from Stanford University's Food Research Institute, and a B.S. in agricultural economics from Ohio State University.

Ruth K. Oniang'o

Professor Ruth Oniang'o is a Kenyan national with a PhD in Food Science and Nutrition. She has taught at the University of Nairobi, Kenyatta University and Jomo Kenyatta University of Agriculture and Technology. She is also Adjunct Professor at Tufts University in the USA. She is the founder and leader of the Rural Outreach Programme, a Kenya-based NGO that supports resource-poor farmer groups. She also holds a Kenya government appointment as Chair of the Board of Trustees of the Moi Teaching and Referral Hospital.

As a member of Kenya's Parliament from 2003 to 2007, Ruth worked to alleviate poverty and hunger, with a special focus on science and technology, agricultural research, food security, nutrition, bio-safety legislation, HIV/AIDS and gender issues. While serving as Shadow Minister for Education she advocated for reforms in the education sector.

Ruth is a member of the Board of Trustees of the Centro Internacional de Agricultura Tropical (CIAT) and has served on the boards of the Bill & Melinda Gates Foundation's Agriculture Strategy Advisory Committee, the International Fertilizer Development Center (IFDC), the International Rice Research Institute (IRRI) and the International Food Policy Research Institute (IFPRI). She is the founder of the online peer-reviewed journal, African Journal of Food, Agriculture, Nutrition and Development (AJFAND).

Nicola Spence

Professor Nicola Spence is Defra's Chief Plant Health Officer and is the Head of the National Plant Protection Organisation for the UK. She is an expert in plant health and international plant trade and was previously the Head of Plant Health at the Central Science Laboratory then Chief Scientist at the Food and Environment Research Agency. Nicola was also Chief Executive of Science City York, an innovation partnership between the University of York, City or York Council and York St John University between 2010-2014.

Nicola is an experienced research scientist and worked on virus diseases of horticultural crops in the UK and internationally whilst at Horticulture Research International, Wellesbourne. She is a Special Professor in the Department of Biosciences at Nottingham University, Board member of the UK Animal and Plant Health Agency, a member of Court at the University of York, a Trustee of Royal Botanic Gardens, Kew and The Yorkshire Arboretum.

She has a BSc in Botany from the University of Durham, an MSc in Microbiology from Birkbeck College, University of London and a PhD on virus diseases of Phaseolus beans in Africa from the University of Birmingham.

Jeff Waage

Prof Jeff Waage is an agricultural scientist with a career in academic and intergovernmental organizations. After an academic career in entomology and pest management at Imperial College London he joined CABI in 1986 and later became Director of its International Institute of Biological Control and Chief Executive of CABI Bioscience. He moved in 2000 to lead the Department of Agriculture at Imperial College (the former Wye College). He left Imperial in 2006 and became the London International Development Centre's first Director in 2007. LIDC is an interdisciplinary and inter-sectoral collaboration on international development between five specialist Colleges of the University of London, with over 2000 academic, postgraduate and alumni members.

In LIDC, Waage led the establishment of a landmark interdisciplinary research initiative on agriculture, nutrition and health, the Leverhulme Centre on Integrative Research on Agriculture and Health (LCIRAH). In 2013, he became the Technical Advisor to the Global Panel on Agriculture and Food Systems for Nutrition launched at the Nutrition for Growth summit in June 2013. At LIDC, Waage also leads interdisciplinary programme on zoonotic disease, higher education and development and development impact evaluation.

Waage has served on the scientific advisory councils of DEFRA, DFID and Natural England, and was a member of the Independent Review and Strategic Results Framework Teams for the Consultative Group on International Agricultural Research (2007-2009). He is a Commonwealth Scholarship Commissioner and Chair of its Monitoring and Evaluation Committee. He received an OBE in 2006 for contributions to science.

