



Food and Agriculture Organization of the United Nations

Evaluation of FAO's contributions to Sustainable Development Goal 2

"End hunger, achieve food security and improved nutrition and promote sustainable agriculture"



Control of transboundary plant diseases and pests

About this document

This review focuses on building national and regional capacities for preventive control of transboundary plant pests and diseases, with cursory reference to large emergency outbreak control operations, including the current desert locust crisis response in the Horn of Africa and Southwest Asia.

The rationale for focusing primarily on preventive control is the widely held view that the management of such threats is less costly and more cost-effective when tackled early on, when the threat is still small and manageable. National pest monitoring and control capacities, as well as regional and global collaboration, are key to success in a preventive, Early Warning Early Action (EWEA) approach to the management of transboundary pests and diseases.

The review underscores how the control of transboundary pests and diseases is as much a governance issue as a technical one. Regional solidarity often determines the pace of progress, while political tensions, regional rivalries and conflicts tend to hamper regional collaboration on the desert locust and other species. The role of the Food and Agriculture Organization of the United Nations (FAO) in this context is to support a fair, collaborative and technically competent architecture of regional commissions and national entities that trust and help one another. FAO must continue to forge this trust, but it cannot be a substitute for national authorities, which also have their role to play. From the perspective of leaving no one behind, pests and diseases remind us that we all share the same planet and that we must cooperate beyond borders in order to succeed.

SDGs



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Contents

1. Introduction	1
2. Scope of the study	2
3. Historical and regional overview of FAO assistance	3
3.1 FAO's work on the desert locust	3
3.2 Work on other types of locust	7
3.3. Work on other species	9
4. Partnerships	10
5. Links to the key principles of the 2030 Agenda	12
6. Factors in FAO's success	15
7. Potential challenges to scaling up	15
8. Readiness to address possible shocks and stresses (such as climate change and epidemics)	16
9. Conclusions and recommendations	16
Conclusions	16
Recommendations	18
Bibliography	19
Appendix 1. People interviewed	20

Abbreviations and acronyms

CLCPRO	<i>Commission for Controlling the Desert Locust in the Western Region</i>
CRC	<i>Commission for Controlling the Desert Locust in the Central Region</i>
DL	<i>Desert locust</i>
DLCC	<i>Desert Locust Control Committee</i>
DLCO-EA	<i>Desert Locust Control Organization for Eastern Africa</i>
DLIS	<i>Desert Locust Information Service</i>
EMPRES	<i>Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases</i>
FAW	<i>Fall armyworm</i>
FAO	<i>Food and Agriculture Organization of the United Nations</i>
IRLCO-CSA	<i>International Red Locust Control Organization for Central and Southern Africa</i>
RPW	<i>Red palm weevil</i>
SWAC	<i>Commission for Controlling the Desert Locust in South-West Asia</i>
ULV	<i>Ultra-low volume</i>

1. Introduction

This review examines an area in which the Food and Agriculture Organization of the United Nations (FAO) has a long history of engagement: the management of transboundary plant diseases and pests. This is topical for Sustainable Development Goal 2 (SDG 2), as FAO estimates that 20 percent to 40 percent of world food crops are lost due to plant pests and diseases annually. Efforts to control the spread of transboundary pests and diseases also tend to involve non-tariff barriers, often causing the closure of trade borders, restricting international trade (SDG target 2.b).

This review is also timely because 2020 is the United Nations International Year of Plant Health (FAO, 2020a). People around the world have obviously suffered the devastating effects of plant pests, including diseases and weeds, for thousands of years. In the modern era, however, with greater international mobility, increased trade and more open borders, plant pests have been able to spread more rapidly.

Almost since its inception, FAO has been engaged in addressing transboundary plant pests and livestock diseases. The coordination of activities to counter locust upsurges has been a feature of FAO's work as far back as 1951, with the establishment of the Desert Locust Control Committee (DLCC) and FAO's adoption of the International Plant Protection Convention (IPPC).

Transboundary diseases and pests, as defined by FAO, are "those diseases and pests of significant economic, trade and/or food security importance for a considerable number of countries; which can easily spread to other countries and reach epidemic proportions; and where control/management, including exclusion, requires cooperation between several countries" (FAO, 1997). This definition covers many pests and diseases that can cause damage or destruction to farmers' properties, threaten food security, upset rural economies and disrupt trade relations. Box 1 lists some of the key transboundary pests and diseases.

The widespread desert locust (DL) plague of 1986–1989¹ caused considerable concern in terms of its economic cost, the environmental impact of chemical pesticides used to control it and the capacity of existing organizations to deal with the problem effectively. At the FAO–Netherlands conference on agriculture and the environment (in the city of 's Hertogenbosch, 15–19 April 1991), Members pressed FAO management to adopt a more proactive and preventive approach to managing transboundary pests and diseases, in addition to trying to contain outbreaks when they occurred. In response, FAO launched in 1994 the Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES). The concept was endorsed by the World Food Summit in 1996.²

¹ A plague developed gradually from initial outbreaks in the Central Region in 1986–1987, which spread to North and West Africa. Numerous swarms invaded the Sahel, East Africa, the Near East and Southwest Asia. By mid-1989, the plague had collapsed, probably for climatic reasons. Control efforts were aimed at protecting the crops rather than stopping the plague at its points of origin in breeding areas. See: Showler and Potter (1991).

² Objective 3.1. of the Rome Declaration on World Food Security states that "governments, in partnership with all actors of civil society, and with the support of international institutions, will, as appropriate: seek to ensure effective prevention and progressive control of plant and animal pests and diseases, including especially those which are of transboundary nature, such as rinderpest, cattle tick, foot and mouth disease and DL; [...] and promote concurrently, regional collaboration in plant pests and animal disease control and the widespread development and use of integrated pest management practices" (FAO, 1996).

Box 1

Examples of significant transboundary plant pests

Migratory pests move in search of food and suitable breeding places. Such migrations can extend over thousands of kilometres, across seas and political borders. The pests usually concentrate as swarms (locusts), infestations (armyworms) or flocks (quelea birds). Transboundary pests form a much broader group, one that includes migratory pests, but also so-called 'quarantine pests' that can be introduced to a country through the trade of agricultural produce. The list is potentially endless.

Migratory pests

Locusts are the most damaging of the migratory pests. They have adapted to semi-arid or desert environments where rainfall is scarce and irregular but often torrential when it occurs. The locusts fly to areas of recent rain, where moist and sandy conditions, growing vegetation and the absence of natural enemies offer ideal breeding conditions.

Armyworms are caterpillars that develop into nocturnal moths, capable of long-distance migration (covering more than 100 km per night). The caterpillars cause extensive damage to grazing land, cereals and sugar cane. Compared with locust outbreaks, armyworm infestations are usually on a smaller scale, but may extend over several hundred square kilometres. Outbreaks and movements are usually tied to the rainy seasons.

The **red-billed quelea bird** is a common and destructive pest of ripening grain in many semi-arid parts of sub-Saharan Africa. Millet, sorghum, wheat and rice are the most frequently attacked crops. Migration is influenced by rainfall patterns that affect the availability of certain annual grass seeds, which are the staple food of this species. They migrate over distances of more than 1 000 km, consequently crossing political borders. Affected areas may lose most or all of their cereal crops.

Quarantine plant pests

The **red palm weevil (RPW)** *Rhynchophorus ferrugineus* is a major pest of date, coconut, ornamental and oil palms in a diverse range of agro-ecosystems worldwide. After gaining a foothold on date palm in the Near East in the mid-1980s, it has spread rapidly over the last four decades. The pest has established in the Caucasian region, East Africa and the Arabian Peninsula. It has now been detected in more than 60 countries in total, including France, Greece, Italy, Spain and parts of the Caribbean and Central America.

Wheat rust diseases, with the continuous evolution of new pathotypes, poses a serious threat to wheat production worldwide. Their impact is more pronounced in the major wheat growing regions, such as East Africa, North Africa, the Near East and Asia. It is estimated that 37 percent of the world's wheat is at risk of potential epidemics of yellow, stem or leaf rust disease.

Cassava mosaic and **brown streak** viruses continue to affect cassava throughout the Great Lakes region of Eastern and Southern Africa.

Fusarium wilt disease has been a major constraint on banana production for more than a century. The disease is caused by the soil-borne fungus *Fusarium oxysporum* f.sp. *cubense* and is one of the most destructive banana diseases worldwide. Its most recent strain, Tropical Race 4, has been causing serious losses in Southeast Asia, resulting in the abandonment of thousands of hectares of banana plantations. It has spread to the Middle East, Africa, South Asia, and Latin America and the Caribbean.

Originally, FAO's work focused mainly on rinderpest and DL. In 2009, EMPRES was expanded to address safety issues along the food chain, such as foodborne pathogens, residues and other contaminants. Currently, the three main components are animal health (including aquatic animals and wildlife), plant protection (including forest health) and food safety.

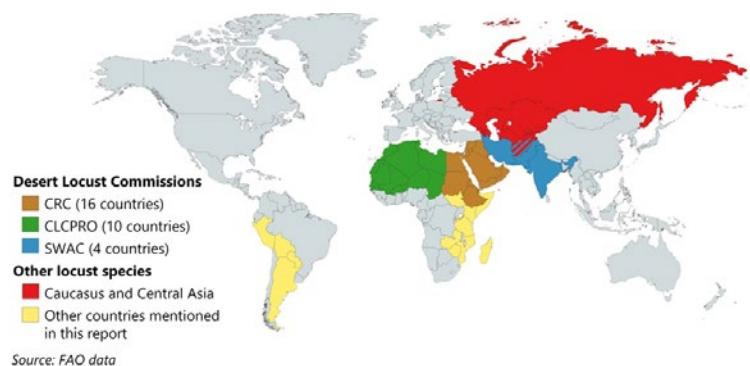
The EMPRES approach is to establish prevention systems for transboundary animal and plant pests and diseases through surveillance and monitoring, early warning and early reaction, enabling research and communication, capacity development and coordination.³ The approach has a regional component to take into account the transboundary nature of the threats, which calls for strong regional and international collaboration.

In the case of locusts, the preventive approach is to treat areas where there is a worrying density of locusts as they enter the "gregarious phase", when the insects are still slow-moving hoppers and not yet flying adults.

The vast breeding area of DL has been sub-divided into three regions: the Western Region (West and Northwest Africa), the Central Region (countries bordering the Red Sea) and the Eastern Region (Southwest Asia).⁴ Each of these has a separate FAO DL

commission that coordinates the work under Article XIV of the FAO Constitution (FAO, 2017), with a secretariat and an executive secretary: the Commission for Controlling the Desert Locust in the Central Region (CRC), the Commission for Controlling the Desert Locust in the Western Region (CLCPRO)⁵ and the Commission for Controlling the Desert Locust in Southwest Asia (SWAC) (Figure 1).

Figure 1.
FAO's three desert locust commissions



2. Scope of the study

This review focuses on building national and regional capacities for preventive control of transboundary plant pests and diseases, with only cursory references to large emergency outbreak control operations, including the current DL one.

The rationale for focusing primarily on preventive control is the widely held view that the management of such threats is less costly and more cost-effective when tackled early on, when the threat is still small and manageable. National pest monitoring and control capacities, as well as regional (and global) collaboration, are key to success in a preventive, Early Warning Early Action (EWEA) approach to the management of transboundary pest and diseases – hence the focus on national and regional capacities.

In the Phase 1 report of the SDG 2 evaluation, this review was originally supposed to have a broader remit: the control of transboundary diseases and pests, as well as support for food-chain crisis management, including transboundary animal diseases. However, an FAO evaluation of the humanitarian–development–peace nexus is planning a case study on transboundary animal diseases in the coming months, so this review was limited to plant pests and diseases.

Of those there is no shortage, however. FAO's work concentrates on the most aggressive ones, namely, migratory and transboundary pests and diseases of significant economic importance, such as (currently) the fall armyworm (FAW), the red palm weevil (RPW), various locust species, banana fusarium wilt diseases and wheat rusts.

