Eur J Plant Pathol (2008) 121:365–375
DOI 10.1007/s10658-008-9311-4

# The challenge of providing plant pest diagnostic services for Africa

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Received: 6 July 2007 / Accepted: 20 March 2008


**Abstract** The consequences of a globalisation of trade and climate change present an increased threat from first-entry pests and a challenge to plant health authorities. In this paper, pest reporting for the continents of Africa and Europe are discussed, and argued as a barometer of effective Plant Pest Diagnostic Services (PPDS) in terms of human capacity, infrastructure and policy-culture for phytosanitary issues. To illustrate particular areas of concern, case studies are presented on recent pest events which include outbreaks of *Ralstonia solanacearum* on *Pelargonium*, *Xanthomonas campestris* pv. *musacearum* on banana (banana Xanthomonas wilt) and *Puccinia graminis* f.sp. *tritici* race Ug99 on wheat (black stem rust). Examples are given of some recent initiatives to invigorate diagnostic capacity in East Africa, spanning state-of-the-art centres of excellence, traditional capacity building and networking projects, and grass-root level 'going-public' pest surveillance initiatives. Discussion is presented on the provision of PPDS and the impact of technology, institutional factors, the private sector, accreditation of services and policy. Emphasis is placed on the role of PPDS in support of regulatory policy. In recognising the precarious nature of many African cropping systems, the argument is made for a more consolidated approach to PPDS in and for Africa. The paper is presented from the perspective of European practitioners in pest diagnostic and risk analysis.

**Keywords** Climate change · Globalisation · Plant Pest Diagnostic Services · Centres of excellence · Reference laboratory · Capacity building

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## Introduction

Additive consequences of an increase in global trade (Josling et al. 2003), climate change (Garrett et al. 2006; Harwell 2002) and evolving plant pest pathogenic capacities (Brazier 2001; Zhou et al. 1997) that may be exacerbated by new host encounters due to global trade and adaptation to climate change (Garrett et al. 2006) identify an increased risk from plant pests for agriculture and the environment across the globe. A recent review on the causality of emerging infectious diseases of plants has recently been undertaken

(Anderson et al. 2004). Against this background, it is a widely accepted view that developing nations, and the more vulnerable sectors of these nations, are at the greatest risk from the predicted events of climate change and globalisation (Chancellor and Kubiriba 2006, Waage et al. 2006; Anon 2006).

Recent and high impact examples of animal and plant pest introductions in the UK, such as foot and mouth disease, Newcastle disease, Avian influenza, horse chestnut miner, potato brown and ring rot and *Phytophthora ramorum* and *P. kernoviae* exemplify the concern (see www.defra.gov.uk). Likewise, in Africa the spread of plant pests such as banana Xanthomonas wilt (BXW; Tushemereirwe et al. 2004), coffee wilt (Rutherford 2006) and cassava mosaic disease (Zhou et al. 1997) across East Africa have presented an additional and serious risk to the livelihoods of already vulnerable households. The impact of these events has prompted an increased and global vision of the threat presented by pest introductions, focusing research on future technologies for pest diagnostics (Barker et al. 2006) and more 'biosecure' quarantine systems (Waage and Mumford 2008). The function of Plant Pest Diagnostic Services (PPDS) is at the nexus of policy-based phytosanitary systems, trade, breeding programmes, integrated pest management and farmer advice.

Further evidence from a recent UK government 'foresight study' focusing on future infectious disease risks (Brownlie et al. 2006) has highlighted the global nature of these threats, drawing comparisons for plant diseases between Africa and the UK in terms of the impact of climate change (Chancellor and Kubiriba 2006), prospects for future disease control (Barker et al. 2006), and governance issues which may affect these (Quinlan et al. 2006). More specifically the foresight study presented a preliminary analysis of plant disease introductions (viruses, fungi and bacteria) into Africa and Europe based on first reports (Waage et al. 2006). These data suggest that Europe has experienced a growing rate of new plant pest introductions over the past century, while introductions in Africa (whilst greater overall, possibly due to greater crop diversity), appear to have peaked and declined during that same period. The study concludes that this may reflect differences in recent international trade by Europe and Africa, but that it may, alternatively, reflect differences in national plant protection capacity. That is, a recent lack of plant protection capacity, infrastructure and effort may cause a decline in reporting of new diseases in Africa, in contrast to continuing, strong European systems.