ANNEX 3

Managements Response to the 2009 Recommendations

Summary of Recommendations

- **Recommendation 1**

  CABI could use its reputation and expertise to influence policies and changes by playing a stronger role in advocacy aimed at creating awareness and informing policies on the control of pests, diseases and invasive species. It is also well placed through its networks, membership and abstracting activities to identify gaps in knowledge and opportunities might lie. CABI could also identify which organisation might be best placed to take the lead and encouraged to do so, and also where CABI could be an appropriate partner.

2009 comment; There are several aspects here, which are components of a leadership role in pests (*sensu* invertebrates, diseases, weeds) and invasive species. Given that CABI is to sharpen its focus in this area, then this is good advice. We would add to this recommendation that papers in peer-reviewed journals as an important aspect of profile raising and leadership /advocacy credibility.

2015 update: This recommendation was adopted and to support advocacy leadership, CABI invested in a new post. A Senior Director was appointed as Director for International Liaison. The post was provided with a significant travel budget for a trial period. The post was reviewed after approximately 18 months and we came to the conclusion that advocacy was only consistently feasible in the context of a focussed programme such as Plantwise and now the Invasives Big Push, and as part of the thematic Global Director role. This is the route we now pursue.
The move to the Key Account Management approach to donors has also helped CABI understand requirements but also to form relationship where input to policy development is sought.
In addition, an external consultant was employed to run a series of 'thought leadership' workshops for senior staff.
CDF funding is now ring fenced to support preparation of papers and senior members of staff use social media etc to initiate debate, plus production of think pieces and much greater success in reaching global media .

- **Recommendation 2**

  As many of the environmental markets and barriers to trade are driven by legislation, CABI should consider whether there is business case for tracking the development and enactment of environmental legislation and directives in a new 'Abstracts' publication.

2015 update; Since the previous Science Review CABI has launched an Internet Resource called Environmental Impact, which combines a subset of CAB Abstracts relating to human impacts on the environment with a range of other full-text content and editorial commentary. This product can be found at www.cabi.org/environmentalimpact and it is sold to academic users in institutional markets. This product does not contain a definitive list of environmental legislation and directives, but picks up all references to them when they appear in the research literature.

The CABI Book programme also publishes relevant titles, which are available in both printed and electronic format. For more details see www.cabi.org/bookshop.

- **Recommendation 3**

  CABI should accumulate and publicise more evidence on the economic and social impact of the pests, diseases and invasive species and evidence about the impact of current and future investment in their current science and ID programmes.

2009 comment: This is very much linked to #1. CABI agrees that this fits well into the advocacy and profile raising needed to take a lead in the area of pests and invasive species. The impact of past CABI interventions such as classical biological control are now being published and prepared.

- **Recommendation 4**

  The RT recommends that CABI moves quickly to modify the existing project monitoring system to improve its capacity for assessing quality and progress and for reviewing and updating systematically project objectivities, outputs and outcomes. CABI should also put in place an ex-post impact assessment system. The responsibility for organising and managing such a system needs to be vested in a member of the management team.

2015 update; CABI adopted PRINCE 2 across the organisation for project monitoring and management. The Portfolio Management Group meets monthly to approve projects, assess milestones, close out reports etc., processes are now managed from a Projects Management Office. In terms of M&E, these are CABI's monitoring tools.
In terms of evaluation, over the last 3 years CDF has been allocated to carry out a rolling programme of short impact assessments. The need for a much more significant effort was identified by the review team and this was totally accepted by CABI management. However this required significant investment which was not available to the CABI of 2009. Availability of funds through Plantwise has allowed CABI to recruit a Director of M&E and to establish a small team. In addition to this, a number of 'champions' from across the organisation were trained last year. It has however taken longer than anticipated to develop processes and systems and embed them across all CABI project activities. This is an EMT priority.

- **Recommendation 5**

  The RT recommends CABI continues with regular staff surveys and subsequent management feed back as an important means to engage staff, build a common understanding of strengths, weaknesses and opportunities and monitor trends and perceptions. Future surveys might be used to encourage a focus on fewer priorities and build cohesion.