This review focuses mainly on building national and regional capacities for the preventive control of locust species, chief among them, the desert locust (DL – *Schistocerca gregaria*), considered the world's most destructive migratory pest. As noted, DL was high on the list of original EMPRES concerns. The species threatens agriculture over a very wide area, from the Atlantic coast of Africa through the Near East to the Indo-Pakistani border, and the livelihoods of one-tenth of the world's population in some 60 countries. Locusts are highly mobile and cannot be effectively controlled by any one country acting alone.

This focus on locusts also stems from the fact that FAO has a long experience working on the management of these species. It was hoped that lessons could be drawn from its DL prevention and control operations to help the control of other pests of current importance, such as FAW.

The term 'locust' refers to a few species of acrid capable of forming swarms under certain conditions. DL lives and breeds mostly in arid and semi-arid areas of Africa, the Near East and Southwest Asia. Like other locust species (Table 1), it can change its behaviour depending on population density: normally solitary, individuals become gregarious when reproduction raises the density beyond a given threshold. In their gregarious phase, locusts form winged swarms that can be highly mobile (up to 150 km a day). Swarms can move out of desert areas into wetter areas, where they pose a serious threat to crops, as they eat up every bit of vegetation on their way.

³ The EMPRES system originally focused on plant and animal health and has recently been broadened to include fish and forest pests and diseases, albeit with limited work on these issues so far.

⁴ These regions do not operate in a vacuum: swarms may well migrate from one region to another.

⁵ CLCPRO = Commission de lutte contre le criquet pèlerin en région occidentale.

East Africa, the Arabian Peninsula and Southwest Asia are currently in the midst of the most devastating DL infestation of the past 25 years, threatening the livelihoods of millions of already food-insecure people. Another invasion of a related species (*Schistocerca cancellata*) is unfolding in Argentina, Bolivia (Plurinational State of), Paraguay and southern Brazil. Frequent outbreaks of Italian locust,

Moroccan locust and migratory locust also occur in the Caucasus and Central Asia, necessitating large control operations: on average, over the past ten years, 4.9 million hectares (ha) have been treated annually in the Caucasus and Central Asia against these three locust pests.

Table 1: ***Species of locust currently posing threats to agriculture⁶***

Common name	Latin name	Habitat	Current status
Desert locust	<i>Schistocerca gregaria</i>	From West Africa to Asia	Significant crisis. An upsurge developed from the 'Empty Quarter' of the Arabian Peninsula in 2018. Swarms emigrated to the Horn of Africa and to the Indo-Pakistani border in 2019.
Latin American locust	<i>Schistocerca cancellata</i>	Latin America	Significant crisis. Since 2015, a resurgence in Argentina has spread to Bolivia (Plurinational State of), Paraguay and southern Brazil.
Central American locust	<i>Schistocerca piceifrons</i>	Central America	Small outbreak in Guatemala and Mexico, with no significant damage to crops.
Migratory locust	<i>Locusta migratoria</i>	From Africa to Asia	In remission (still regular swarms in Madagascar).
Red locust	<i>Nomadacris septemfasciata</i>	Southern and Eastern Africa	Namibia declared an outbreak in June 2020.
Brown locust	<i>Locustana pardalina</i>	Southern Africa	In remission.
Italian locust	<i>Calliptamus italicus</i>	From Western Europe to Central Asia	Frequent outbreaks in the Caucasus and Central Asia.
Moroccan locust	<i>Dociostaurus maroccanus</i>	From Northwest Africa to Central Asia	Frequent outbreaks in the Caucasus, Central Asia and North Africa.
Australian plague locust	<i>Chortoicetes terminifera</i>	Australia	In remission.

3. Historical and regional overview of FAO assistance

3.1 FAO's work on the desert locust

Global information systems

Good information is central to the preventive control of locusts and other transboundary pests. Historically, the first area of work was DL, with the creation in 1974 of the Desert Locust Information Service (DLIS), based at FAO headquarters.⁷ All locust-affected countries transmit locust survey, control and environmental data to DLIS. These are combined with weather and habitat data, satellite imagery and historical data to assess the current locust situation and provide forecasts for up to six weeks. On this basis, DLIS prepares monthly locust bulletins forecasting the scale, location and timing of locust migration and breeding on a country-by-country basis. This information is disseminated by way of an email list, the Locust Watch website (FAO, 2020b) and social media.

In close collaboration with FAO's regional DL commissions, DLIS also regularly trains a network of information officers in national locust centres as part of an 11-month programme at FAO headquarters. One national information officer per country is taught DL population dynamics, data management and analysis, remote sensing interpretation and other related topics. DLIS also conducts annual training courses for information officers in the three regions to keep them updated on the latest technologies, methodologies and tools. Lastly, DLIS provides advice and assistance for emergency control campaigns during periods of increased locust activity.

Data capture is done by national teams surveying locust populations on a handheld tablet. The current version is called eLocust3. It has a multilingual operating system (Arabic, English and French), a mapping/navigation capability and can display vegetation and rainfall images. This helps teams to prioritize areas for monitoring. It also contains a digital library of reference materials and user

⁶ Some other species caused plagues in the past but are now quite rare, for instance the high plains locust (*Dissosteira longipennis*), which devastated the North American plains in the 1930s, or the Bombay locust (*Nomadacris succincta*).

⁷ This followed the closure of the British Anti-locust Research Centre (ALRC) in the early 1970s, which once pioneered much of the work on preventive DL control for the British Empire. Some of the staff and archives from the ALRC were transferred to the DLIS. Colonial empires more broadly were heavily involved in locust control during the 20th century, as locust outbreaks tended to reduce the profits derived from their colonies. Regional locust control organizations in Africa, such as l'Organisation commune de lutte antiacridienne et de lutte antiaviaire (OCLALAV), the International Red Locust Control Organization for Central and Southern Africa (IRLCO-CSA) and the Desert Locust Control Organisation for Eastern Africa (DLCO-EA) have their roots in the colonial period, which goes a long way to explaining why they are often so weak.

manuals. Geo-referenced photos of habitat conditions and locust infestations can be taken and uploaded, along with a standard survey questionnaire. Survey data are then transmitted in real time via satellite to the national locust control unit and DLIS. The data are then compiled and mapped using the RAMSES (Reconnaissance and Management System of the Environment of Schistocerca) software, which combines a database, a geographic information system (PostgreSQL) and satellite imagery.

In 2020, the eLocust3 suite of tools was expanded to include a mobile app version (eLocust3M), a Global Positioning System (GPS) version (eLocust3G) and an Internet version (eLocust3W) to help ensure that all survey and control teams were equipped with at least one eLocust3 device for real- or near-real-time data collection and transmission.

These tools facilitate the preparation of decadal (ten-day) and monthly locust bulletins by "frontline" countries (home to the locust breeding areas) in the three regions, the regions themselves and FAO at headquarters. It is critical that DLIS remain somewhat centralized in order to have a complete and rapid overview of the global situation, given the highly migratory nature of DL. Still, it should be strongly supported by the regions and the countries in question, if effective and timely early warnings and forecasting are to be provided.

It is worth noting that the DLIS Senior Locust Forecaster will retire in a few years and FAO has yet to take steps to fill this looming gap.

The Central Region

The EMPRES Desert Locust Programme was first launched in the Central Region, comprising nine countries around the Red Sea: Djibouti, Egypt, Eritrea, Ethiopia, Oman, Saudi Arabia, Somalia, Sudan and Yemen. This area was considered to be the origin of most DL outbreaks.

The programme began with pilot activities in 1995 and worked until 2006 to introduce the various components of preventive DL management to national programmes, supporting capacity-building and regional cooperation between the affected countries, developing early detection and early warning systems (eLocust), promoting the use of locust-specific ultra-low-volume (ULV) pesticide formulations and sprayers⁸ and helping nations develop contingency and rapid deployment plans. The total cost up to 2006 amounted to USD 11.5 million, funded by the Netherlands, Germany, Switzerland and the United States of America, among others.

The programme also supported the FAO Commission for Controlling the Desert Locust in the Central Region (CRC), which has 16 member countries: Bahrain, Djibouti, Egypt, Eritrea, Ethiopia, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Sudan, the Syrian Arab Republic, the United Arab Emirates and Yemen.⁹

According to all of those interviewed, EMPRES (Central Region) did an impressive work in introducing the preventive control system. Most countries in the region now have specialized locust units, many of them with strong capacity. Of course, the countries in the region are very diverse and this has an impact on their locust control capacity. At one end of the spectrum, the Desert Locust Directorate in Saudi Arabia is very well funded and equipped. The capacities in Sudan, Egypt, Eritrea and Oman are also considered solid. At the other end, however, Yemen is in the throes of civil war. In 2015, a militia looted the equipment and vehicles of the country's DL centre, which can no longer operate. And yet, Yemen is the most important frontline country in CRC.

Somalia, also marred by civil war since 1992, is another country in the Central Region that harbours extensive breeding areas for DL. Needless to say, capacities for locust monitoring and control in Somalia are next to non-existent at present. Somalia is not a member of CRC – a significant gap in coverage.¹⁰

In 2006, the Central Region EMPRES programme was transferred to CRC to ensure the sustainability of the preventive control system. CRC self-funds all of its activities through a yearly contribution, initially set at USD 266 000.

Following the example of the CLCPRO (see next section), in 2014, the Commission agreed to double the contribution of member countries, with yearly contributions now set at USD 533 000. An emergency fund was also created to decrease CRC's reliance on external donors and to allow for prompt reaction in case of an outbreak. There was an initial allocation of USD 150 000 from the Commission's Trust Fund, in addition to a call for further funds from countries and donors. CRC member states have not financed the fund, however. Worse still, CRC member countries – some of which are among the world's richest countries – have not paid their contributions regularly and have accumulated arrears to the tune of USD 1.8 million (FAO, 2019a).¹¹

Thus, while the Central Region has built capacity over the years thanks to EMPRES and the Commission, conflicts in Somalia and Yemen have left large gaps in the regional preventive control system. Moreover, CRC has faced difficulties in terms of maintaining momentum and policy relevance since the end of the EMPRES Programme, as well as in advocating for regional solidarity in the face of a common threat. This may be one of the factors behind the region's slow response to the current DL invasion.

The Western Region

In 2003, an upsurge grew into a significant crisis in West Africa (the Western Region), where FAO had not yet mobilized any resources. The total cost of the campaign and associated rehabilitation in Northwest Africa was estimated at more than USD 400 million, including food aid, multilateral, bilateral and national contributions. More than 13 million ha were sprayed with chemical pesticides to bring an end to the upsurge. The livelihoods of 8 million people were affected.

⁸ ULV spraying is a pesticide spraying technique developed specifically for locust control in the 1950s and still the standard method of locust control. As its name implies, it requires less volume per hectare treated than regular spraying techniques and is, therefore, well suited to hard-to-reach areas and aerial treatments. EMPRES has systematically promoted the use of ULV formulations and sprayers in preventive locust control.

⁹ Djibouti, Eritrea and Ethiopia became members after the FAO Council approved a proposal to widen CRC at its 108th Session (in Rome, 5–14 June 1995). The Executive Secretary is based in the FAO Regional Office in Cairo.

¹⁰ Even so, CRC has provided training to staff in northern Somalia in the past, in cooperation with the Desert Locust Control Organization for Eastern Africa (DLCO-EA).

¹¹ Report from the 31st Session (Amman, February 2019).

By early 2000, the Western Region had thus become the weak link in DL control. In contrast, the same upsurge in the Central Region in 2003–2005 was rapidly contained.