A further observation from the study by Waage et al. (2006) was the differences over time in the rates of first plant disease records for bacteria, fungi and viruses. In this comparison, it is observed that a marked increase has occurred for viruses for both continents, but particularly Europe. Most probably this trend is explained by recent advances in technology for diagnosis, such as the application of PCR, and a rapidly increasing database resource of nucleic acid sequences of diagnostic value that have increased our ability to detect and identify non-culturable organisms amongst field crops and in the environment. First disease reports of phytoplasmas would be expected to mirror this trend. The facility for molecular identification can be expected to increase further because of the myriad of research projects, such as the Bar Coding of Life Project (http://www.barcoding.si.edu), that continue to add to the sequence database available (e.g. GenBank). The consequences of advanced technologies for pest diagnostics on PPDS may be profound and present a particular challenge for African nations that often have neither the trained personnel nor the fiscal resources to take advantage of such change. Consequently the technology gap between north and south, which is already significant, may grow further over the coming years unless major effort is sought to address these capacity and infrastructural needs.

Finally, although it is beyond the scope of this paper to look in depth at the interface of National Plant Protection Organisations (NPPO) and how these are aligned to regional (e.g. European Plant Protection Organisation (EPPO) for the European Union and Inter African Phytosanitary Council (IAPSC) for Africa) and international treaties (e.g. World Trade Organisation and the Sanitary and Phytosanitary (SPS) Agreement, International Plant Protection Convention (IPPC), *Codex Alimentarius* (CODEX), Office International des Epizooties (OIE)), it is important to note that collectively these provide the overarching framework for safeguarding the health of humans, animals and plants against adverse effects through the international movement of people and traded goods. For example, under the IPPC it is recognised for contracting parties 'to the best of their ability' to have updated lists of regulated plant pests known to occur within their territories and to conduct pest surveillance as supports non-records of presence. The incomplete and poorly verified nature of national pest lists amongst many African nations is recognised as a key constraint in negotiations on trade.

In the sections below, case studies for three pathogens of recent significance within East Africa and one methodology for extension and surveillance are discussed that identify with particular technology, trade, and institution mandates. Emphasis is given on the role of PPDS in support of related regulatory policy. This paper does not include provision of services for food, such as mycotoxin, pesticide residue and GMO testing, as extend to private sector compliances of GlobalGap and EurepGAP (Labuschagne 2006). However, the opportunity of linkages with these services is brought into some of the discussion in the context of the value of generic technologies, broader laboratory function and the engagement of the private sector for the commercialisation of diagnostic services.

## Case studies

### Case study 1: *Ralstonia solanacearum* on *Pelargonium* within the private sector of Kenya

In 2003 the *Pelargonium* industry of Kenya and USA suffered significant economic losses due to an outbreak of *Pelargonium* wilt caused by *Ralstonia solanacearum* biovar 2a, a pathogen normally associated with potato and of quarantine status in Europe, USA and many other countries (e.g. EU Council Directive 98/57/EC). In the USA, the outbreak resulted in the contamination of 27 *Pelargonium*-growing greenhouses in 13 states and the quarantine of over a further 800 glasshouses (Anon 2003). Immediate economic cost to the flower industry was estimated at several million US dollars, with longer-term consequences to trade. Interceptions of the pathogen were also made in Europe (Janse et al. 2004).

The presence of *R. solanacearum* biovar 2a in *Pelargonium* was first confirmed in Europe in 1999 and 2000, and the source of infection was traced to Kenya (Janse et al. 2004). Although this was not a first report for this pathogen on *Pelargonium*, these were the first confirmed reports of biovar 2a affecting *Pelargonium*. Earlier reports of *R. solanacearum* on *Pelargonium* from the USA did not substantiate the race or biovar status (Strider et al. 1981); however, it was assumed that these were most probably race 1 strains as this race is known to have the greatest propensity for extending its host range (race 1 has the largest host range of the five races of *R. solancearum*) and biovar 2a (synonymous with race 3) is not known to occur in the USA (Anon 2004).