2015 update: There has been an annual staff survey with management feedback. A new survey relating specifically to science in CABI was commissioned for the 2015 Science Review.

- **Recommendation 6**

  The RT recommends that CABI puts in place a means to identify where age and staff

movements are reducing CABI's science capacity and outputs in areas that are critical to its business and where scientific integrity and credibility may be at stake, and take the steps necessary to retain or restore capacity and critical mass within these areas.
These tasks should be undertaken by the Chief Scientist but a periodic independent input would be advisable.

2015 update: Staff turnover is low within ID, staff retention has not been a problem. Succession planning and talent management however have been and to some extent still are issues, particularly in Europe and South East Asia. Centres have developed their own plans since 2009 but 2014 was the first time CABI initiated a centrally led, formal succession and talent management process. This is ongoing.

- **Recommendation 7**

  A further strategic imperative should be to merge the Egham and Delemont sites as a single Centre under one Director. The RT view is that this should not be the Chief Scientist who should have a much wider remit across all of CABI's operations. The current split is simply not sustainable for an organisation of CABI's size. If action is not taken, the one area (invasive species and classical biological control) where CABI has international recognition will inevitably decline, as will the consultancy work in this area, which strongly depends on this international recognition.

2009 comment: CABI does not consider this is necessary or practical. There is overlap in interests related to biological control, invasive species, and IPM, but large areas of E-UK activity do not overlap with E-CH. Current strategy is to look at integration of groups (internally and externally) where it helps us to generate business, particularly joint projects.

2015 update: The above was kept under review and last year the 2 centres were amalgamated with the Caribbean and Latin American centres as a new region, Europe and the Americas under one Regional Director. The European centres were downgraded from regional to country centres with a new country director in each.
Systems and staff are still being reviewed within this new region.

- **Recommendation 8**

  The office in Pakistan is heavily engaged with programmes in and for Pakistan. The RT recommends that more attention be given to future initiatives in South Asia being driven from India, even if these are based on pragmatic rather than strategic considerations initially.

2015 update; CABI CWA (Central and West Asia) is substantially involved in activities in Pakistan, Afghanistan and Sri Lanka (the latter for historical reasons). We have expanded the donor base significantly to include international funding agencies since 2009. CWA has a new young, very capable Director and its business plan foresees expanding work into the middle-east and regional 'stan' countries. Project proposals are currently in progress with middle-eastern countries.
Together, the South Asia centres have adopted pragmatic business plans that respond to needs and the availability of resources in the region. It has not been politically feasible to run the region from either centre. However this has led to growth in both regions and activities at the India Office, particularly relating to the use of mobile technology, has led to very significant

expansion and its re-designation as a Regional Centre. CABI is also placing some generic IT support capacity in Delhi.

- **Recommendation 9**

  In the Caribbean the RT recommends that CABI should explore the possibility of building on its existing link with CATIE or perhaps develop some key arrangements similar to that between Rothamsted and Embrapa, rather than maintaining a dedicated Regional Centre.

2015 update; These options have been reviewed several times. The link with CATIE is dependant on project funding, which remains uncertain in the medium term. There are significant operational problems to expanding CABI activities out of CATIE. Options for working with Latin American countries such as Brazil have been explored, leading to an increased understanding of the basis for such relationships, recognising that most LA countries (and certainly Brazil) already have excellent technical capacity. An office has now been established with Brazil, to facilitate Brazil to help developing countries, research partnerships and Plantwise activities. The Caribbean, with limited resources and manpower, has a continuing need for the sort of technical support that CABI can readily offer, particularly in relation to invasive species and pest management. CABI also has a significant number of Caribbean members. However the presence has been reduced to an office and the building returned to UWI usage.

- **Recommendation 10**

  The RT recommends that CABI should review its current partnerships so as to identify which are the most productive, why and whether CABI is the senior or junior partner?