The Commission de lutte contre le criquet pèlerin en région occidentale (the Commission for Controlling the Desert Locust in the Western Region, CLCPRO) covers ten countries in West and North Africa (Algeria, Burkina Faso, Chad, Libya, Mali, Mauritania, Morocco, the Niger, Senegal and Tunisia). It was formed in 2001 by merging two former regional organizations, the Organisation commune de lutte antiacridienne et de lutte antiaviaire (OCLALAV)¹² and the FAO Commission de lutte contre le criquet pèlerin en Afrique du Nord-Ouest (CLCPANO).¹³ This was seen as a major improvement, as the two organizations did not coordinate well and OCLALAV was poorly funded by its members.

The EMPRES Desert Locust Programme was first implemented in the Western Region in 2006, right after the end of the 2003–2005 invasion. An African Development Bank (AfDB) project originally meant for crisis response was redirected to capacity-building. Similarly, the United States Agency for International Development (USAID) and the World Bank made additional funds available to countries in the region for DL control. From 2006 to 2009, FAO's EMPRES Programme in the Western Region spent about USD 10 million, or 17 percent of all funding for preventive DL control in the Western Region (estimated at USD 61 million).¹⁴ This period of abundant funding stemmed from the 2003–2005 crisis, just as the birth of the EMPRES Programme and its implementation in the Central Region in the 1990s were triggered by the plague of 1986–1989.

Many of the EMPRES activities in the Western Region focused on preventive control in the four countries that were home to the main DL breeding areas (Mauritania, Chad, Mali and the Niger), commonly referred to as "frontline countries", and on the establishment of strong national locust control units with administrative and budgetary autonomy. While frontline countries have made a lot of progress over the years, the most efficient control units in the region remain those of Morocco and Algeria.

Having rightly predicted that a slowdown in donor funding would follow the phase of abundant funding triggered by the 2003–2005 crisis, CLCPRO worked to strengthen its own finances. It reformed its grid of member state contributions in 2011, indexing it to agricultural gross domestic product. This led to a fairer system, whereby richer member states (mainly in North Africa) supported a significantly larger share of the regional organization's budget than the poorer ones (mainly in the Sahel). All countries paid up in line with the new grid, including their arrears. These reforms allowed CLCPRO to raise about USD 600 000 a year from its ten members, more than double what CRC managed to raise from its 16 members.

With the money from its members and project funding from the French Development Agency (AFD), CLCPRO continued to develop and strengthen national preventive control capacities. It even created an effective emergency fund. The requested capitalization

was only USD 6 million, so the CLCPRO member countries decided, at a ministerial meeting in Algiers in 2016, to fund it directly. USD 4 million has been received so far from Algeria, Mali, Mauritania, Chad and Senegal. A rapid intervention force was created, comprising 18 vehicles in two bases in Chad (Abéché) and Mauritania (Nouakchott), which are on standby for major outbreaks.

Another interesting feature of the Western Region is its emphasis on research and education. CLCPRO has a memorandum of understanding with the French Agricultural Research Centre for International Development (CIRAD). CIRAD provides scientific support and information and oversees master's and PhD theses sponsored by CLCPRO. Moreover, realizing that the acridologists in the region were ageing and that many of them would soon retire, CLCPRO linked up with the Institut Vétérinaire Hassan II in Agadir, Morocco to launch a master's degree in acridology. Four-year groups were trained between 2009 and 2015, some of whom later worked for national locust centres and even FAO.

The region has stopped numerous locust outbreaks over the past decades (the last one in 2016) without recourse to any donor funding. The challenge now is to maintain this capacity, particularly in Mali and the Niger, where terrorism in the north has stopped surveys and control operations.

The Eastern Region

The EMPRES Programme was never implemented in the Eastern Region (Southwest Asia) for lack of donor funding. FAO support has focused on providing modest technical assistance to facilitate the work of the Commission for Controlling the Desert Locust in Southwest Asia (SWAC), which has four member countries (Afghanistan, India, Iran (Islamic Republic of) and Pakistan).

Member states' contributions to SWAC have amounted to slightly over USD 107 000 per annum since 2016. Prior to that, they had been pegged at USD 71 000 per annum for decades. The Eastern Region has thus been the poorest of the three DL commissions in terms of both donor funding and member contributions. That said, it is also the smallest of the three.

The Senior Locust Forecasting Officer in DLIS at FAO headquarters acts as the Executive Secretary of SWAC and participates in annual (spring) joint surveys in the locust breeding areas of Iran (Islamic Republic of) and Pakistan.

In addition, India and Pakistan usually meet four times a year in the summer along their common border to share DL information.¹⁵ In a worrying sign of escalating tensions between the two neighbours, these meetings did not happen in 2020. Both countries currently face the worst DL invasion in decades, so they need to exchange information more than ever.

Current crisis response in East Africa and Southwest Asia

The Horn of Africa and Southwest Asia are facing the worst DL crisis in more than 25 years, posing a significant threat to their food security and livelihoods. More than 20 million people are already facing severe acute food insecurity – Integrated Food Security Phase

¹² Independent of FAO, OCLALAV involved ten countries in the Sahel and Coast of Guinea (Benin, Burkina Faso, Cameroon, Côte d'Ivoire, the Gambia, Mali, Mauritania, the Niger, Senegal and Chad).

¹³ An FAO commission at the time comprising five countries in North Africa (Algeria, Libya, Mauritania, Morocco and Tunisia).

¹⁴ The World Bank accounted for about 26 percent of the total, while funds and resources from CLCPRO countries themselves accounted for more than half, around 52 percent (FAO, 2009).

¹⁵ These meetings used to be funded by SWAC, but Pakistan and India agreed to bear the cost in 2005.

Classification (IPC) Phase 3 and above – in Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Uganda and the United Republic of Tanzania.

Since 2007, in part thanks to EMPRES, there had been no significant locust outbreaks in the region.

The present crisis started to develop in 2018. Two cyclones hit a desertic area on the border between Oman, Yemen and Saudi Arabia, called the Rub' al Khali (the "Empty Quarter").¹⁶ Abundant rains created favourable breeding conditions, which were not addressed, including by Saudi Arabia, reportedly because of the remoteness of the location. From there, swarms moved into Yemen in 2018, where further reproduction went unchecked. As mentioned, the country is currently at war and all of the Yemeni Desert Locust Monitoring and Control Centre's equipment was looted by militia in 2015.

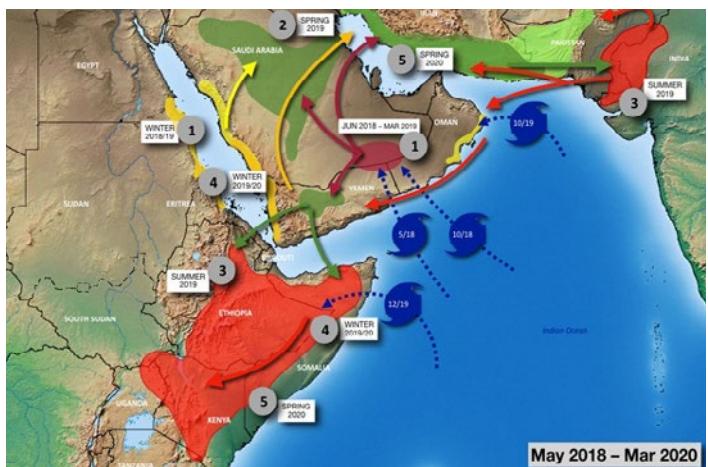
From January 2019, small swarms spread further across the Arabian Peninsula, along the Red Sea and into Iran (Islamic Republic of) and Pakistan. In June, locusts crossed the Red Sea and the Gulf of Aden and started to spread into the north of Somalia and Ethiopia, where floods in October and November created good conditions for further reproduction (Figure 2).

CRC called for a high-level emergency meeting in Cairo in July 2019, where it presented the idea of an emergency fund and asked for funding to control the emerging crisis. The meeting failed to elicit pledges. Saudi Arabia later donated USD 1.5 million to the response in Sudan, Eritrea, Ethiopia and Yemen, while the United Arab Emirates funded USD 1 million for Eritrea in April 2020, both through the CRC trust fund.

Ethiopia embarked on control operations in 2019, but its efforts clearly lacked capacity. Ethiopia is a member of CRC and received support over the years, including from EMPRES up to 2006. However, it lacks a dedicated DL control unit, with its own staff, equipment and budget, elements that facilitate the retention of capacity over the years. Rather, DL control is one of the many responsibilities of the Ministry of Agriculture's Plant Protection Department. By 2019, many of the Ethiopian staff trained over the years had moved on or retired and much equipment was unserviceable, obsolete or missing.

Further generations of breeding in favourable conditions allowed the locusts to spread into Kenya in December 2019. Kenya is not a CRC member, had no national locust control capacity at the start of the crisis and was taken by surprise. Further movement occurred from Kenya back to Ethiopia and Somalia in spring 2020. By then, FAO had raised the alarm at the highest level. In January 2020, it launched an appeal for USD 70 million, revised up to USD 138 million in February and later to USD 311.6 million, for the Desert Locust Global Response Plan, for rapid control and surveillance operations, as well as for livelihood and food-security support in the Greater Horn of Africa and Yemen, Southwest Asia and West Africa. The Director-General has been following the matter closely and has taken the lead role in communicating about the crisis and the appeal, which has been well funded. As of 11 September 2020, the funding pledges amounted to USD 198 million (FAO, 2020c).

Figure 2. Development of the current crisis



Source: Locust Watch website (FAO, 2020b). Map conforms to UN. 2020. *Map of the World*.

Some of the key activities underway as part of FAO's Desert Locust Response Plan include (as of end of June 2020):

- i. 2 million ha surveyed, and 902 000 ha treated so far, 400 000 of which are in East Africa;
- ii. 834 000 liters of pesticide and 12 675 kg of bio-pesticide procured;
- iii. 5 370 handheld sprayers and knapsack sprayers operational, with 750 delivered and an additional 1 817 handheld and knapsack sprayers are being procured;
- iv. five fixed-wing airplanes currently contracted and operational in Kenya (three aircraft) and Ethiopia (two aircraft), as well as a number of helicopters for survey and control (three in Ethiopia, three in Somalia, one in Chad);
- v. dozens of vehicles with vehicle-mounted ULV sprayers donated to Kenya, Somalia and Ethiopia; and
- vi. development and roll out of eLocust3M, primarily for Kenya, in cooperation with PlantVillage.

The fixed-winged aircraft leased by FAO are Ayres Turbo-Thrush equipped with ULV sprayers and able to map the movement of the aircraft and the spraying quantities, which avoids overdosing. They are more economical to fly and have greater range and capacity than the two DHC-2 Beavers of the Desert Locust Control Organization for Eastern Africa (DLCO-EA) (see Box 2), which are over 50 years old.

The COVID-19 pandemic slowed the initial response in spring 2020, notably the acquisition and receipt of equipment and the recruitment and movement of personnel, such as pilots. Pesticides and equipment for ULV spraying are not off-the-shelf items and COVID-19 has affected the supply of raw chemicals, including to pesticide companies. COVID-19 has also made it difficult to procure protection equipment for staff, so some of the campaign was undertaken without proper protection clothing or masks.

The Central Region also found out the hard way that it no longer had the requisite human resources, with an ageing or retired cadre

¹⁶ The Rub' al Khali is a vast sand desert (erg) in the southern Arabian Peninsula, extending over parts of Saudi Arabia, Oman, the United Arab Emirates and Yemen.

Box 2

The Desert Locust Control Organization for Eastern Africa (DLCO-EA)

The DLCO-EA is a regional pest management organization headquartered in Addis Ababa. It was created in 1962, outside the framework of FAO, in a convention signed by the governments of Ethiopia, France (for Djibouti), Kenya, Somalia, the United Republic of Tanzania and Uganda, later joined by Sudan. It inherited the equipment, staff and mandate of the Desert Locust Survey established by the British in the 1940s.

In 1968, a sudden upsurge of locusts was well controlled. In the 1970s, DLCO-EA's mandate was extended to include other migratory pests, such as the African armyworm moth (*Spodoptera exempta*), quelea birds and tsetse flies (*Glossina* spp.).