At the time of the confirmed reports of *R. solanacearum* biovar 2a in Europe, preventative actions were introduced by Europe on imported material that have, in conjunction with better practices within the industry in Kenya, to date prevented further introduction. These better private sector practices, though not accredited to any recognised international criteria, have been developed in partnership with CSL specialists, and include the use of rapid diagnostic kits (Pocket Diagnostics® lateral flow devices) for *R. solanacearum* and *Xanthomonas hortorum* pv. *pelargonii*, a pathogen of *Pelargonium* with similar symptoms. Likewise, the trade of *Pelargonium* cuttings with the USA is now governed by a 'Minimum Sanitation Protocols for Offshore Geranium Cutting Production' that operates as a certification protocol to ensure freeness of the pathogen (Anon 2007d). The formal nature of the *Pelargonium* industry in Kenya, which is a consequence of its private sector basis, has markedly assisted in the positioning of pest preventative measures and the strategic monitoring of biovar 2a through the use of diagnostic kits.

### Case study 2: banana Xanthomonas wilt (BXW) within the informal cropping systems of East Africa

Having been a relatively minor disease of enset and banana in Ethiopia since the mid 1960s (Yirgou and Bradbury 1968), *Xanthomonas campestris* pv. *musacearum*, the causal organism of BXW, has recently been reported in Uganda in 2001 (Tushemereirwe et al. 2006) and, subsequently, other nations of the Great Lakes region of East Africa (Reeder et al. 2007). Damage attributed to the disease on banana within the Great Lakes region has been significant (Karamura 2006). Prior to the occurrence of the disease in Uganda the risk presented by this disease had not been formally considered. However, the Global Plant Clinic (GPC) on identifying the bacterium as a new pest record for Uganda advised on a precautionary approach, stating the risk posed by the disease was unknown for Uganda and the Great Lakes region and that the more intense and contiguous banana cultivations of the region could identify with a higher risk of spread and impact than seen in Ethiopia. Events have shown this to be true (Smith 2007) and, although a formal Pest Risk Analysis is now available (Smith et al. 2008), the absence of a contingency plan to manage an outbreak of BXW may have contributed to delays in action that allowed the disease to become more established.

From a PPDS perspective the outbreaks of BXW have identified various issues in national capacity to survey for and identify the causal organism (Smith 2007; Aritua et al. 2008). Notably, for some nations the evidence from farmers and national authorities on the date of introduction of BXW has been inconsistent, with farmers reporting awareness of the disease prior to the national authorities (Reeder et al. 2007). Whilst such observations are anecdotal, they suggest that for these nations national surveillance mechanisms for emerging plant diseases are inadequate. Moreover, confirmation of the disease in all the affected nations has required the support of the Global Plant Clinic (GPC: www.globalplantclinic.org) as an external northern partner. Indeed, in the case of Burundi, confusion has persisted as to the disease status (present or absent) when reports of disease had been based on symptoms only and not supported by successful isolation and identification. In this instance the uncertainty as to disease presence (which has been confirmed by the GPC) diverted attention and action away from implementing control measures that must have been to the detriment of the control effort. Only in Kenya was a successful isolation of the bacterium onto culture medium performed as a step towards identification, with these cultures then transported to the GPC in the UK for formal identification. From these events it is evident that across East Africa, and most likely for other developing African nations, there is a general low level of expertise and infrastructure available in bacteriology; spanning the capacity to undertake isolation of the bacterium from infected plants onto culture medium through to the identification that frequently requires the use of sophisticated analytical methods.