2015 update: Partnerships were reviewed and strategic relationships were re-enforced (eg leaders in the creation of AIRCA and long terms partnership in MIRRI). It was felt though that in terms of project development a pragmatic approach is necessary. Better opportunity scanning by PDG has given us the time in many cases to build partnerships for specific project bids. We should continue working on this though, enhancing our partner and consultant databases.

- **Recommendation 11**

  CABI should explore the opportunities for increasing the levels of outsourcing of its molecular characterisation work, bio-pesticide development, bio-prospecting in its collections and diagnostic services. This outsourcing could also be used to build new strategic and business partnerships and develop capacity with member country institutions in the public and private sectors, but CABI should retain a small capacity for method fine-tuning and quality control.

2015 update: It was felt that ‘bar coding’ of the whole CABI collection was not a realistic target without significant expenditure on external contractors. Strains key to Plantwise, CABI projects and contracts have been characterised and a database created for use in the ID service which continues to grow.
The ID service now supports member countries better by offering ‘free’ identifications and technical advice which is supported indirectly by funding from membership subscriptions.
The molecular facilities are currently under review.

- **Recommendation 12**

  The RT recommends that CABI should prepare as soon as possible, a project to accelerate the process of characterising the microbial fungal collections, possibly in collaboration with their Food and Environment Research Agency (FERA) for funding by DEFRA and DFID (UK).

2015 update: Significant effort was put into the development of a Business plan with RHUL to establish a JV to screen CABI isolates for potential novel antibiotic. However it proved very difficult in the financial environment after 'the crash' to raise funding.
Some small screening contracts are in place and a successful relationship with BAS/NERC has led to potentially interesting IP.

- **Recommendation 13**

  The RT recommends that CABI should explore the possibility of 'biopesticide partnerships' with institutions in India.

2009 comment; CABI tried such an approach under apparently ideal conditions in 2003-4, with SDC backing and financial support. In the end, the initiative was completely blocked by access and benefit sharing issues and lack of effective cooperation. The project was stopped early, and CABI and India have not prioritised this approach in India since then.

2015 update: The above comment remains very pertinent. Projects involving biopetsicides and biocontrol agents have continued but the movement of organisms into and out of India has been very difficult and indeed became worse after recent reorganisation between Indian institutes. However very recent information suggests that the new Indian government is intending to streamline processes and the synergies between CABI and ICAR expertise in Biopesticide development had led to these activities being identified as objectives for the new proposed joint laboratory.

- **Recommendation 14**

  CABI should consider the business case for the development of a global surveillance system and to use its expertise to assist countries to develop their own phyto-sanitary institutions, but to do so CABI it would need to identify suitable partners and sources of funding.

The development of contemporary global and regional surveillance systems for pests and diseases, involving monitoring, risk analysis and prediction, and the use of GIS and spatial modelling. This would be a logical expansion of the Invasive Species theme, spanning research and development, and linking projects at the farm scale with national reporting systems. This could provide a clear focus for the Regional Centres, involve Bioservices, especially the Global Plant Health clinics, and make full use of the central information resource.

The development of a Disease Observatory, such as has received some attention in the medical/veterinary domains (especially with zoo noses) but not with plant health, with little activity by comparison within FAO. CSL (now FERA) has been working of this idea for UK and Europe but the concept could be expanded with other partners to provide a global picture

This in effect was the basis for Plantwise.

- **Recommendation 15**

  With respect to consultancy the RT recommends that CABI puts in place the means to answer the following questions and to determine and monitor the balance that is beneficial and sustainable.

To what extent does obtaining a consultancy depend on the R&D expertise and reputation of the staff member?

Is the use of gross margins by category of work (e.g. project type x theme) really suitable for making strategic decisions?

Can the categories used (e.g. by LEK) really be mutually exclusive or simply be an artefact of the way they are put together, e.g. could some of the projects in a category such as Knowledge Management (with a high gross margin) include projects relevant to Invasive species (with a low gross margin) and which could equally have raised the gross margin of that category?