However, over the years, DLCO-EA has failed to modernize. The grid of contributions from member states has never been updated. Arrears have piled up. Salaries have not been paid regularly and some staff have left. The organization's once large fleet of aircraft has shrunk. DLCO-EA now operates two aircraft in Ethiopia, one in Uganda and one in Kenya, both 50-year-old DHC-2 Beavers with a 300-litre capacity and range of 90 miles (149 km). The organization's management is aware of the need to modernize, but points to its cash-strapped situation.

In normal times, relations between FAO and DLCO-EA are limited to annual joint training events and, on occasion, DLCO-EA's participation in small FAO projects. Currently, the two organizations are collaborating on the DL control effort in the Horn of Africa, but the DLCO-EA's contribution is described as modest, primarily due to the limited range and capabilities of its aircraft.

Shortly after its foundation, DLCO-EA members expressed a wish that the organization be brought into the FAO fold, under Article XV of the FAO Constitution. The ensuing negotiations failed. Perhaps it is time to revisit the idea, or even to merge DLCO-EA with CRC. There is precedent in the Western Region: the merger of CLCPANO and OCLALAV in the 1980s created the CLCPRO, bringing Sahelian countries together with North African countries for better regional preventive control. A merger of DLCO-EA with CRC would help rationalize regional cooperation on DL control in the Central Region (in East Africa and countries around the Red Sea).

of experts, all busy in their own countries on their respective locust campaigns. Mobilizing experts, especially English speakers, was difficult, as most current experts and operators are French speakers.

At time of writing, the situation remains under control in Sudan, Eritrea, Egypt, Saudi Arabia and Oman. It is improving in Kenya, but still alarming in Ethiopia and Somalia, where widespread breeding is in progress, as well as in Southwest Asia (India, Pakistan and Iran [Islamic Republic of]), though to a lesser extent. Technically, FAO has yet to label the upsurge a "plague", but it probably should, as several regions are now affected.

A number of stakeholders stressed that CRC had not communicated enough during the current crisis and that regional financial and material support was inadequate. Somewhat paradoxically for a crisis that originated from the Central Region and still affects it disproportionately, CRC support and visibility in the current crisis

appears somewhat discreet. That said, CRC did raise USD 1.5 million from Saudi Arabia for Eritrea, Ethiopia, Sudan and Yemen.

3.2 Work on other types of locust

Caucasus and Central Asia

The Caucasus and Central Asia is currently the region with the greatest number of hectares infested by locusts every year. On average (over the past ten years), 4.9 million ha there have been treated every year. The 600 000 ha treated in East Africa in the five months to May 2020¹⁷ were equivalent to what Uzbekistan, alone, sprays in a year.

The former Soviet locust control system included plant-protection stations in every republic, centralized under ministerial control in Moscow, as well as special anti-locust units in Uzbekistan and Kazakhstan for survey and preventive control. The system was quite effective against several local locust species,¹⁸ but collapsed in the early 1990s. Pests that used to be managed within national borders became transboundary overnight in December 1991 with the dissolution of the Soviet Union.

The first attempt to formalize regional cooperation on locust issues was in 2000, following a major Italian locust upsurge in Kazakhstan. In 2000, FAO organized a regional round-table and produced a letter, which it sent to the FAO Director-General (Jacques Diouf at the time), asking him to explore the possibility of establishing a Central Asian Locust Commission under FAO. This was followed by a number of regional consultations, but no action was taken after 2003, in part due to a lack of feedback from the countries at the time. The Russian Federation was not yet a Member of FAO and there were not enough FAO personnel to go around, as they were busy managing the major 2003–2005 DL crisis.

In 2007–2008, FAO received official requests for assistance from several Caucasus and Central Asian countries. It conducted a needs assessment and developed a comprehensive programme, which was agreed by the ten Caucasus and Central Asian countries at a Regional Consultation in 2009. The group agreed to start building a technical network and to conduct during programme implementation a comprehensive study of all possible options for long-term regional cooperation.

The multi-funded and interregional "Programme to improve regional and national locust management in the Caucasus and Central Asia", based on the key concepts of the locust preventive control strategy, was officially launched in Tbilisi in October 2011. It has been implemented in ten countries (Afghanistan, Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, the Russian Federation, Tajikistan, Turkmenistan and Uzbekistan) thanks to various partners, including USAID, Japan and the Japan International Cooperation Agency (JICA), Turkey (under the FAO–Turkey Partnership Programme) and FAO (Regular Programme and Technical Cooperation Programme), through national and sub-regional projects targeting all or some of the ten countries. As of mid-2020, contributions to the programme amounted to USD 9 million. In late July, a JICA-funded project for Central Asia was signed, worth USD 16.3 million.

Among the major achievements in the Caucasus and Central Asia to date are the creation of a technical network, including the exchange

¹⁷ The number had risen to 900 000 ha by the end of June 2020 (see previous section).

¹⁸ The father of modern acridology is Boris Uvarov (1886–1970), a Russian entomologist who built the scientific basis for preventive control by studying the biology and ecology of *Locusta migratoria* in the 1910s.

of regular and standardized information, with a monthly regional bulletin published by FAO's Locust and Transboundary Plant Pests and Diseases (NSPM) team during the locust campaign (since 2010). Major efforts have also been made to strengthen human capacity for locust monitoring and control and pesticide risk reduction. While technical support is provided to all ten participating nations, most of the equipment deliveries to date have been to Afghanistan, Kyrgyzstan and Tajikistan (FAO, 2020d). There has been a push for ULV treatments and technology (the dominant practice in the region is still to use conventional formulations, even for locust control).

A specific geographic information system called the Caucasus and Central Asia Locust Management System (CCALM) and an Automated System for Data Collection have been developed using standard forms to facilitate the collection and transmission of standardized field data and which can be installed on tablets, mobile phones and computers. The system is available in 11 languages.¹⁹ These tools are similar to eLocust and RAMSES, which were developed specifically for DL. They are currently being tested. Attention to pesticide risk reduction has also increased substantially. Human health and environmental monitoring teams have been set up in four of the ten Caucasus and Central Asian countries and FAO has issued practical guidelines to help with pesticide risk reduction in locust control in the Caucasus and Central Asia, the most up-to-date FAO publication on the topic (FAO, 2019a).

Evolution to an Article XIV Commission now seems both possible and necessary. The Russian Federation is now a Member of FAO and the Organization has a new Director-General. After years of efforts, a solid technical network has been established in the Caucasus and Central Asia, resulting in greater trust between members, at least at the technical level,²⁰ which now routinely exchange information and advice. Thus, the situation has evolved positively over the past decade.

The model of a mere technical network funded by resource partners is also showing its limitations: projects and programmes have a start and end date. The work is not sustainable without a Commission or some kind of regional organization to capitalize on the assistance provided and ultimately take over the entire operation. High staff turnover at national level is another issue that calls for the steady hand of a Commission, which would be partly self-funded by member states, enabling better retention of the capacity provided over the years. To this end, steps have already been taken as part of the programme, including a study on potential mechanisms for long-term regional cooperation on locusts in the Caucasus and Central Asia (2014, updated in 2018), with related discussions in annual workshops. Country delegates have expressed a broad-based wish for the creation of an FAO Article XIV Commission, which offers the highest guarantee in terms of sustainability. The envisaged next steps include advocacy of high-level decision makers.

Southern Africa

Southern Africa is affected primarily by red and migratory locusts. The International Red Locust Control Organization for Central and Southern Africa (IRLCO-CSA) was founded in 1970, outside the FAO framework, as a successor to the International Red Locust Control Service, which dated back to 1949. It presents many similarities to DLCO-EA in terms of history and structure. The member countries are Kenya, Mozambique, Malawi, the United Republic of Tanzania, Zambia and Zimbabwe. Botswana pulled out of the organization in the 1990s.

IRLCO-CSA originally focused solely on locusts. Some countries had no outbreaks for a long time and saw no danger of one, so its mandate was broadened in 2009 to include armyworms and quelea birds. There has been sporadic contact with FAO. Member countries asked FAO to undertake a review of IRLCO-CSA in 1995 with a view to reducing costs. This resulted in a 50 percent staff reduction at IRLCO-CSA. Still, like DLCO-EA, member arrears have continued to mount. FAO has provided some support to IRLCO-CSA over the years: it donated a survey helicopter (now the only operational aircraft the organization has left) and helped with the use of biopesticides in the United Republic of Tanzania in 2009. FAO recently approved a Technical Cooperation Programme (TCP/SFS/3801 – Southern Africa Emergency Locust Response and Preparedness) to help IRLCO-CSA respond to outbreaks of the African migratory locust in some parts of Botswana, Namibia, Zambia and Zimbabwe.

Latin America

There are a number of locust species in Latin America and the region is home to one of the oldest national locust control programmes, dating back to 1891.²¹ However, FAO has only once supported a government in Latin America and the Caribbean in its fight against locusts and that was through a single Technical Cooperation Programme project in Peru from 2000 to 2002 (TCP/PER/0065(A)).

There had been an outbreak of *Schistocerca interrita* in 1998 and, by the end of 1999, it had become unmanageable thanks to the archaic methods used at the time, which were generally restricted to classic crop-protection techniques. FAO conducted a diagnosis of the situation and drafted an ambitious operational plan to control the plague, using a more modern, species-specific and preventive approach. The plan was entirely funded by the Government of Peru, to the tune of slightly more than USD 2 million. The plan included the use of ULV pesticides for the first time in Peru, with some control operations located far away from cropped areas, in the pest's breeding areas. The advice from FAO (and CIRAD) was fundamental to understanding the reproductive cycle of the locusts, prioritizing the critical points in a vast area of infestation and predicting future pest developments. This allowed the Peruvian authorities to get ahead of the problem, to target control operations more strategically and to make the most of their limited financial and human resources.

¹⁹ Armenian, Azeri, English, Georgian, Dari, Kazakh, Kyrgyz, Russian, Tajik, Turkmen and Uzbek.

²⁰ At the political level, the region is relatively peaceful, though tensions remain between Armenia and Azerbaijan.

²¹ The Argentinian National Locust and Tucurian Programme, formerly known as the Acridios Programme, is the country's oldest programme. It dates back to 1891 and the creation of the Comisión Nacional de Extinción de la Langosta. Argentina has adopted and implemented a preventive control strategy since 1954, focused on the detection and control of incipient outbreaks in juvenile stages of the pest (SENASA Argentina, 2017).

SENASA had to fight a small upsurge in *Schistocerca interrita* in 2017. A Peruvian expert noted in an interview for this study that during the 2001 invasion, Peru had invested more than USD 2 million to fight the infestation, while in 2017, the preventive campaign cost only a tenth of that, at USD 207 730.

Since then, Peru's National Agrarian Health Service (SENASA Peru) has been able to maintain a team of professionals and technicians with experience in managing the locusts to avoid a repetition of 1998–2002. SENASA Peru has even developed its own methodology to adapt conventional pesticides to ULV application, so that they are able to use any molecule available.²²

More recently, in 2015, there was a resurgence of *Schistocerca cancellata* in the province of Santiago del Estero, Argentina. In January and February 2016, locust swarms were recorded in several regions of Bolivia (Plurinational State of) and Paraguay. From these neighbouring countries, they were able to move back to northern and central Argentina, which they did in June 2017. After that, locust outbreaks were recorded in Formosa, then in Chaco, Santiago del Estero, northwest of the province of Santa Fe and, finally, in Córdoba.²³ The Argentinian National Service for Agrifood Health and Quality (SENASA Argentina) intervened with an intensive monitoring and control plan, in coordination with local institutions and producers.