In efforts to control BXW, much debate has centred on the use of a diagnostic tool (Smith 2007; Aritua et al. 2008; Aritua et al. submitted), and if such a tool had been available at the time of the first outbreak would a different scenario of disease spread have occurred. In considering this question, it is necessary to appreciate the type of detection technology, the receiving environment of the test (the banana cropping system of Uganda and the Great Lakes region) and the entry points for the technology along the farm-fork continuum, from producing banana plantlets for farmers, to production and marketing of the banana itself, to the disposing of crop waste. An analysis quickly concludes that within the informal banana cropping systems typical of the Great Lakes region no obvious entry point for detection technology, be it laboratory or field-based, is readily identifiable as would allow for a critical intervention to reduce the rate of spread of the pathogen (Smith 2007). In practical terms, any diagnostic tool, without a critical entry-point from which to operate, will only have limited application in confirming and 'chasing' the disease. This is not to conclude that we should not invest in diagnostic technologies, for example, the prosaic ambition of achieving a rapid and accurate identification has value in mobilising contingency efforts, but it would be a mistake to see such tools as a panacea on their own. The point is made that in development of such tools, effective entry-points for the technology must be recognised, and for Africa and food this most notably requires a greater degree of formalisation of agricultural production (private sector players) and the strengthening of the policy environment that oversees such practices. The potential and use of such technologies for Africa have been considered by the Foresight Project (Barker et al. 2006, Quinlan et al. 2006).

## Case study 3: black stem rust and a new virulence

A new variant of black stem rust, caused by *Puccinia graminis* f.sp. *tritici* race Ug99, was identified in Uganda in 1999 that had evolved the capacity to overcome resistance genes present in the majority of globally cultivated varieties (Pretorious et al. 2000; Singh et al. 2006). The risk posed by this variant within Africa and globally has been described by the Consultative Group for International Agricultural Research (CGIAR) centre, CIMMYT (International Centre for the Improvement of Maize and Wheat), as significant and requiring rapid action, and that the response to the threat to date has been inadequate. In an article to the New Scientist Environment (Anon 2007b) it is argued that in previous times the routine surveillance for variants of the pathogen that was, but is now no longer due to financial constraints, undertaken by CIMMYT would have allowed for the earlier detection of the variant and a more effective response. The disease has now spread across East Africa and spores have been detected in Yemen and Sudan, making the link to Egypt, Turkey the Middle East and beyond highly likely (Brown and Hovmoller 2002). A parallel can be drawn with the UK Cereal Pathogen Virulence Survey (UKCPVS) that screens for changes in virulence of named UK cereal pathogens (yellow and brown rust of wheat, brown rust of barley, powdery mildew of wheat and barley and *Rhynchosporium* of barley), and determines the consequences of any changes observed (Anon 2007f). This surveillance has been undertaken by National Institute of Agricultural Botany (NIAB) since 1967 and continues today, with the costs accepted by UK Government (Department for Environment, Food and Rural Affairs) and the private sector cereal levy board, Home-Grown Cereals Authority (HGCA). Amongst developing nations, where governmental and private sector support for pest surveillance is historically weak, such a role of surveillance for pathogens known to present a high risk (through introduction, emergence and/or through having a known predisposition to evolving new virulence) is appropriate for the CGIAR (or any other body with the capacity to provide such a service). Some complementarity with the primary mandate of the CGIAR as a custodian of germplasms seems evident. The example of cassava mosaic disease and the recent new virulent form that has swept across East Africa would also fall within this category (Zhou et al. 1997).

### Case study 4: pest surveillance, field level diagnosis and provision of advice to farmers (extension services)

The delivery of extension services is a highly challenging ideal and historically, for Africa, one that has met with limited success. Even within developed nations, many such services have been radically reduced where these have relied on government support, with a transfer of service delivery provided by the private sector. A positive innovation in this area has been the example of 'Going Public' and mobile 'Plant Health Clinics', as initiated under the Global Plant Clinic (GPC) (Bentley et al. 2004; www.global-plantclinic.org). Going Public (on a particular disease) and Plant Health Clinics (for general plant health) are not extension services in the typical form, but rely on trained diagnosticians attending public gatherings with relatively limited and simple props and making themselves available. These approaches have shown the effectiveness of being 'with the people' in the two-way communication of plant health news between researchers and farmers. Advice can be provided and new disease concerns can be quickly reported and followed-up on, with the option of taking samples for laboratory analysis if necessary. For example, Going Public has been effective in raising awareness on identifying and controlling napier grass stunt in Kenya (Anon 2005a) and the concept of mobile Plant Health Clinics has been enthusiastically received within Uganda (Anon 2005b). Under the GPC these modes of extension have been piloted with significant success in numerous countries, including Uganda, DR Congo, Tanzania and Kenya within East Africa. As a mechanism for communicating to, and gathering information from, grass-root level stakeholders on 'today's' pest concerns, along with other issues such as food quality and marketing constraints, these approaches command significant merit (Boa 2007).