What is the down-time and success rate of getting a consultancy compared with a project, and how does this relate to the time actually commissioned?

2015 update: This was addressed in the early stages of the LEK business planning process, and not prioritised to take forward. If we return to this area, these pertinent questions will need to be answered. In the meantime, a leavening of consultancy work, helps the project portfolio profitability, builds staff capability, and can lead to new project opportunities.

- **Recommendation 16**

  The RT recommends that CABI creates more opportunities for staff from the ID, Regional and Publishing businesses to meet around specific areas of CABI's businesses to exchange views and ideas and to establish small inter-disciplinary strategy groups to follow-up on ideas that emerge.

2015 *update*: Plantwise in effect has addressed this and the new ventures around invasives will continue the effort. The new KB business has also established cross CABI teams.

- **Recommendation 17**

  The first of these would be a series of position papers aimed at raising the awareness of the public, business and policy makers on the nature, costs and impacts of pests, diseases, microbial action and invasive species on food security, the environment and poor people.

2015 update; This recommendation links to #1 and #3. Position papers – if good – are an effective way of raising profile, and generating interest in the pest and invasive species issues, but they do involve significant inputs of (often senior) staff time. Nevertheless a series '*CABI Position Papers*' has been established, several relevant position papers have been published in this series or in peer-reviewed journals, and others will be in future.

- **Recommendation 18**

  The creation of a Global Plant Health Clinic/Centre by bringing together several activities of CABI's different programmes and themes of work into a more coherent and geographically extensive plant health advisory service. This might eventually be expanded into a 'Global Surveillance System or Observatory' to provide a contemporary service on the location and spread of pests and diseases, assessments of risk and early warning systems on the emergence of new diseases.

This is covered under #14 and #15.

- **Recommendation 19**

  CABI should create and sponsor an award scheme or prize for achievements in the fields of plant health etc at both junior and senior levels as a means not only raise CABI's international profile but as a means to encourage partnerships with strategic partners, member states and to bring 'new blood' into the fields of plant health;

The objective of bringing in new blood might best be served by finding mechanisms to sponsor research degrees (full-time or part-time), in conjunction with funded projects as far as possible, as already happens at E-CH. Short-term internships should also work, and these have been started under Plantwise and at E-UK. The scope for an award scheme as such to recognise achievements was examined, but CABI concluded that there are already many of these existing providing awards at a level we could not afford to invest in at the time.

ANNEX 4

Partner Survey Results

Twenty four individuals from partner and donor organizations around the world, familiar with CABI's science, were invited to provide feedback through a very brief questionnaire. A total of 15 responses (63% return) was received.

The individual replies to each of the 5 key questions have been re-ordered and in a couple of cases slightly edited to help preserve respondents' anonymity.

List of respondents:

Africa

1) Bashir Jama Agra, Director Health Programme and Director Accra Office Alliance for a Green Revolution in Africa (AGRA), Accra, Ghana. (*partner*)

Asia

2) JDH Keatinge, Director General, AVRDC – The World Vegetable Center Taiwan. (*partner and sister member of AIRCA*)

3) Fuziah Binti Haji Hamdan, Assistant Director of Agriculture, Department of Agriculture and Agrifood (DoAA), Brunei, Darussalam. (*partner*)

4) Maolin Hou, Scientist, Institute of Plant Protection, Chinese Academy of Agricultural Sciences (CAAS), Beijing, China. (*partner*)

5) Mohamad Roff Bin Mohd Noor, Director of Strategic Planning & Innovation Management Divisions, Malaysian Agricultural Research & Development Institute (MARDI), Serdang, Selangor, Malaysia. (*partner*)

6) Keibin Li, Entomologist, Institute of Plant Protection, Chinese Academy of Agricultural Sciences,Beijing, China (*partner*)

Europe

7) Steven Walker, Director General, Campden Bri, UK. (*partner*)