Good progress has been made on controlling the upsurge, but financial resources are said to be insufficient. While Argentina has one of the best preventive management systems for locusts in the region, budget cuts since the 1990s have reportedly affected capacity. The COVID-19 pandemic also makes control operations more difficult, and the cross-border nature of the pest further complicates the matter. There are now outbreaks in Bolivia (Plurinational State of), Paraguay and southern Brazil, so greater regional cooperation and capacity are required. A technical group for locust control has recently been formed within the regional phytosanitary organization, the Comité de Sanidad Vegetal (COSAVE),²⁴ as a platform for countries to exchange information on the pest and support each other in controlling it.²⁵

Argentina has also requested FAO support, as it has international experience that could be brought to bear in South America, but without success to date, apparently because the country's TCP allocation is exhausted and the regional office did not support the request for an emergency allocation.

3.3. Work on other species

Fall armyworm (FAW, *Spodoptera frugiperda*) is a lepidoptera, a moth native to tropical and subtropical regions of the Americas. The adult moth is a strong flyer and can travel more than 100 km per night. Its larva feeds from 18 species of plant, but mainly maize and sorghum at the moment. FAW was first detected in Africa in 2016 and Asia in 2018. Although still technically migratory, FAW has been widely confirmed in Africa, Asia and the Near East, although not all countries have declared it. It is knocking at the door of Europe (Malta, France, Italy, Spain, Portugal) and the Pacific (Australia). Australia is recognized as a champion of biosecurity, but even it could not do much to prevent its spread.

FAW can frequently damage as much as 20 percent of a crop and the leaf damage is remarkable, so it is important that farmers control it and find ways to cope with the threat. Over the past three years, FAO has spearheaded 63 FAW-related projects, mostly in Africa. Its work focused initially on tracking the spread of FAW and trying to prevent its spread to new countries. FAW is quite different to DL, however, which tends to follow predefined patterns of migration. FAW spreads opportunistically, which makes it harder to track and far harder to spray than swarms of locusts.

This means that Integrated Pest Management (IPM) approaches are preferable for FAW control, such as pheromone traps or light traps to try and capture the adults, or the use of natural enemies. FAO issued an extensive farmer field school (FFS) (extension) guide on the topic in 2018 and a number of FFS have been organized (FAO, 2018a).

Its method of propagation also meant that the tools of FAW monitoring should be in the hands of farmers. FAO designed the Fall Armyworm Monitoring and Early Warning System (FAMEWS) smartphone application (app) for this purpose. The system has been rolled out in some 50 countries, mostly in Africa. App users can upload pictures and other data through a datalink or Wi-Fi to a server maintained by PlantVillage, an offshoot of Pennsylvania State University.

Formed in December 2019, the Global Action for FAW Control partnership is meant to upscale these efforts. It aims to raise USD 500 million over a three-year period (2020–2022) and mobilize a broad range of stakeholders to reduce damage and prevent the introduction of FAW into new areas. Research institutions, the private sector, South–South cooperation and regional and national plant-protection organizations will be involved. Dedicated FAW task forces are being created at global, regional and national level. FAW control and tropical pests, in general, are an area where there are many players involved, including the Center for Advanced Bioenergy and Bioproducts Innovation (CABBI), the International Centre of Insect Physiology and Ecology (ICIPE) and the International Institute of Tropical Agriculture (IITA), which was the first institution to detect FAW in Africa.

A smaller programme on RPW was launched in 2017, with a regional focus on the Near East and North Africa. An international scientific seminar was held in Bari, Italy on 24 October 2018 to present a number of control options (ASPP, 2019). Most of the work to date has been funded by Technical Cooperation Programme projects. A consolidated programme of work was presented to a donor meeting in Abu Dhabi on 9 March 2019, including research, capacity-building and knowledge-sharing. The call was well received, and significant pledges were made. The United Arab Emirates and Saudi Arabia pledged USD 2 million each, Libya pledged USD 250 000 and the Arab Organization for Agricultural Development promised USD 100 000. To translate these pledges into actual resources has been a challenge, however.

²³ Climate change is cited as a factor in this resurgence, inasmuch as the reproduction of *Schistocerca cancellata* is facilitated by longer summers, spawning three generations a year rather than two, as before.

²⁴ COSAVE is a regional organization for intergovernmental coordination and consultation on phytosanitary matters, established based on the provisions of Article VIII of the International Plant Protection Convention (FAO, 1951). Its members are Argentina, Bolivia (Plurinational State of), Brazil, Chile, Paraguay, Peru and Uruguay. The organization does not currently have a permanent headquarters, instead rotating every two years.

²⁵ A similar platform for Central America (from Mexico to Panama) is the Organismo Internacional Regional de Sanidad Agropecuaria, based in El Salvador, which works on *Schistocerca piceifrons* (among other species).

As mentioned, the list of transboundary diseases is almost endless. In addition to the species already cited, FAO works on:

- i. Banana fusarium wilt, which is caused by the fungus *Fusarium oxysporum* f. sp. *cubense* (Foc). It is a major banana disease, present in almost all banana-producing countries. The latest strain, Tropical Race 4, is causing a lot of damage globally on plantations of Cavendish banana, the dominant cultivar today.

- ii. *Xylella fastidiosa*, a bacterium from the Americas that affects a wide range of host plants, from grapevines, olives and citrus to ornamental plants. It has arrived in the Mediterranean basin, causing severe damage in Italy, as well as in France, Spain, Iran (Islamic Republic of) and Israel. *Xylella fastidiosa* is a xylem-limited bacterium transmitted to plants by xylem sap-feeding insects. The other pathway of introduction to a country is through infected planting materials. The cost of managing it in the European Union has been estimated at EUR 20 billion.

4. Partnerships

Member states and commissions

The most important partnerships in this review have been with FAO Members, particularly those that belong to one of the FAO regional DL commissions. As we have seen, these commissions are important forums, where concerted political will and technical means are built and leveraged against a common threat. Their anchorage in FAO appears to be a strength, inasmuch as the locust control organizations not organically linked to FAO (such as IRLCO-CSA, DLCO-EA and OCLALAV before its demise) have had difficulties maintaining technical excellence, as well as the trust, commitment and funding of their members. Indeed, DLCO-EA members originally requested to be part of the FAO architecture for precisely these reasons.

A classic problem with locust control funding, and the funding of emergency and risk management more generally, is that donors and affected countries are willing to fund preventive control right after an invasion, when awareness of the risk is still high. EMPRES benefited from the positive effect of plagues on funding in both the Central Region (where donor support was linked to the plague of 1986–1989) and the Western Region (which saw abundant funding from 2005 to 2011 due to the 2003–2005 crisis).

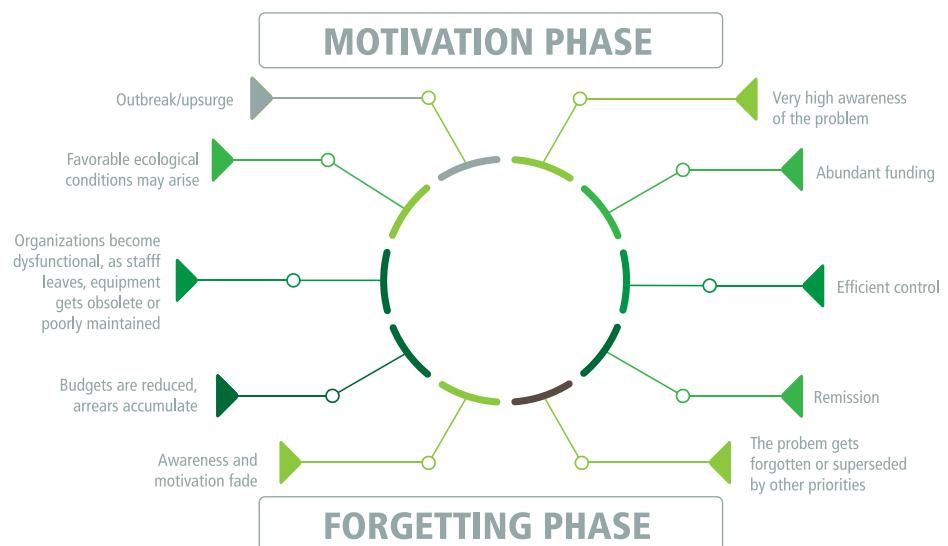
If preventive control works well, however, locusts do not become a threat again for many years, during which time decision makers are subject to many other requests and priorities. The funding and political importance associated with locust control gradually diminish and, as vigilance and means shrink, all it takes is a year or two of good rainfall to trigger a new invasion (Figure 3).

This is a vicious circle that can only be broken by keeping the desert locust threat firmly in the minds of decision makers, as CLCPRO has been quite successful at doing with a series of ministerial conferences and a “pitch” to politicians.

In contrast, CRC suffers from a number of failings, laid bare in the current DL outbreak. One is its gap in geographical coverage. Yemen and Somalia harbour extensive breeding areas for DL, but have no capacity for locust monitoring or control at present. Somalia is not even a member of CRC. Another critical shortcoming is the irregularity of funding for CRC, which may suggest a lack of trust between member countries. It is symptomatic that funding mobilized from the region is usually strictly earmarked for certain countries and not others.

This illustrates how being anchored in the FAO governance system does not guarantee continued relevance for a regional locust control organization. The FAO governance structure can act as facilitator, offering a conducive environment to harness political will and mobilize resources, more than a standalone organization can muster. However, the members must make good use of this environment for any real collaboration to take place.

Indeed, the FAO governance architecture for locust control is showing its age. Formed in the 1950s, the apex DLCC did not meet between 2012 and 2019, as countries could not agree where it



Adapted from: Lecoq, 1991. ITAD 1991.

should meet. Politicking took precedence, undermining the body's resolve and weakening the esprit de corps of its members.

The impasse was thankfully broken in 2019. In view of the emerging crisis, Ethiopia, the Chair of DLCC at the time, offered to host the meeting, which took place in Addis Ababa in December 2019. There, FAO and Member States described the current DL situation as extremely serious. During the opening ceremony, the delegate from Iran (Islamic Republic of) stated that the level of DL infestations in Iran (Islamic Republic of) was its highest in 50 years, with more than two million hectares infested and over 750 000 hectares treated. Concerns were similarly expressed about the very serious DL situation in Ethiopia. The session report noted that 1 688 000 hectares were treated for DL worldwide in 2019, a sharp increase on previous years (FAO, 2019b). On reading the report, it is hard to avoid the impression that the system is waking up to the threat, though perhaps a little too late.

Academia

The Western Region has placed much emphasis on research and education. CLCPRO has a memorandum of understanding with CIRAD, which provides scientific support and information and oversees CLCPRO-sponsored master's and PhD theses. Moreover, realizing that the acridologists in the region were aging and that many of them would soon retire, CLCPRO linked up with the Institut Vétérinaire Hassan II in Agadir, Morocco to launch a master's degree in acridology. Four-year groups were trained from 2009 to 2015, some of whom later worked for national locust centres and even FAO.

In the Central Region, CRC has backed a master's degree in DL science at Sudan University of Science and Technology. The programme aims to qualify specialists in all areas of DL management, but its launch has been delayed by the COVID-19 pandemic. An earlier programme trained 43 graduates from several countries in the region, but was discontinued in 2008 due to a lack of resources.

There are many other examples of successful partnerships with academia, for instance, PlantVillage's collaboration with Pennsylvania State University on the development of the FAMEWS and eLocust3M android applications.

Non-governmental organizations

FAO has not partnered with civil society and non-governmental organizations (NGOs) in this area of work, which is dominated by governmental mechanisms and actors. The rare cases where NGOs do partner with FAO on the control of transboundary pests are in data collection, for example, in FAW monitoring or in the current DL crisis response.

The private sector

Similarly, relationships with the private sector (or even farmers who are private operators) have not featured heavily in this work. The potential influence of pesticide companies and related national interests is perceived by FAO personnel more as a problem than a potential solution. However, professionals also point out that they lack effective and modern molecules for locust control, which would be less ecologically damaging than the organophosphates still in use for this purpose. Greater research and investment in this area by pesticide companies would therefore be beneficial.