## Functionalising diagnostic capacity (PPDS) in Africa

Over the past few decades, significant external investment has been made in African agricultural research and phytosanitary institutions. For example in Kenya, in the 1980s and 1990s, the Kenya Agricultural Research Institute was substantially supported under the National Agricultural Research Programme (NARP I and NARP II), which aimed to improve infrastructure and human capacity through building and equipping new premises, *ad hoc* training and PhD programmes. Similarly, Uganda has been a focus for major external investment. Consequently, amongst East African nations, Kenya and Uganda support the highest number of national agriculture-related PhDs and have some of the best-equipped laboratories. Yet, despite the marked progress achieved through such investment, by example of the impact of diseases such as **Cassava mosaic virus** (CMV), coffee wilt and BXW, even these better-equipped nations remain vulnerable to new and emerging pests. Perhaps reflecting this concern, in recent years support by development partners has moved towards more grass-root level activity, notably in working with Non-Government Organisation (NGOs) and in promoting private sector entrepreneurialship and the market values of agriculture. The crux of a sustainable PPDS is in connecting institutions, farmers, the private sector and consumers within a policy framework, where all the stakeholders of a food chain equitably share risks and benefits of investment.

Within Europe, the discussion on how to support PPDS is relatively well advanced. The starting point is not strongly comparable with the challenges that beset Africa, particularly with respect to private sector activity and the opportunity this affords through levy boards and other industry platforms as, in part, characterise developed nations. However, some aspects can be paralleled.

## Capacity and advances in technology for PPDS

The maintenance of plant pest taxonomic expertise for identification purposes in Europe increasingly resides with a few institutes. For the UK this is primarily with the Central Science Laboratory (CSL) that serves as a national laboratory for the identification of plant pests. This diagnostic capacity is in the main supported by the UK government, through the Department for Environment, Food and Rural Affairs (Defra), with a further value realised (approx. 10% for 2006) with commercial customers. Defra further supports CSL to undertake underpinning research on pests of strategic importance that builds from and adds synergy to the taxonomy and diagnostic resource. Notably, taxonomy and diagnostic capacity are not seen as a stand-alone resource and are integrated with other areas of research and development. It is the fullness of this understanding between CSL and Defra, and Defra's responsibility (policy position) to industry and the public that is important in maintaining a credible PPDS at CSL.

It is recognised that PCR-based and generic nucleic acid platform diagnostic technologies (micro-arrays) have the potential to 'reduce' diagnostic procedures for the divergent disciplines of bacteriology, mycology, nematology, virology and even entomology to a much simplified non-technical testing format (Mumford et al. 2006; Boonham et al. 2007). Thus, a move towards the use of advanced approaches questions the need for expertise in classical pest identification and presents an opportunity to deliver a service with fewer and less qualified staff. Requirements for ISO-accreditation in pest diagnostics are also more attainable by advanced methods that avoid some of the subjective assessments required by classical taxonomy and diagnostics. Such accreditation of PPDS is becoming increasingly important with clients. Thus, on a fiscal basis, cost-saving and greater business opportunity may be envisaged by embracing modern methods. It is widely recognised that expertise in classical taxonomy for plant pests is on the decline and the high costs of maintaining this is often seen as a core factor. In this context, advanced molecular methods for pest diagnostics are seen positively. However, it would be interesting to establish the truths of this statement, especially in the context of Europe and Africa, noting the respective positions of high salary, low consumable costs and low salary, high consumables costs for these continents, respectively. Moreover, there is also a view that classical taxonomy and diagnostics should not be overlooked as, whilst it seems expedient to embrace technology, there is a risk of the diagnosis process becoming detached from the deeper knowledge of the organism inherent to classical approaches. The consequences of diluting expertise in taxonomy, if this leads to a less effective research and development programme for controlling a particular pest, might prove to be to a greater detriment than the investment needed to maintain such capacity.