8) Ren Wang. Assistant Director General, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. *(partner)*

9) Craig Fedchock, Coordinator, International Plant Protection Convention (IPPC) FAO, Italy. *(partner)*

10) Lucia Castillo-Fernandez, (Policy Officer), Unit C1 Rural development, Food security and Nutrition, and Rodrigo Iglesias-Daveggio, (Program Officer – Plantwise) Unit Inra-ACP, EU, Brussels, Belgium. (*donor agency*)

11) Carmen Thönnissen, Senior Advisor. Swiss Agency for Development and Cooperation (SDC), Bern, Switzerland. (*donor agency*)

12) Rachel Lambert, Senior Livelihoods Advisor, Agricultural Research team, Department for International Development (DFID), London, UK. (*donor*)

Latin America

13) John Beer, Director Research and Development, Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Turrialba, Costs Rica. (*partner and sister member of AIRCA*)

North America

14) Hilda Diaz-Soltero, Senior Invasive Species Coordinator, United States Department of Agriculture - Animal and Plant Health Inspection Service (USDA-APHIS). *(partner)*

15) Dr Peter G. Mason, Research Scientist, Agriculture and Agri-Food Canada (AAFC) Ottawa, Ontario, Canada. *(partner)*

Responses

1) How do you rate the quality of CABI's scientific work in the different areas with which you are familiar? Based on what information?

- CABI's scientific work, particularly in the areas of food security, agriculture and crop protection are of extremely good or high quality – an assessment that is mainly based on CABI's publications such as books and journals and compendia, that are filled with extensive and relevant data. CABI's high quality work was also reflected in their microbial Identification services.
- Top class and often in subjects that are neglected by others: e.g. biological control of plant diseases. Invasive species is another important speciality area covered by CABI but I am unable to judge quality in this case
- We rate quality based on the reports provided to us against a number of performance indicators that include numbers of publications, case studies, outputs which include gender analysis, as well as performance against programmatic deliverables. In 2015 we are piloting a new system to assess quality and development relevance of research outputs, based on expert review of a number of publications put forward by the centres as their "best" publications from the last year. The Annual Review process provides an overall rating of the extent to which CABI (and other centres) have performed and present value for money. For the last 3 years CABI has been judged as representing good or very good value for money, based on this overall assessment.
- Quite good, based on the project progress CABI is achieving and from the papers and reports.
- Excellent. From the cooperation with the people coming from CABi
- So far we are satisfied and happy with the collaboration and excellent work done by CABI.
- High quality research in areas of biological control, microbiology and pest management; world leading research in agricultural information management.
- Good – they produce high quality books and other publications. Soil health area – average; this is a new area.
- I am aware of CABI's recent two success with highly competitive large grants under the SDC/ SNF partnership program.
- CABI's scientific work is first rate and they are recognized as the leaders CABI's work in IPM is excellent and likewise in the critically important area of invasive weeds. We also appreciate CAB abstracts and the publishing side of the business.

- in biological control. This is based on extensive collaboration with CABI scientists and collaboration with other agencies. CABI publishing is also outstanding, is based on collaboration to produce two books.

2) Do you see any major gaps in CABI's current scientific work programme?