Donors

FAO's relationship with donors has been a complex one. On the one hand, the breadth of donor support is quite wide. USAID, for instance, has been a steady supporter and partner of FAO over the years in promoting preventive control of transboundary pests, including for locust control in the Caucasus and Central Asia and FAW control in East Africa. Indeed, this is one of the few areas in which it is still funding FAO. Japan and some European countries (such as Germany) have also generously contributed over the years, including recently to the FAO appeal for the response to the DL upsurge in the Greater Horn of Africa and Yemen (Table 2). EMPRES came into being as a result of Members and resource partners stressing the need for preventive control as a way of saving resources.

Thus, there is effective donor support for the preventive control of transboundary pests, including locusts. The financial support has not always been sustained over the years, however. The phenomenon of cyclical funding patterns in DL control (Figure 3) can be observed among resource partners, too. Mobilizing resources for the response to an ongoing crisis is far easier than for preventive control, even though the former is ten times costlier than the latter.

Table 2. Financial pledges for the response to the desert locust upsurge in the Greater Horn of Africa and Yemen (as of April 2020)

Resource partners	Funding (USD)
Germany	21 978 032
Foundations	20 100 000
United States of America	19 300 000
European Union	11 767 803
Central Emergency Response Fund (CERF)	10 000 000
Russian Federation	10 000 000
United Kingdom of Great Britain and Northern Ireland	6 446 660
FAO	4 300 000
Sweden	4 136 000
Sudan Humanitarian Fund (OCHA)	3 400 000
France	3 393 665
Norwegian Agency for Development Cooperation (NORAD)	1 800 000
Asian Development Bank (ADB)	1 500 000
China	1 200 000
Netherlands	1 131 222
Switzerland	1 029 736
United Arab Emirates	1 000 000
Africa Solidarity Trust Fund (ASTF)	1 000 000
CRC	800 000
Denmark	800 000
Canada	750 000
Belgium	500 000
Italy	414 011
Stand-by partners	72 000
Grand total	126 819 129

5. Links to the key principles of the 2030 Agenda

This area of work is a traditional element of FAO's mandate and, as such, it should probably not be expected to comprehensively reflect the latest trends in and principles of the global development agenda. For instance, as noted, partnerships with the private sector and civil society – a key feature of the 2030 Agenda – are largely absent from the control of transboundary plant pests. The arena is dominated by Member State-based commissions, some of which are more functional and proactive than others.

Holistic approaches and interconnection

The impact of control operations on the environment and human health are important aspects of this work from an SDG perspective. The control of locust species comes at a significant ecological and health cost: every year, hundreds of thousands, if not millions of hectares are sprayed with old broad-spectrum pesticides that are often banned in Europe or the United States of America for their toxicity to humans.

The issues have been addressed to a degree by the EMPRES Desert Locust Programme. During the 2003–2005 campaign, FAO formed the Quality and Environment Surveys of Treatments (QUEST) teams, whose role was to monitor potential pesticide impact on non-target fauna, especially arthropods (insects and spiders) and on the health of staff involved in locust control operations. QUEST teams are recruited from ministries of agriculture, health and environment. In addition to monitoring treatments as they happen, they also impart training to a range of stakeholders on methods of cholinesterase testing to monitor staff health and on pesticide management (safety measures, obligatory protection gear, etc.). These teams tend to be highly appreciated, as they help to preserve the health of the treatment teams exposed to dangerous pesticides. In addition to CLCPRO, they have been deployed in four Central Region countries and in four Caucasus and Central Asian countries (more are being planned).

A fundamental issue is a lack of modern, safe pesticides for locust control. In the current response in East Africa and Yemen, FAO is spraying hundreds of thousands of litres of organophosphate pesticides, such as Chlorpyrifos or Fenitrothion. Organophosphates are molecules discovered in the 1950s,²⁸ which act by inhibiting a neurotransmitter that human beings happen to share with insects: acetylcholine. They are basically nerve gases, dangerous both to our health and that of the environment. This issue should be reviewed by the Pesticide Referee Group, recently reconvened to that end under the aegis of FAO.

However, preventive control strategies minimize the ecological footprint of locust control. Early response to small outbreaks means smaller quantities of products applied in a timely manner to well-defined targets, usually in relatively remote areas – far from crops

and inhabited areas. In addition, it potentially allows for the use of less environmentally destructive tools than broad-spectrum chemical pesticides. This is because early action on hoppers is more conducive to the use of slow-acting biopesticides, such as Metarhizium (under the trade name Green Muscle), as well as insect growth regulators (IGRs applied in barriers), a class of pesticide that is less harmful to the environment.²⁹ Thus, early action is potentially less costly, not just financially but also environmentally, at least in locust control operations.

The full-scale use of alternative control methods, such as the mycopesticides (fungus-based biopesticides, of which Metarhizium is one) is growing. FAO successfully used Metarhizium in its programme response to the migratory locust plague in Madagascar (2013–2016). In 2019, the Permanent Interstate Committee for Drought Control in the Sahel's (CILSS) Pesticides Committee approved the use of Metarhizium for five years to control DL and CLCPRO has stockpiled small reserves in Algeria, Mali, Mauritania, the Niger, Chad and Tunisia. The quantities delivered to Algeria and Tunisia aim to allow the two countries to conduct field trials for registration purposes.

CRC has also tested the biopesticide in the Central Region. Notably, it is being used on a large scale in northern Somalia, where FAO opted to use only Metarhizium, due to security concerns over having a pipeline of pesticides in a country affected by terrorism. Large quantities are hard to come by, so the FAO Country Office procured 100 percent of the supply available (4 tonnes).³⁰ Hopefully, the experience will be studied and documented. The registration process for new products requires trials, and trials require locusts. Now is a good time to introduce new products, such as Metarhizium and Novacrid, even though the product is slow acting and does not kill off all locusts, so is ill-adapted for the control of an active upsurge.

IPM and the use of natural enemies, in particular, are also gaining traction for other species of pest, such as FAW. Equipping farmers with low-cost, ecologically friendly and healthy alternatives to pesticides to manage a pest that is now endemic to many countries is clearly the way to go.

The lack of an integrated approach is evident in the various systems, regional structures, phone apps, databases and early warning bulletins developed for each major transboundary species. The need for a more integrated approach was highlighted in the evaluation of FAO Strategic Objective 5 (to increase the resilience of livelihoods to threats and crises), on the hypothesis that developing joint applications and systems would bring cross-fertilization and economies of scale and better reflect the One Health approach, which considers the health of humans, plants and animals to be interrelated (FAO, 2016).

²⁸ ULV formulations are also an old technology from the 1950s, developed specifically for locust control. The use of ULV makes the logistics of large spraying operation easier than more diluted water-based formulations.

²⁹ IGRs prevent insects from evolving to a more mature stage, so they are more active on locust hoppers (immature) who undergo many stages in their development, than on some other insect species. IGRs are also sprayed on smaller surface areas than conventional pesticides (barrier spraying), so when used well, are more respectful of the environment than conventional pesticides. The disadvantage is that they are slow-acting and take 8–10 days to kill, so are ineffective on swarms of adult, flying locusts. They also kill aquatic arthropods (such as shrimps), so cannot be used near significant water ecosystems.

³⁰ In 2012, the only producer of Green Muscle, Becker Underwood South Africa, was acquired by BASF. After that, the product disappeared from the market and its registrations lapsed. A new company, Éléphant Vert, registered in Switzerland with subsidiaries in France, Morocco, Mali, Senegal, Côte d'Ivoire and Kenya, decided to develop a new product, Novacrid, based on a different strain of Metarhizium acridum. In 2019, Éléphant Vert won a licence to produce and sell Green Muscle. They are now the sole producers.

The 2018 EMPRES evaluation noted a lack of progress in integrating the various strands of work across the programme, the fragmentation of results and a loss of effectiveness in the internal programming, coherence and optimization of services, as well as in external advocacy, outreach and visibility. These findings extended to the animal health component of EMPRES (not reviewed here), with various initiatives found to be poorly linked and structured (FAO, 2018b).

There are a few legitimate reasons for maintaining species-specific FAO systems for controlling transboundary pests and diseases: each species has its own biology, reproduction cycle, biotope, crops it damages and countries it affects. One could argue that the very reason why FAO's work on locusts is doing so well is that it is focused on a small number of highly problematic species where the Organization has a track record of success. Integrating these efforts on a wide range of species into a fully integrated EMPRES programme would entail risks in terms of loss of effectiveness, at least for the most advanced components.

That said, there are a few "low-hanging fruit" that could be harvested, approaches that FAO could easily implement to reap economies of scale at the lowest cost. One is to integrate the messages emanating from FAO's various early warning tools, rather than try to integrate the information systems themselves. This has been tried for a few years now, in the quarterly Food Chain Crisis Early Warning Bulletin (FAO, 2020), two issues of a 2017 FAO Subregional Office for Southern Africa Resilience Hub (SFS-REOSA) newsletter (SFS-REOSA, 2017a; 2017b) and the EWEA report on food security and agriculture (FAO, 2020g). Another way would be to develop joint advocacy material for preventive approaches, showcasing the cost effectiveness of the approach across a variety of species and threats. Regular knowledge-exchange events could also be organized to share the experience of FAO personnel and partners working on different species.

Acting at scale

This appears to be an area of strength, in that the geographical scale of the programme is very wide, if not global. The impact of transboundary pests and diseases can also be systemic, as the present locust crisis (and COVID-19) indicates, by affecting the food security, incomes and livelihoods of millions.

As this study has shown, preventive approaches allow for more cost-effective control, rather than waiting for a crisis to emerge: over the long term, they help save precious resources and assets on a massive human and geographical scale.

A strong emphasis has been placed on regional cooperation, for good reason and with good effect, especially where the governance system has allowed trust and solidarity to emerge between neighbouring nations and team spirit to gradually form between national control teams. There needs to be a sense of meeting a common threat with common resolve. This spirit of true, bona fide regional collaboration determines the pace of progress towards real convergence and coherence of regional capacity and policies, which is crucial to success in the fight against transboundary pests.

From this point of view, the control of transboundary pests and diseases is as much a governance issue (SDG target 16.6 to develop effective, accountable and transparent institutions at all levels) as a

technical one. It requires trust and effective collaboration between member nations, as well as decision-making based on a neutral, science-based, shared assessment of the threat. This is precisely why FAO has had a comparative advantage here: its mandate is at the convergence of neutral governance processes and science-based decision-making.

Historically, the Organization was conceived and structured precisely with this type of problem in mind. It is telling that Members from the Caucasus and Central Asia, most of whom joined in the late 1990s, asked FAO as early as 2000 to institute a Commission for the Caucasus and Central Asia similar to CLCPRO or CRC.

Unsurprisingly, given its transboundary nature, FAO's work on species other than locusts is also global in nature, and frequently draws on regional programmes and collaborative arrangements. As work on other species is more recent (for example, the Global Action for Fall Armyworm Control initiative), FAO is still building the corresponding regional architecture and its relationships with the numerous other institutions, notably within the CGIAR system, that deal with tropical pests and diseases (such as ICIPE and IITA).

Social inclusion and leave no one behind

Social inclusion is not a strong feature of this type of work. Acridologists rarely speak to farmers, for instance, as locusts typically breed outside farmed areas, for example, in the desert. What's more, locust plagues or banana diseases do not discriminate; pests will eat the plots of female farmers and male farmers alike and make no distinction between rich and poor.

In the context of transboundary pests and diseases, FAO's role stems from the need for all nations to collaborate against a common transboundary threat, which needs to be controlled everywhere (or as widely as possible) in order to be efficiently controlled anywhere. Hence, in this work, the solidarity principle of leaving no one behind resonates most not at individual level, but at national and regional level. The bonds of solidarity, the calls for fairness and mutual support and the inequalities that matter most are between neighbouring countries, not between individuals.