## Organisation of PPDS

Whilst for most nations the provision of PPDS is considered a national responsibility, at the European level some discussions are in train on the value of identifying Community Reference Laboratories (CRLs) that may serve a regional function. This may seem attractive especially for those nations without a critical mass in PPDS. For example and on a bilateral basis, CSL provides an identification service to the Swedish government for plant pests. An extension of this idea may see institutes recognised at the EU level to provide regional PPDS for particular organisms for which they are recognised experts, with others pests aligned to different institutions within the same or another EU country. This approach to 'partitioning' expertise is already evident within veterinary diagnostics of the EU where CRLs are recognised for the key pests (e.g. the CRL for Avian influenza is the

Central Veterinary Laboratory, Weybridge, UK; Dir 2005/94/EC) that serve to backstop National Reference Laboratories (NRL; Anon 2007h). In this context the CRL will provide resources to the region that are unique for that pest, such as reference strains or highly specialised diagnostic tests that are not available to the NRL. A further example is also evident with mycotoxin and GMO testing in food and feed where EC regulations recognise NRLs and a single CRL, the Joint Research Centre Institute for Reference Materials and Measurements (Anon 2007i, j).

For Europe a dispersed regional facility in the area of plant health, akin to that with veterinary diagnostics, would be achievable. However, such partitioning of expertise may risk fragmenting the synergies that operate between taxonomic disciplines, synergies that are increasingly apparent with the generic nature of many of today's emerging nucleic acid-based technologies, and would not allow for the necessary institutional planning (succession of staff and infrastructure updates) to maintain a critical mass in diagnostic capacity. Thus, whilst a credible service can be identified today this may not be the case in 5 to 10 years if a disparately located PPDS was realised. The opportunities and concerns in setting up plant health CRLs are being discussed by the European plant health community (Giltrap, N., personal communication).

Aspirations of CRL in Europe have not extended to the establishment of a single or limited number of regional 'centres of excellence' that aim to provide a complete PPDS for the region. However, with the continuing advances being made in molecular diagnostics, e.g. microarrays (Boonham et al. 2007) there may well be greater motivation towards such an holistic approach in the future. Currently for the EU, the relative strengths and long histories of many national laboratories makes this scenario unlikely. However, in an African context, where there is not such a strong existing plant pest diagnostic capacity and the investment needed to raise the standard of many nations appears prohibitive, such an argument for a 'one-stop' centre of excellence with a regional mandate may be more viable. Another view may suggest it runs against political will to 'outsource' services to another nation when this may lead to an erosion of national expertise and a reduced-competitiveness in bidding for research and service contracts, an argument that is also applicable with the development of CRLs. Ideas of consolidating institutions further, as might be suggested when generic diagnostic technologies allow for plant, animal and human health pest diagnostic services to be joined, would present a further political dimension.

These arguments are very relevant to Africa where the scarcity of human capacity and infrastructure strongly identifies with the logic of identifying a regional capability, located centrally or virtually through a network.

## Examples of pest diagnostic initiatives in Africa

Examples of initiatives to invigorate pest diagnostic capacity in Africa are evident as training projects, networks and regional 'centres of excellence'. To note a few within the East Africa region:

Bioscience East and Central Africa (BeCA; Anon 2007a) is based in Kenya on the grounds of the CGIAR centre ILRI (International Livestock Research Institute) and aims to serve as a research centre of excellence for the East Africa region that could extend to PPDS. As a recently formed centre, BeCA is still at an early stage of development. A key to its success will be the complementarities realised with the regional national research institutions with which BeCA must make effective partnerships.

