Embedding crop pest risk assessment and surveillance into commercial and community practices for a more secure farming and food future

A case study for East Africa

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EMBEDDING CROP PEST RISK ASSESSMENT AND SURVEILLANCE INTO COMMERCIAL AND COMMUNITY PRACTICES FOR A MORE SECURE FARMING AND FOOD FUTURE: A CASE STUDY FOR EAST AFRICA

VISION STATEMENT

To provide for a resilient and trusted capability in plant health and food safety through a devolved model for surveillance and monitoring of crop pests during production, storage and trade with the private sector and rural communities, underpinned by core government processes in information assimilation and risk analysis as supports effective policy development and implementation.

CONCEPT SUMMARY

The failings of African agriculture are not essentially about gaps of knowledge and a need for research, but more about a failure of systems, processes, planning and pre-emptive action; about organisation, strengthening what is already available, in enabling for innovation to take hold and in being prepared to prevent shock events. This is most evident in areas of plant health and food safety, and in the provision of surveillance and analytical testing services.

To date the research and development agenda has struggled with these areas, and more specifically engaging effectively with plant health and food safety government institutes that by mandate are not natural research partners. Much of what has gone before has been prefaced by research and not functionality and service delivery of actors within a cropping system or production pathway. This has amounted to a ‘market failure’ in providing the necessary support to farmers, traders and the consumers at scales of farm, village and upwards for regional coherence.

This concept sets out to identify and justify the primary elements, or pillars, for redefining the traditional roles of national plant and food safety institutes as front-line architects and implementers of related policy and services, by pulling in the commercial sector to provide for much of the service delivery. The transition recognises the currency of the commercial sector as an information broker and looks to take advantage of changes in crop pest diagnostic technology and information analysis that creates for different ways of working. The approach advocated retains and gives focus to the oversight and policy-setting mandate of the national authorities. In essence it allows those sectors of plant health and food safety to deliver on what they are best able to deliver on, with a critical appreciation of cost sharing and sustainability. A schematic of the change is provided in Box 1.

Box 1: Bridging the disconnect between government with the private sector and community

The traditional model for pest risk analysis and surveillance for plant health and food safety is with a central government hub that takes on the vast majority of associated tasks, both in implementation and cost. Most notable is the expectation of central resourcing of analytical testing and extension services.

This model has largely failed for most African countries because of a spatial and temporal disconnect of services with the production chains and cropping system. Moreover, the concept of central support from government is increasingly challenging for all countries, developed and developing country alike.

1 Testing can be in seed certification or with food safety for pesticide residues and mycotoxins
2 Extension services to farmers has long been the preserve of government and government staff working directly with rural communities, mainly in crop production
A solution, and a new model, is to devolve plant health and food safety services out with communities and the private sector, with oversight maintained by government bodies. In this model costs are embedded more with existing and valued activities of the private sector and community than with government, thus building for sustainability.

For this transition to be successful three main areas of innovation are needed, centred about:
- Novel diagnostics for pests, mycotoxins and pesticides, and decentralised use
- Community surveillance and smart-ICT
- Institutional strengthening at national and regional scales

**Challenge Statement**

Faced with a growing population and climate changed world, the challenges of meeting local and global food security have never been steeper. Some of the more immediate and bigger gains to be maintained are related to the impact of crop pests.

In this context the default assumption is often about producing more and reducing crop losses to pests as this is a simple and compelling message. Yet whilst this is true in a broad sense, it is also well known that bigger yields will not result in food security if the markets are absent to support supply. The truer challenge is about ensuring yield reliability and quality and the market premium that these attributes of supply can leverage along the food chain, through to a market-pull for products and confidence for investment for higher value processed products. These challenges identify with areas of plant health, (eg freeness from pests in seed or produce) and pest related food safety (eg mycotoxins and pesticide residues) and the prevention of shock events (eg new pest outbreaks or aflatoxin peaks). Critical in this space of surveillance, reporting and response, is the real-time availability of information for early and timely interventions, where delays can lead to pest epidemics or contaminated foods being consumed by the public. Retrospective actions rarely hold value in the context of plant health and food safety, neither in a political or a commercial context.