In short, the world cannot afford to leave poor countries behind in the fight against transboundary pests, as they would become pest reservoirs, negating the efforts of other countries. As mentioned, conflicts in Somalia and Yemen have affected the capacity of the whole region to control an emerging locust outbreak. The same holds for individual nations: trying to control a migratory pest in one part of a country and not another is not as effective as a countrywide effort (itself less effective than a region-wide effort). Pests and diseases remind us that we all share the same planet and that we must cooperate beyond borders to succeed.

From this perspective, regional cooperation on the control of transboundary pests and diseases is a manifestation of mutual self-interest. However, that does not make it automatic, as there are also disincentives to collaborate. For instance, for a country to declare the presence of a certain pest or disease on its territory often implies a cost in terms of lost trade. Likewise, political tensions and regional rivalries tend to hamper regional collaboration on locusts and other species (including between the different DL regions). There is often a temptation to blame one's neighbours for transboundary pests, rather than to help them.

³¹ There are exceptions and variations. FAW control is somewhat different from locust control, as the moth lays its eggs in farmers' fields, so farmers are a primary actor in FAW control and monitoring.

Against this backdrop, FAO's role is to work towards a positive outcome through a fair, collaborative and technically competent architecture of regional commissions and national entities that trust one another and help one another, including through the transparent exchange of information.

This finding chimes with that of the 2007 independent external evaluation of FAO, that the Organization's strength in plant pest and animal disease management is seen as its capacity to provide "a joined-up global response linking global monitoring, international legislative instruments and forums for discussion, resource mobilization and coordination with disease and pest management" (FAO, 2007, p.130).

The example of CLCPRO shows that the fairness of the system, including fairness in setting and paying members' fees to the regional commissions, is one of the keys to success in this regard. In short, rich countries should pay more than poor ones.

Use of innovation and digital technologies

Good information is central to the preventive control of transboundary pests, and FAO has made a lot of progress on the use of remote sensing, drones and digital technologies, especially for the monitoring of the DL and, more recently, the FAW. A series of tools have been developed over the years, including the eLocust3 suite of tools for data capture and a central database (RAMSES) maintained by the DLIS. Five hundred eLocust3 units are in operation around the world. Their data form the basis for the numerous locust bulletins issued by DLIS and the regional commissions. The microdata are now available at <https://locust-hub-hqfao.hub.arcgis.com/>.

These tools greatly facilitate prospecting and reporting, which was previously done by radio, with many encoding errors. Managers in national locust control units can also monitor their field teams and improve survey and control operations by viewing the location and itinerary of each team in real time through a secure web browser. That said, there are gaps in coverage – such as in Yemen, Darfur, Somalia, northern Mali and northern Niger – all of which are areas of high insecurity. Surveyors have been kidnapped, their gear and vehicles stolen, etc., while travelling to these areas. This has spurred trials by CRC and CLCPRO on the use of fixed-wing drones for surveying. This is clearly the next frontier in locust monitoring, although applications in locust control are quite far off.

Another set of tools facilitating the collection and transmission of standardized chrono-, geo- and taxo- referenced field data is being tested in the Caucasus and Central Asia, called the Caucasus and Central Asia Locust Management System (CCALM). There are three locust species in the region, different to DL, so the eLocust3 and RAMSES suite cannot be used there.

These tools can only be used by well-trained professionals. The current locust crisis in East Africa called for locust prevalence data in Kenya, a country that is not a member of CRC, with no capacity to use the eLocust3 tablets. With the help of PlantVillage from Pennsylvania State University, FAO developed a version of eLocust3 for android phones, called eLocust3M (M for mobile), in order to crowdsource locust data in Kenya and other countries. A version was also developed for a GPS handset made by Garmin (eLocust3G). These tools cover the basic dataset, not the complete set, because of the low capacity of users. Most of the data FAO uses for the response in Kenya come from eLocust3M, while in Ethiopia, traffic from eLocust3M users has seemingly been hampered by the cost of 4G and frequent internet outages.

The quality of the crowdsourced data has been an issue. For instance, in Somalia, another locust monitoring app was disseminated by NGOs and led to a lot of false reporting. Apparently, people were downloading locust pictures from the Internet (including from the FAO site) and presenting them as taken in their area, supposedly as a way of attracting international assistance (such as food aid or livelihood support). The state of Punjab in northern India has also developed its own app, which is incompatible with the FAO system.

Clearly, dedicated tablets such as eLocust made more sense 20 years ago than now, when tablets and smartphones are ubiquitous. This calls for the development of widely portable apps rather than proprietary tablets. These apps could be offered in two versions: one for the general public (untrained users) and one for professionals. Having such apps widely available would mitigate somewhat the emergence of incompatible apps.

FAMEWS is another example of an android app developed by FAO to help farmers identify FAW and transmit data about its prevalence. PlantVillage helped develop the app and stores the data. The data seem to show pulses of activity in the year after the system is rolled out and training is given in a country, then a decrease in the volume and frequency of data sent by users. Evidently, the data flow correlates to the maize season, so some seasonality of data is to be expected. Only monitoring these trends in the long term can ascertain the validity of this hypothesis.

Once it has become endemic, there is limited incentive for farmers to report the continued presence of a pest month after month, year after year, especially if this does not result in some form of support. This suggests there is little use in monitoring the progress of a pest in countries where it is well established. Of course, information is still needed to develop predictive models and make forecasts about the spread of the pest but modelling and forecasting FAW is more useful when the pest is emerging in a country and there is hope of controlling it by focusing on a few "hotspots", than when it is already well established in numerous locations. The priority then becomes to equip farmers, so they can control it.

These are only the most salient examples. FAO has many early warning systems and quite a few devoted to transboundary pests and diseases (often species-specific). The SO5 evaluation highlighted the need for greater integration of FAO's early warning tools, both internally and externally, with those operated by partners (FAO, 2016) – a call echoed by the 2018 EMPRES evaluation (FAO, 2018b). For a few years now, information from these different early warning systems has been collated and synthesized in the quarterly Food Chain Crisis Early Warning Bulletin (FAO, 2020f), which also integrates information on other threats to food security from the Global Information and Early Warning System on Food and Agriculture (GIEWS). A related periodical is the EWEA report on food security and agriculture (FAO, 2020g), designed to consolidate forecasting information while providing comprehensive risk analyses. These products have been issued by the Food Chain Crisis Management Unit in FAO's Agriculture and Consumer Protection Department (AGD), a unit recently abolished.

The aggregation of different threats to food security enables them to be put into perspective in relation to their impact on agriculture, food trade and food security. The number of transboundary pests and diseases to control is very large, so perhaps FAO's focus on locusts and a few other species has been too narrow. This is the rationale behind current efforts to broaden the spectrum of species

in FAO's portfolio. Perhaps the Organization is spending too many resources on one threat and not enough on another, for instance, so comparing their impact is potentially useful. Unfortunately, at present, there are few data available on the food-security and economic impact of each species and the studies that have been

conducted all use different approaches and metrics. The 2018 EMPRES evaluation recommended that FAO develop a study on damage and loss and carry out a comparison of prevention and crisis response costs to create a strong business case for preventive control (FAO, 2018b).

6. Factors in FAO's success

The following factors can be highlighted as having often led to success:

- i. FAO's capacity to act as an "honest broker" of regional and global efforts and the good use of this capacity in terms of political engagement. In CLCPRO, for example, success has primarily been attributed to the diplomatic acumen of a former Secretary, who managed to keep DL control in the realm of public attention.
- ii. Strong support for the preventive approach from certain donors, such as USAID, Germany and France (AFD).
- iii. Annual contributions from members to the system or their regional Commission, enabling the system to be self-funded. Fairness in setting these contributions was a key factor in the success of CLCPRO reform, enabling the region to raise significant resources from its members and sustain a high level of readiness in preventive control after the end of FAO EMPRES support to the region.
- iv. A sense of team spirit among national technical teams, which tends to emerge between colleagues after years of close interaction. This has been achieved in many regions, including CRC and the Caucasus and Central Asia, and goes some way to ensuring transparent information-sharing.
- v. Good, effective and credible data systems, developed by FAO and partners, combined with access to satellite imagery products and services. Originally, these tools (such as eLocust) were proprietary (with dedicated tablets) but are now evolving into apps that are widely available and able to operate on a range of cell phones and tablets.
- vi. Quality of data. This is an important factor and crowdsourcing is not always dependable. There is still a large need for professional surveyors able to use sophisticated data-collection tools.
- vii. Capacity to overlay different early warning systems into comprehensive assessments of risks to agriculture posed by transboundary pests, as evidenced in the Food Chain Crisis Early Warning Bulletin (FAO, 2020f).

7. Potential challenges to scaling up

Among the issues explored in this report, the following stand out as having widespread incidence:

- i. The cyclical funding issue. Donors and affected countries are willing to fund preventive control right after an invasion, when awareness of the risk is still high, but this awareness decreases over time as the risk is successfully managed. Consequently, funding crisis response is often easier than funding preventive control, even though the latter is far more cost-effective and ecologically respectful than the former.
- ii. Difficulties in mobilizing resources for EMPRES in the Eastern Region (SWAC) have led to very little presence and work there.
- iii. FAO's regular programme budget cuts have resulted in the abolition of 235 posts over two biennia (FAO 2015 CL 153/3 paragraph 8). These cuts have led to reduced in-house expertise in many priority areas for EMPRES approaches.
- iv. Staff turnover is a problem in all countries, as well as in FAO, where there has been insufficient succession planning (as in the case of the DLIS director, who will retire soon).
- v. There is a lack of trust among the members of some regional commissions, as well as a degree of distance between the different commissions, perhaps tied to DLCC not having met for a decade. At the bottom of this issue is a certain timidity in FAO's political and diplomatic stance, a reluctance to confront these issues and deal with the political toil involved.
- vi. Open conflict in Yemen and insecurity and terrorism in Somalia and the Sahel have created "blind zones", areas of DL breeding that cannot be safely surveyed and treated. This liability lies at the root of the current locust crisis.
- vii. The question of arrears from Member States tends to plague quite a few institutions, including the FAO commissions. Those suffering most in this regard are the regional organizations inherited from colonial institutions, such as DLCO-EA and IRLCO-CSA, which lack a firm anchor in the United Nations system and whose relevance, finances and operational means have tended to shrink over the years.

- viii. There is a lack of data on incidence and impact, such as the number of hectares treated or damaged, as countries are reluctant to release these figures, lest they be seen as indicative of failure. In the worst cases, a pest can be known to be in a country, but not officially declared, because of trade implications. This issue affects resource mobilization and preventive control.
 - ix. The former FAO Information Technology Division (CIO) was described as a bottleneck in the development of new platforms and tools, to the extent that avoidance strategies are being used, such as working with outside partners to develop new apps.
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8. Readiness to address possible shocks and stresses (such as climate change and epidemics)

This topic is central to this review. It contributes to a long experience of preventive control measures, including through the sharing of information, skills and capacity across borders. Preventive control is far less costly and less damaging to the environment than crisis response.

This practice has highlighted the need for strong, well-funded national control units that can constantly monitor the threat, coordinated through regional platforms – the commissions – that facilitate far more than just biennial meetings. Their role is to build a sense of team spirit and solidarity between members in the face

of a common threat, to help them realize that they are all in the same boat. In doing so, they must facilitate meaningful regional and global technical collaborations that are well funded, credible in their warnings and protected from petty politics and the facile temptation to blame one's neighbours for transboundary pests or diseases.

It is easy to relate this experience to the current COVID-19 pandemic, where true global and regional collaboration and the free and transparent exchange of information are key to eventual success.

9. Conclusions and recommendations

Conclusions

Conclusion 1.

The control of transboundary pests and diseases is as much a governance issue as a technical one and highlights the political effort needed to foster genuine technical collaboration between neighbours. It is an issue that is more important than ever in the face of multiplying threats.