- One area is in policy and climate change – some synthesis work (publications) in this area would be great
- At the moment, scientific works programme in terms of Crop Protection in the SE Asia region is lacking receives minimal research attention. Biological data on plant pests and pathogens as well as control/ management practises for certain pest and diseases are hardly available. Despite CABI having programmes in several ASEAN countries, the island of Borneo which may have a different microclimate than some of the other ASEAN countries, is largely unexplored in the above-mentioned aspects
- We would flag the need to continue to focus CABI's work on key development outcomes, to embed robust impact evaluations to assess the impact of programmes, and deepen research capacity on gender analysis. We would also flag the need to continue to strengthen work on sustainability of development outcomes and business models.
- CABI' current programme is very good, I cannot see any gaps
- Limited capacity in outreach and knowledge dissemination; limited capacity in bioinformatics and information systems program that require large scale networking
- No
- No
- A major gap is the lack of taxonomic expertise in arthropod groups such as insects and mites. This expertise would be highly valued, particularly in regions (e.g. Europe, China) where invasive species (and their natural enemies) that are important to north America originate. Expertise on arthropod groups in these regions is declining (Europe) or weak (China) and CABI could fill an important gap
- CABI is interested in territorial approaches (e.g. in AIRCA) but to my knowledge they do not have the expertise. I perceive that their programme is very bio-physical neglecting the socio economic variables but again I may be unfair due to a lack of knowledge (and it is a mistake to try to do everything just because donors demand it)!
- Should do more activities and working together with MARDI for nation program and activities.

3) What would you miss if CABI no longer existed?

- We would definitely miss the access to and availability of extensive knowledge database that CABI manages, especially CABI publications as well as the Compendia. The long list of experts and specialist in various agriculture fields is also amongst the privileges that we would lose
- Yes, I would miss CABI
- CABI's role as a knowledge repository on global plant diseases and knowledge manager on other agricultural practices. Ability to use this knowledge management expertise to respond to emerging priorities (open data, nutrition sensitive agriculture).
- CABI's development programmes including work on Plantwise, invasives, value chains etc.
- Many, among the others, CABI's literature and the opportunity to cooperate.
- The commitment of CABI in providing expertise in solving problems especially in agricultural systematics; innovative ideas and capacity in linking information management with applications and agricultural development.
- Their good publications
- Very much - they are a key partner now and in the future.

- We appreciates CABI's special role in making knowledge accessible, also the bridging function between science and national programs and farmers, and here Plantwise is an excellent example.
- Biological control releases globally would suffer immensely!! It takes approximately a decade to discover and assess new biocontrol agents in collaboration with CABI. Without CABI and the network of contacts, infrastructure and their expertise in developing new biocontrol agents would take at least 20 years or longer!! This would basically make research in this scientific area next to impossible and lead to greater reliance on pesticides
- Literature services.

4) What do you see as CABI's main role in the national and international agricultural research systems?

- Specialist skills and expertise in knowledge management and global plant health. Growing expertise and leadership in digital and open data. Delivery of tangible development outcomes which benefit poor people in developing countries.
- Research such as in Plantwise, in the dissemination of key information and in IPM matters and weed control in general.
- At national level, CABI can be seen playing major role in building the local capacity in agricultural research systems and this is mainly achieved via strong linkages with the national programme. On the other hand, in the international arena, CABI is the major driving force in agriculture research systems and specifically in ensuring sustainable agriculture practices.
- CABI play regional role and have office all over the world.
- Filling a gap in information management; providing ideas and technical support in the application of agricultural information; providing advice and coordination in the areas of integrated pest management, microbiology, and knowledge dissemination
- Intermediary platform
- Similar to above, i.e. the link to implementation. Compared to the CGIAR, CABI has different networks, among others because of the membership nature of the organisation. This results in closer ties to partners.
- Extension and integration of existing advances in agricultural sciences for the benefit of farmers.
- Publications.
- Synthesis of knowledge (reviews)/ data bases/ literature services.
- CABI has a key role to play in invasive species research and research related to outreach (e.g., acceptance by users).

5) What shifts, if any, would you see in CABI's scientific focus going forward?

- I would hope that with more core-funding they would be able to further support research in Central America and in the Lake Victoria Basin.
- Current activities are highly relevant and no shifts of current programmes are needed.
- If it is possible, provide more chance to scientific researcher with other country
- Expansion of capacity in taxonomic research should be a high priority.
- Focus more on food security for the expanding global population.
- Focus on a smaller number of development programmes/intervention areas demonstrating rigorous evidence of impact and delivering excellence in research and development outputs.
- Dealing with hard science in the future and initiating proper tools to communicate the science to the public.