**Plant health**

A ‘pipeline’ of emerging and new crop pests, facilitated by increased trade and climate change, continue to expose a soft underbelly of crop production in Africa (see Box 2). Afflicting some of our most important food security crops, such as cassava, wheat, maize and banana, pest epidemics have, with some frequency, swept across vast areas of Africa and threatened territories beyond. Moreover, the impact of these outbreaks is not limited to immediate and local food shortages, but can destabilise markets, both locally and overseas over extended periods of time. The shock event of a pest outbreak also undermines confidence in the farming and food sectors to risk investment that may otherwise realise a more resilient and profitable cropping and food system. Thus, in a realm of ever-increasing demands for global food, such vulnerability extends beyond Africa to economies of Europe, USA and Asia. To mitigate the threat of crop pest outbreaks is therefore a global responsibility that will need to be shared by all parties to production and trade.

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3 ICT – Information and Communication Technology

4 Any species, strain or biotype of plant, animal, or pathogenic agent, injurious to plants or plant products (FAO glossary definition)
Box 2: Example of some major crop pest outbreaks to affect sub-Sahara Africa

- Cassava Mosaic Disease – new genetic variants broke the resistant of current varieties and the disease spread across Africa
- Cassava Brown Streak Disease – like with CMD a new genetic variant was first reported in Uganda and has subsequently spread across all countries of the Great Lakes region
- Maize Lethal Necrotic Disease – a complex of two viruses, one atypical to the type strain normally associated with the disease, is now reported in Kenya and Tanzania for the first time and is spreading unchecked within the region
- Banana Xanthomonas Wilt – a disease endemic to Ethiopia was first reported in Uganda in 2002 and by 2005 was widespread across the Great Lakes region
- Black Stem Rust of wheat – a new genetic variant, Ug99, was reported in Uganda and has since spread south to Yemen and Iran and threatens the major wheat zones of India and Pakistan

Crop pest related food safety

Parallel to risk assessment and surveillance for shock, outbreak pests, is the need to monitor the burden of those pests that are familiar to farmers’, maybe sprayed for, or managed by, some cultural practices, or simply tolerated. In this context the challenges extend to food safety and in monitoring for pesticide residues and mycotoxins, especially aflatoxin in grain. In the context of food safety, most crop pest-related impacts for Africa are documented with respect of export trade to developed world countries such as the EU, USA that have effective food safety capabilities. What is striking is that whilst these trade pathways regularly identify food that is seen as unfit for human or animal consumption, the food that is exported is likely to be at the higher quality end of what is generally available at the local markets. The prevalence and level of pesticide residues and mycotoxin within local market foods is frequently shown as exceeding what is acceptable according to FAO guidance. The below provides some headline facts about mycotoxins and consequences.

- It is estimated that 4.5 billion people, predominantly within the developing world, are at risk from mycotoxin exposure through food
- Mycotoxins contribute to acute or chronic health problems, such as liver toxicity and cancer.
- In addition to human consumption, animals and fish fed with contaminated feed have low productivity, with stunting or disease.
- Major agricultural food commodities are prone to mycotoxins including maize and groundnuts, and to a lesser extent sorghum, millet, soybeans and cottonseed.

Analysis of prevailing position; building on what is good and new ways of working

Transitioning away from government plant health and food safety services through partnership with commercial sectors and the community

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Crop protection, better than cure

For most countries the traditional model of risk assessment, surveillance and response has been with government through expert panels, extension services and large government laboratories for analytical testing. However, increasingly this approach appears dated for successful agricultural countries and has largely failed to provide for developing countries, notably those of Africa. As a general direction of travel there is an increased reluctance by government to afford these plant health and food safety services, and a growing expectation that a greater sharing of responsibility with the private sector and community can be brokered. In this new realm, lowering the barrier for the commercial sector and community to enact such service roles is key. Innovation in analytical services (see Innovation Area 1), Extension (see Innovation Area 2) and information gathering and assimilation (see Innovation Area 3) are providing for such new ways of working. A partnering of government with the private sector and community in plant health and food safety service provision, with associated sinking of costs, must result in an overall win for the interests of all partners, and ultimately the consumer.