In the case of DL, this work is mediated through the FAO regional commissions and the DLCC. To be effective, they need a bit more than just a biennial meeting: they require a sense of team spirit, true regional solidarity and the feeling that the burden is being shared fairly. As this study shows, regional solidarity often determines the pace of progress, as it creates a "safe space" for technical cooperation to occur. In contrast, political tensions, regional rivalries and wars tend to hamper regional collaboration on DL and other species. There is often a temptation to blame one's neighbours for transboundary pests, rather than to help them.

Conclusion 2.

The role of FAO in this review is to support a fair, collaborative and technically competent architecture of regional commissions and national entities that trust one another and help one another. FAO must continue to try to forge this trust, but it cannot be a substitute for national authorities, who also have their role to play. From the perspective of leaving no one behind, pests and diseases are reminding us that we all share the same planet and that we must cooperate beyond borders in order to succeed.

One of the lessons from the review is to draw on the regional level – as needs and priorities are always local to a degree, even in the case of transboundary pests – but also operate on interregional and intraregional exchange. FAO's work on species other than the locust (such as FAW) is more recent and the Organization is still building up its regional architecture and relationships with numerous other institutes, especially within the CGIAR system, which deal with tropical pests and diseases (ICIPE and IITA, for example).

Historically, the Organization was conceived and structured precisely with this kind of work in mind. It is telling that Member States from the Caucasus and Central Asia, most of which joined FAO in the late 1990s or early 2000s, asked FAO as far back as 2000 to institute a Commission similar to CLCPRO or CRC for the Caucasus and Central Asia.

Conclusion 3.

Difficulties in funding preventive control are cited as a key constraint. They are one reason why EMPRES was never implemented in SWAC, for instance. There is a paradox in preventive control, in that a well-controlled threat progressively becomes invisible, in particular to decision makers, who then tend to defund and weaken preventive control, until the system fails to stop the next crisis.

CLCPRO has managed to break this vicious circle (so far) by developing a clear pitch to decision makers and by not being shy about using it to try and convince ministers of the importance of funding their own DL control system. The same approach could be used much more widely. The 2018 EMPRES evaluation recommended increased coordination on branding, co-marketing and advocacy for FAO's work on transboundary pests and diseases (FAO, 2018b).

The preventive approach is as relevant as ever and perfectly in line with the latest thinking on crisis management, as evidenced, for instance, by the outcome of the Istanbul World Humanitarian Summit (May 2016) and its Agenda for Humanity (Agenda for Humanity, 2016).

Surprisingly for an FAO flagship programme, launched concurrently with the Special Programme for Food Security at a World Food Summit, EMPRES has never been "branded" by FAO, on the rationale that the world does not need yet another brand and that supporting national capacities and giving them visibility is what matters most. The name may also be an issue. The acronym is reminiscent of past empires and as such, more nostalgic than resolutely modern. It may even evoke a caricature of FAO itself, a vision of an old empress sitting in Rome, pulling the strings of a global network of subjugated institutions. Whatever the reason, the acronym is generally unknown, even among development professionals, and may need a facelift.

Conclusion 4.

Efforts were made in recent years to broaden the range of species that FAO covers and to integrate early warning messages for different types of threat. Further integration makes sense, inasmuch as lessons could be learned from one species that may apply to others, also for advocacy and communication. However, there are legitimate reasons for keeping the FAO systems for the control of transboundary pests and diseases species-specific: each species has its own biology, crops it affects and countries it plagues. The methods of control are, therefore, very different too. A fully integrated EMPRES programme across a wide range of species would risk a loss of effectiveness, at least for the most advanced components. And anyone trying to integrate the institutional component, for example, the use of DL commissions for another species, such as FAW, would likely face insurmountable bureaucratic and diplomatic hurdles.

The relevance of such an integrated One Health approach appears stronger at the regional and national level than at the global level. The FAO Regional Office for Asia and the Pacific (RAP) has committed to the use of the One Health approach as a driver for its regional and national work, for instance. At the national level, ministries of agriculture are responsible for protecting crops against many different pests and diseases. This calls for efforts to integrate approaches across species to become the responsibility of FAO Regional and Country Offices, rather than that of headquarters (for example, through Regional Initiatives on One Health and regional projects).

This does not mean that headquarters cannot support the process and do its part through integrative knowledge products for instance, as done with the Food Chain Crisis Early Warning Bulletin and the EWEA report (FAO, 2020f; 2020g). Another low-hanging fruit is to develop joint advocacy material for preventive approaches, showcasing the cost effectiveness of the approach for a variety of species and threats. Regular knowledge-exchange events could also be organized to share the experience of FAO personnel and partners working on different species.

Conclusion 5.

The impact of control operations on the environment and on human health are important aspects of this work from an SDG perspective. The control of locust species, in particular, comes at a significant ecological and health cost: hundreds of thousands, if not millions of hectares are sprayed every year with old broad-spectrum pesticides that are often banned in Europe or the United States of America for their toxicity to humans. These elements have been addressed in the EMPRES Desert Locust Programme through the QUEST teams, who monitor the potential pesticide impact on non-target fauna and on the health of staff involved in locust control operations. They have been deployed in the Central Region and the Western Region, as well as in the Caucasus and Central Asia, and should be expanded further (for example, in SWAC). They could also be used on other species and better document the results of their work.

There is a lack of modern, safer pesticides for locust control. However, preventive control strategies are a good way of minimizing the ecological footprint.

The mycopesticide Metarhizium (Green Muscle) is currently being used on a large scale in northern Somalia. The experience will be studied and documented with a view to registering the product in the region. IPM and, in particular, the use of natural enemies is also gaining traction for other species, such as FAW. It is clearly a promising avenue to equip farmers with low-cost, ecologically friendly, healthy alternatives to pesticides to manage a pest that is now endemic to many countries.

Conclusion 6.

Good data are essential in the fight against transboundary pests and diseases. Efforts to crowdsource such data have had mixed results, as the quality and regularity of the data are sometimes irregular. This underscores the need to maintain a professional channel through trained specialists able to identify species and their stage of development, and record the data on professional data collection tools.

In several interviews for this study, CIO was described as a bottleneck to the development of platforms and tools, to the extent that avoidance strategies were being used.

Recommendations

These recommendations are based on a rapid review of a large programmatic area and should be taken as suggestions, or food for thought on programme development, rather than imperatives.

- i. Efforts should be made to advocate and mobilize resources from Members for preventive control, including through advocacy for the payment of arrears to all regional commissions and organizations and a concerted effort to raise resources to roll out an EMPRES Desert Locust Programme in the Eastern Region (SWAC) and for the CRC emergency fund.
- ii. The current crisis will raise significant resources, some of which should be used to strengthen preventive control capacity in the Central and Eastern Regions through CRC and SWAC.
- iii. There is a need for adequate succession planning for the handover of key technical positions, notably that of the head of DLIS. SWAC also deserves a full-time Secretary from the region, able to act as a champion of collaborative preventive control in the Eastern Region.
- iv. Although it was recommended in the 2018 evaluation, it is unclear from this review whether branding EMPRES would bring any value in terms of heightened visibility and funding for preventive approaches. 'EMPRES' is not a very good brand to start with, as the acronym is evocative of past empires, while the aim of branding should be to showcase preventive control as resolutely modern. Besides, branding EMPRES would only make sense in terms of raising funds for FAO itself, whereas the real goal should be to arrive at self-funded national and regional institutions. What is important is to convince nations to invest in their own preventive control systems, not to brand another FAO programme.
- v. The use of drones for locust surveying is critical to covering "blind zones" and should be stepped up. In the twenty-first century, it is difficult to envisage sending teams of surveyors into insecure, dangerous and remote environments when less risky alternatives are available.
- vi. Not all data can be crowdsourced. FAO should maintain professional information collection channels, through trained specialists, able to identify species and their stage of development.
- vii. The lack of modern, safe pesticides for locust control should be reviewed by the Pesticide Referee Group, recently reconvened to that end under the aegis of FAO, with a view to encouraging research and development.
- viii. The Somalia Country Office's experience with the use of the mycopesticide Metarhizium in DL control should be studied and documented with a view to registering the product in the region.
- ix. Likewise, the work of QUEST teams on the environmental and health impact of locust treatments needs to be better documented, so lessons can be learned from it. If found useful, they should be deployed elsewhere, for example, in SWAC or in treatments for other species as well.
- x. The request from Caucasus and Central Asian countries for an FAO commission on locust control in their region should be revisited and, hopefully, granted. This request is based on the reasonable expectation that all countries are equal in a multilateral system and that FAO has much to teach the region, thanks to its experience elsewhere. Current regional cooperation relies mainly on extra-voluntary contributions, in other words, projects. Establishing a permanent institutional body within FAO, with contributions paid by its members, seems to be the solution that offers the greatest guarantee in terms of sustainability.
- xi. Similarly, requests for support from Latin America (such as from Argentina on the current outbreak of *Schistocerca cancellata*) deserve FAO's attention, even though the region lies beyond the Organization's traditional geographic focus on locusts.
- xii. FAMEWS is used and supported by many countries, despite reduced interest from some farmers and countries where the pest is now well established. The collected monitoring data provide opportunities to better model and forecast (and thus prevent or manage) the pest's further spread, but its relevance in countries where the pest is already endemic seems more limited. The app should be further developed with better internal support from CIO. The upload and download of data should be made available to farmers for free (for example, through contacts with national telephone companies).
- xiii. There is room for a general mobile phone app that allows farmers to diagnose a variety of pests and diseases on their own crops and access a library of appropriate control techniques. This app could transmit data automatically to FAO, allowing it to centrally track a variety of diseases and pests.
- xiv. The Global Action for FAW Control initiative needs to focus on helping to train farmers in control techniques, working with ICIPE and others on the use of natural enemies and other IPM approaches. The global platform should also be used to better coordinate research and technology sharing.
- xv. Ways should be found to continue the work started by the Food Crisis Unit in AGD (a division now abolished), as it usefully explored ways to integrate various FAO systems and capacity to tackle numerous species of pests and diseases in a more integrated manner.

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Appendix 1. People interviewed

Last name	First name	Institution/Agency
Al Dobai	Shoki	FAO-NSPM
Al Sarai Al Alawi	Mamoon	FAO-CRC
Belayneh	Yeneneh	USAID
Chiris	Marion	FAO-NSPM
Cressman	Keith	FAO-NSPM & SWAC
Dillon	Neil	
Elkahky	Maged	FAO-NSPM
Felege	Elias	DLCO-EA
Hamouny	Mohamed Lemine	FAO-CLCPRO
Hughes	David	PlantVillage, Pennsylvania State University
Latchininsky	Alexandre	FAO-NSPM
Medina	Hector Emilio	SENASA Argentina
Monard	Annie	Ex-FAO
Piou	Cyril	CIRAD, France
Said	Ghaout	
Salato	Zebdewos	FAOET
Salih	Huyam	FAO-AGDD
Showler	Allan	USDA-ARS
Solano Morales	Ricardo	SENASA Peru
Tagliati	Elisabetta	FAO-NSP
Yaseen	Thaer	FAO-RNE
Zitsanza	Elliot S.	IRLCO-CSA

Evaluation of FAO's contributions to Sustainable Development Goal 2

"End hunger, achieve food security and improved nutrition and promote sustainable agriculture"

Signature Product 1: Legal and parliamentarian work on food and nutrition security

Signature Product 2: Nutrition education

Signature Product 3: Support to value chain development

Signature Product 4: Support to secure tenure of natural resources through VGGTs and other guidelines

Signature Product 5: Farmer field schools and their derivatives

Signature Product 6: Control of transboundary plant diseases and pests

Signature Product 7: Agroecology

Signature Product 8: Protection and fair share of genetic resources for food and agriculture

Signature Product 9: South-South and triangular cooperation

Signature Product 10: Support to agricultural investment

Signature Product 11: Support to fair and informed commodity markets and international trade in agriculture

Signature Product 12: Rural women's empowerment

Signature Product 13: Food for the cities and urban agriculture

Signature Product 14: Aquaculture promotion and Blue Growth

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