- Support Africa's research and training institutions to produce strong scientific publication. The Africa institutions should feel CABI's presence and support more. I think their work in this area is currently weak, especially in Africa.
- Focusing on developing systems of linking information management with application, knowledge dissemination and agricultural extension with modern information and communication technologies; building a balanced portfolio of public goods (e.g. through donor funded programs) and commercial products and services.
- CABI's scientific focus has been very comprehensive, especially in the field of food security, agriculture and the environment. However, if research focus can be extended to Agrifood sectors, this will definitely be able to complement the agriculture industry.
- More emphasis on system thinking; e.g. in a territorial context. They are excellent at the plant to molecule levels, but at higher levels?

ANNEX 5

Possible Outline of a Science Strategy for CABI

Introduction

- CABI's Mission*: CABI improves people's lives worldwide by providing information and applying scientific expertise to solve problems in agriculture and the environment.*
- Why a strategy is needed? - *to guide science and provide a reference against which future progress can be measured …*
- *Who are CABI's primary clients for its scientific work: What is the market demand?*
- *How the strategy has been developed*
- *What does it aim to achieve and over what timeframe? E.g. a) to identify those scientific fields and geographic regions in which CABI should focus future investment and planning; b) to establish some key performance indicators (KPI) - goals and milestones; c) describe where responsibility rests for delivery; and d) to define science quality and the means of maintaining it.*

Science in CABI

Science and technology are central and pervasive to CABI's mission, purpose, programmes, services and reputation. The strategy should present a theory of change that explains how the development and application of scientific research will aid the achievement of CABI's goals. It should show how CABI's ability to meet the needs of its members and to contribute relevant outputs, outcomes and impacts in development require it to have a unique capacity to generate, adapt, curate, package, disseminate, test and evaluate science and technology. It must also continue to meet the expectations of members for services (e.g. identifications, information). To achieve these exacting goals CABI needs to blend its in house capacity with strategic partnerships and the development of capacity in those fields where it is required.

Strategic Priorities

What are CABI's areas of special expertise and comparative advantage? Who are its main competitors (and partners) in these areas.

List the 3-5 (?) top strategic science priorities that CABI intends to address, together with appropriate goals and milestones.

Key Areas of Science in CABI to address these priorities

Within each 'area' indicate how the work will link to the institute's strategic priorities, list the main scientific issues and how they will be addressed, and indicate the resources needed. These might include, for example:

- *Trade and commodities - SPS*
- *Invasive spp – the Big Push*
- *IPM/BC*
- *Development Communications and Extension*
- *Plantwise*
- *Soils/ICM/Seed Systems*
- *Policy advice*
- *Bioservices*

- *Other?*

International Science Leadership
- *In which fields will CABI seek to maintain its world leadership position – or aspire to become a world leader?*
- *How will this be achieved?*
- *How will science quality be maintained?*

Modus Operandi
- *CABI cannot do everything by itself; in which areas (and following what principles) will it seek to maintain and/or develop its own in-house capacity and in which areas will it seek to outsource the work or seek partnerships?*
- *Who will be the main partners and how will CABI pursue partnering with them?*
- *How will CABI help build partners' science capacity?*
- *The role of monitoring and evaluation in ensuring scientific excellence and credibility.*

Building in-House Capacity
- *Which fields will require particular attention in terms of building or maintaining staff capacity?: succession planning*
- *The role of research students, honorary staff etc.*
- *Providing incentives for high quality research*
- *Investment in infrastructure*

Governance and Management
- *The role and responsibility of the Board for overseeing science policy, strategy and quality, and how it will fulfil that role (e.g. through advisory panels, etc.)*
- *The structure and role of management, and mechanisms to be employed in implementing the science strategy*

Securing the necessary resources
- *Strategic use of CABI-generated funds*
- *Mobilizing the necessary resources from both public and private sources.*

Conclusion: What success looks like in 2020 (2025?)