Innovation Area 1: Novel diagnostics for pests, mycotoxins and pesticides, and potential for decentralised use

New diagnostic technologies are being developed that heighten testing efficacy, lower cost, and are less dependent on highly technically trained individuals and large, expensive laboratory infrastructures. For pests and mycotoxins it is now relatively easy to develop diagnostics that allow quick and affordable detection, undertaken in basic laboratories, even field-side. Such example already exists for numerous pests, mycotoxins and GMOs as Lateral Flow Devices.

The capability for decentralised testing is currently less of an option for pesticide residues due to the technical challenge in detecting small molecules and by virtue of the vast array of pesticides to be monitored. Yet even in this challenging area new technologies are emerging for the detection of food contaminants, such as with RNA-aptamer-based assays, that in a few years will provide for decentralised testing of prioritised pesticide residues comparable to that achievable for crop pests.

Innovation Area 2: Community surveillance and smart use of ICT

A massive and largely unharnessed potential for surveillance resides with the community and what is evident in their farms and markets. An approach for community surveillance was recently successful piloted in the Democratic Republic of Congo for the first identification of Cassava Brown Streak Disease (CBSD). Based on the CABI Plant clinic approach, NGO staff shared images of disorders of cassava (mostly caused by pests, but also abiotic stresses) with attendees of a market to identify those types of disorders they experience with their cassava (see below). From this communication informed leads were followed-up on at the farm to obtain samples for full verification. By this

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A GM crop already requires a detection method as a requirement of commercial release, but not necessarily one that can be performed in a basic laboratory or remote locality

approach a raft of ‘horizontal’ data was realised on pest prevalence within the community, that although raw and requiring various means of proofing for reliability, provided a real-time resource on pests events within the area. The approach contrasts to the normal researched-led surveillance, centred on driving and stopping that is rarely informed by any community intelligence as to where a pest may have been seen. Moreover, this method tends to sample an often biased sample of fields, i.e. those nearest the roads and known by extension staff, and is very unlikely to find a rare event, such as a first pest outbreak.

The next logical step for this type of surveillance is to build commercial sustainability to the clinics. An option may be to have the clinics hosted by stockist and agricultural agents, and joined with extension services. With increased use of digital images and remote sharing of data, via mobile phones and other similar devices, the potential to embellish surveillance and extension services about a stockist, that links feeds of information through to the government for filtering, checking and assimilation (‘vertical’ integration of data) to give intelligent analysis is compelling. Out with this linkage with the commercial sector is the considerable potential to take advantage of the outreach the multinationals provide, both within countries and between countries and regions. This scaling of information gathering across a region by the commercial sector is not easily achieved by national governments.

Left: Community surveillance for first outbreaks of Cassava Brown Streak Disease in DR Congo. NGO staff share images of cassava disorders with animated farmers and marketers at a rural market. These events were replicated over 30 markets over a 3-month period. Over 1,600 people were interviewed, with 100 farm visits and 200 samples analysed. First reports of CBSD outbreaks for DR Congo were confirmed in two farms from different districts.

A UK example on surveillance that takes advantage of mobile technology is with CropMonitor™. With data recorded from field sites across the UK by technical aids from the research and advisory sector, CropMonitor™ provides a web and iPhone App enabled service to UK farmers’ that relays pest prevalence for crops such as potato, cereals, rape and beans. The information is also assimilated as long-term data sets as fits the interest of government in providing evidence in support of policy development.

The challenge to engage the private sector and the community in pest surveillance is not slight, but the gains to be achieved in real-time reporting and timely and well targeted action are considerable. The rapidly moving area of ICT is likewise both with challenge and opportunity. For Africa the culture of mobile technology has proceeded so quickly, with substantial investment in networks that cover some of the most remote areas, that this area of innovation may well take place first and most successfully in this environment.