The International Plant Diagnostic Network (IPDN) is a USAID-supported initiative that aims to establish regional networks for plant disease diagnostics through a 'hub (main laboratory) and spoke (neighbouring country laboratory)' structure (Anon 2007c). Currently, three regional networks are in development, two in Africa (West and East Africa) and one in Central America. With this initiative, strong emphasis is placed on communication and data-networked systems that extend to partners in the USA and Europe. The placement of such networks with regional bodies of Africa such as COMESA in the context of sanitary and phytosanitary measures and the realising of robust data sets for national/regional pests as complies with the WTO and facilitates region/export trade would be of substantial value.

The Nematode Initiative for East and Southern Africa (NIESA) is ostensibly a capacity-building programme for expertise in nematology that is funded by the Gatsby Charitable Foundation. The primary aim of the project is to develop a 'Nematology in Africa Platform' for accessing and sharing information on all aspects of plant parasitic nematodes (Anon 2007e).

The Global Plant Clinic, an ostensibly DfID-funded plant health diagnostic clinic, has for many years provided a service for pest diagnosis for developing nations that is free on a request basis and, significantly, in recent years has extended to field support. The work of the GPC represents an example of on the ground surveillance for pests, through linking field and market observations of farmers and consumers to extension-styled diagnostics and on-the-spot provision of control recommendations, with referrals to technical laboratories as required (see case study 4).

## Implementing policy standards

How a plant health standard is implemented (policy position) represents a key challenge that goes to the core of functionalising institutions that either implement or oversee standards. In Europe provision to ensure its new member states are proficient in plant health has been addressed through twinning projects tailored to address specific policy positions. For example, in the twinning project on plant health in Estonia (Anon 2007g), provision has been made to address EU regulations on ring rot of potato that has involved the purchase of a TaqMan PCR machine, capacity building and the implementation of Standard Operating Procedures (SOPs) that are accredited to an EU-recognised body. Such projects are akin to 'learning alliances' that simply partner like-mandated institutions between old and new member states for purposes of infrastructure and capacity building. However, within these projects limited consideration is given to the sustainability of the capacity building, and the assumption is made that either the linkages of the PPDS to the private sector or the national government are sufficient to provide viability. Thus whilst 'learning alliances' may present effective models for institutional and policy strengthening, for African nations, where there is a weak private sector pull for services and a limited expectation for support from governments, more is needed to establish the linkages to production pathways to allow for the associated costs of PPDS to be positioned.

## Cost sharing of PDDS

Amongst the farm-to-fork continuum for agricultural produce and the stakeholders therein (farm, institution, private sector and consumer, etc) is the requirement to pay for PPDS. Arguably this presents the greatest challenge as it identifies with the transformation of human capacity, infrastructure and appropriate policy positions into functional systems that deliver services in a cost-effective and timely way such as supports the interests of, and is valued by, all stakeholders. The challenge is truly a difficult one to resolve, as the provision of quality PPDS, especially if accredited, requires quality science, training, infrastructure and processes of monitoring and evaluation that are high cost. When these services are to be placed within informal food chains that are often of low value, as is typical for Africa and its staple crops, how such costs can be supported is not obvious. Evidently, the exception is with high-value products that attract or support private sector activity. However, the majority of crops grown in Africa are destined for local markets of low value where the necessary market structures upon which PPDS can be positioned are not in place.

Examples of paying by the private sector for PPDS in Africa are evident. The example of *Pelargonium* in addressing the disease threat by *R. solanacearum* has been presented in case study 1. Such examples tend to identify with export and higher value crops, where the engagement with PPDS is driven primarily by the needs of consumers of the importing nation and the standards for food safety and agricultural practices therein. Moreover, many of these standards are inclusive of non-regulatory good agricultural practices that have been set by the private sector for, by example, organic, ethical, fairtrade and EurepGAP standards, and as such builds value in the receiving markets with consumers.

A key realisation for Africa will be the positioning of plant health standards that stimulates the engagement of the private sector and a greater volume of formal local and regional trade. In these instances, arguably, standards that are equivalent for export are not appropriate for Africa and it might be advantageous to set less exacting standards, that whilst secure and safe, are more tolerant of pests and their products, and therefore more achievable in the near-term. Such standards may in time act as a stepping-stone towards future higher private sector-led standards that are the equivalent of the exporting standards set by the EU and USA. An example of the constraint imposed by setting overly exacting standards is with seed potato in Kenya and Uganda and the setting of a phytosanitary standard at zero for *R. solanacearum* (cause of bacterial wilt). For these nations where the prevalence of bacterial wilt within farmer's fields is high, the setting of zero tolerance for bacterial wilt in seed-tubers has largely precluded all smallholder-derived potatoes being officially sold as seed. Consequently, the majority of certified seed-tubers available are those produced by the respective national agricultural research stations, with a private sector venture unlikely. It is a circular argument, but it is only when a greater demand exists for certified seed-tubers that a significant private sector interest for seed potato production can be justified, and ware farmers remain to be convinced of the value of good quality seed because of its limited availability and high price. Thus, part of the solution lies with the education of stakeholders as to the need for quality, be this with seed or agrochemical inputs or food, as ultimately the consumers will drive standards.

A further key point to realise is that PPDS and other diagnostic tests that encompass food and feed quality and authenticity are not equal in their commercial value and therefore support from the private sector. Many of the diagnostic services reside with food and feed and are driven as much by the private sector and consumer interface as by regulatory need, and demand a higher volume of testing. Tests for pesticide minimum residue levels (MRLs), mycotoxins and GMO contamination are integral to food and feed-testing regimes for Europe and many developed nations, and potentially these tests can provide the bulk of commercial diagnostic service income for a laboratory. This is the experience of CSL. The corollary of this position is in the provision of diagnostic services that hold little direct value to the private sector, yet are nonetheless recognised as essential to the overall wellbeing of an industry. In these cases, alternative ways of support are required. An indirect mechanism for private sector engagement may be achievable through private sector trade boards that use part of their industry levy to support the industry through provision of services that are most effectively implemented by a higher body. It is worth noting that nations with developed PPDS tend to have established industry bodies, such as the British Potato Council and Potatoes South Africa. In case study 3 the role of the HGCA in cost-sharing with the UK government for virulence surveillance of cereal pathogens is described.

However, it is not the case that the private sector can support all PPDS and, whilst the example of Europe and other developed nations may testify to an increased importance for engaging the private sector in PPDS, a role for government is nonetheless also evident. As in the example of CSL and its relationship with Defra, there remains a key role for government to support the position on regulatory pest diagnosis, risk analysis and contingency planning. Not all pest diagnostic needs can be packaged for the private sector to pick up.

## Concluding remarks

Based on these arguments its seems unavoidable that the development of a pest diagnostic capacity for Africa, that aims to serve the majority of farmers' crops and notably the low value staples, must be part of a broad PPDS that is substantially linked to government or regional support mechanisms of national/regional bio-security. However, were viable, the role and buy-in of the private sector must be identified and strengthened. This would also seem to be the objective of developed nations of Europe and USA that continue to evolve through mult-national arrangements (for the EU), address of homeland security and increasing private sector activity.

The porosity of the borders between African nations to pests identifies with endeavours to promote regional initiatives that address PPDS, especially in the context of phytosanitary policy. Such a remit sits well with the aims and objectives of the New Partnerships for Africa's Development (NEPAD) through its Comprehensive Africa Agricultural Development Programme (CAADP) and its advocacy body, The Forum for Agricultural Research for Africa (FARA), in the facilitation of regionally coordinated actions. The extent to which such an African PPDS capacity is national or regional, networked, with resources duplicated, unique, disparate or centralised and linked with partners of advanced research institutes/centres of excellence in Europe, South Africa or USA requires debate, along with the necessary links to the private sector.

There is however, a clear need for better pest diagnostic capacity, as without such tools any ambitions for pest detection, identification and monitoring will remain unrealised. Costing PPDS serves is a key issue, and noting that policy and private sector-based sanitary and phytosanitary standards shape production and trade and protect the national interest, efforts to develop and implement PPDS that bridge private sector and mandated institutional interests, may provide the vehicle to catalyse broad-based development. The inclusion 'under one roof' of food and feed diagnostic services alongside PPDS will present greater opportunity to maximise processing efficiency, reduce outlay for infrastructure and human capacity and realise revenue through private sector interest.

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