Innovation Area 3: Institutional strengthening at national and regional scales
The institutional architecture and the roles performed by governmental plant health and food safety bodies for a country varies, but provide for common functions at national and supra-national level that set the frame for policies that support food security, trade and human health. In brief review:

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8 http://www.cropmonitor.co.uk/
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- Plant health resides with the National Plant Protection Organisation as the signatory body to the International Plant Protection Convention\(^9\) and is central to providing the frame of operation, extending amongst other functions to the setting of standards and thresholds for tolerance of pests in seed
- Equivalent food safety institutes, as signatures to CODEX Alimentarius\(^10\), undertake similar functions for pesticide residues and mycotoxins in food and feed

The intention to devolve some of the existing, but frequently poorly delivered on, activities of government plant and food health bodies to the commercial sector and community is not to lessen the importance of these authorities. The concept progressed is more about allowing government to give a better focus on those aspects of governance and policy-setting that are their critical roles and thus leverage more effectively their agenda at national and regional scales. The challenge presented by this step-change in roles is one of ensuring oversight of the processes are retained with government, with outcomes communicated effectively through to the appropriate partners.

In developing a community of national bodies that work towards shared policies or aspirational goals, successful example can be taken from the EU and its expansion to bring in other member states. The below identifies three mechanisms of building capacity and maximising coordination.

**Capacity building through Twinning:** Simply stated this identifies with the pairing of an experienced national institute with a less experienced but like-mandated counterpart, typically of the same region, to share time together for capacity building in bringing about institutional change within the inexperienced institute. In context of an East Africa Twinning Programme it may be that an institute of Kenya, such as the Kenya Plant Health Inspectorate (KEPHIS), would, as the experienced partner, ‘Twin’ with an institute from a neighbouring country that was seen as less experienced. An adjunct to this south-south Twinning for Africa would be to recognise that the experienced institute is with some learning needs and thus additional back-stopping would be provided from a third party from outside of the region, such as Fera, to strengthen the overall delivery. The 3\(^{rd}\) party Twinning would be particularly important in strengthening the global position with plant health and food safety.

*Left: Capacity strengthening in testing for Cassava Brown Streak Disease.*

National representative of research and phytosanitary institutes of the Great Lakes region take part in training in the use of CBSV diagnostics.

**Regional risk assessment for fast tracking policy advice:** The contiguous nature of land and food supplies of countries in Europe, as with Africa, requires a regional approach to risk analysis about crop pests and food safety. In Europe this activity is increasingly undertaken by the European Food Safety Authority (EFSA)\(^11\). The operation of EFSA consists of a relatively small core of staff, with panels of experts that are available on a call-down basis. The EFSA model provides for quick,

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\(^9\) https://www.ippc.int/
\(^10\) http://www.codexalimentarius.org/
independent and flexibility access to expert judgement over arrange of risk topics in providing scientific evidence to policy makers.

**Mechanisms for funding coordination on phytosanitation:** Whilst EFSA provides some funding to support research related to improving risk analysis methods, phytosanitary research funding across Europe is mainly coordinated by EUPHRESCO\(^\text{12}\). Initially established as an EU ERA-net, EUPHRESCO provides funding mechanism that pool and coordinate phytosanitary research amongst those EU member countries that have dedicated areas of funding for phytosanitation.

It is proposed by this concept that for East Africa a programme of Twinning for plant health and food safety should be initiated, along with consideration on the need for additional or changes to existing bodies that can take on a roles similar to those of EFSA and EUPHRESCO.

**POSITIONING SURVEILLANCE AND MONITORING WITH THE COMMERCIAL SECTOR AND COMMUNITY**

A fundamental principle to linking surveillance and monitoring with a commercial sector is that the activity is an adage of an existing and valued activity that can off-set a portion of the cost. In this model it would be expected that some cost of the surveillance and monitoring activity would be met by the government as a public-private partnership. Each commercial sector and community may identify distinct windows of cooperation, but good examples are already in evidence:

**With services for testing operated by commercial partners:** With a capability to undertake testing deployed with commercial laboratories or directly with the producer or agro-stockist, various windows of decentralised diagnostic positioning can be considered that broker a linkage between service delivery by a commercial sector and with the government that is valued by the customer and generates surveillance as valued by the government. The below (Box 3) are provided as example:

**Box 3: Some examples of areas where surveillance can be achieved through strengthening existing and valued practices undertaken by the private sector**

- In seed certification the use of field diagnostics for pests in support of field inspection for hard-to-diagnose high impact pests can add direct value with a seed producer or seed buyer due to rigour of the process and the benefit associated with freeness-in-seed from the pest. Thus the use of better diagnostics (e.g., Lateral Flow Devices) in certification can be achieved, with data assimilated as baselines of prevalence for pests that may be interrogated for novel pest events. Currently field certification is performed by government field inspectors, with some charge made to the customer, but the probability is that if these services are to be scaled to meet the demands of a successful seed industry then the capacity of a government service will be rate limiting. Thus field inspection and any associated testing may be devolved to a private sector, with routine activities borne by the customer and any non-routine check or statutory activity attributed to the government.

- Noting that a Lateral Flow Device will only be used for high priority pests (as will be valued by the industry and customer), the private sector can pass-on used devices to the national plant health authorities for authentication or additional analysis. In this context Lateral Flow Devices used for seed certification can also be assessed for presence of other pests, even the cultivar type, in accumulating data that may be of interest to government.

- In receipting in of grain for storage, a direct test for aflatoxin can form the basis for accepting or rejecting or agreeing a price on the grain. Diagnostics suitable for use at point-of-receipting already exist and can be used by the commercial sector. The test data arising can be valued by the government in recording baseline prevalence of mycotoxins at local and regional scales. Such data would underpin a prevalence map of aflatoxin risk that could inform policy and potentially an insurance rating against which a grower may take out insurance to protect against aflatoxin rejection.

\(^{12}\) http://www.euphresco.org/
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- In a rural market, community food inspectors may have a better capacity to test for pesticide residue levels of vegetables on sale in the local market. Although in this example the test is not in the hands of a commercial entity, its proximity to the customer would strongly influence the behaviours of the commercial sector.

In each of the above examples the real-time informed decision-making can carry a price premium that provides for a commercial edge, and the information gained on prevalence of pests can be assimilated by the national plant health and food safety authorities.

In this consideration of a commercial sector taking on a role in testing, it is not to suggest that those central government laboratories that currently take on these tasks stop doing so. But it would be to recognise that if the demand for testing grows with a more mature industry the overall demand of services may well be best shared with a commercial partner. In this dynamic of a commercial testing capability there is an emerging role for the government bodies to take on an increased vigilance for quality assurance over the services provided by industry, as for them. The positioning of government in quality assurance over analytical testing is considered next.

**With Government for oversight of decentralised testing services:** In progressing the opportunity for positioning testing services for pests and food contaminants with both government and, increasingly, the commercial sector such as a private laboratory or agro-stockist, there is a need to ensure that these services are performed effectively and to agreed quality standards. Measuring competence of laboratories in service delivery is a well worked area for analytical service providers. One of the best and most widely used vehicles for ensuring quality, that provide independent auditing, is with ISO accreditation (normally to ISO17025 for services and ISO1720 for inspection), within which a commonly used practice for measuring competence is with proficiency testing.

![Left: Components of the proficiency testing kit developed for Cassava Brown Steak Viruses](http://www.fapas.com/proficiency-testing-schemes/PhytoPAS/)

Competence of the laboratory in a specific test can be demonstrated by participation in a proficiency testing scheme as ran by FAPAS in the UK\(^{13}\). In this example, a laboratory, using the method of their choosing, is asked to determine presence or absence of the two CBSV viruses, alongside an internal control for the extraction of plant nucleic acid.

In a model of increased testing by commercial partners a key role for government plant health and food safety bodies would be in providing independent oversight of the services provided to clients.

**With extension services hosted by a commercial entity:** The other easy-to-appreciate example is at the point-of-sale of products and services, where extension advice is provided and information exchanged. As discussed earlier, the model of plant clinics and plant doctors for rural extension, as progressed by CABI, demonstrates the power of community surveillance in ‘horizontal’ ground level information gathering. The next logical step for this type of initiative is to build commercial sustainability to the clinics, where an option may be to have the clinics hosted by stockist and agricultural agents.

\(^{13}\) [http://www.fapas.com/proficiency-testing-schemes/PhytoPAS/](http://www.fapas.com/proficiency-testing-schemes/PhytoPAS/)
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