

THE ROUTLEDGE HANDBOOK OF THE POLITICAL ECONOMY OF SCIENCE

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 **Routledge**
Taylor & Francis Group
LONDON AND NEW YORK
Not for distribution
Taylor & Francis

First published 2017
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN
and by Routledge
711 Third Avenue, New York, NY 10017

Routledge is an imprint of the Taylor & Francis Group, an informa business

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British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging in Publication Data
[CIP data]

ISBN: 978-1-138-92298-3 (hbk)
ISBN: 978-1-315-68539-7 (ebk)

Typeset in Bembo
by Saxon Graphics Ltd, Derby

Not for distribution
Taylor & Francis

POSTCOLONIAL TECHNOSCIENCE AND DEVELOPMENT AID

Insights from the political economy of locust control expertise

Claude Péloquin

Scientific and technical knowledge and practice play a key role in international development interventions. Expertise, thus, is a key element of the geographical and historical relations between the colonial and postcolonial cores and peripheries (Vessuri, this volume; Ferguson 1990, 2006, Escobar 1995, Watts 2003), and it has accordingly been the object of a great deal of attention in critical development studies and related fields (Mitchell 2002, Goldman 2005, Li 2007, Mosse 2011). For example, scholars have examined the ‘downstream’ effects of expert knowledge on populations’ subjectivities (Agrawal 2005, Li 2007, Birkenholtz 2008), and how dominant narratives within colonial ventures have contributed to the stabilization and selections of some ways of knowing over others (Fairhead and Leach 1996, Bassett and Bi Zuéli 2000, Davis 2007).

A political economy perspective on science can bring additional and valuable insights on the politics of development expertise by shedding light on the specific institutional mechanisms that contribute to aligning scientific practices in these settings with the broader transnational and transcolonial power dynamics to which they contribute (Cooper and Stoler 1989, Hoogvelt 2001, Venn 2009). This approach can illuminate the professional incentives that development projects and interventions present to experts; whether those incentives differ from the ones encountered, for example, in national public research agencies or private think-tanks in industrialized core countries, and what the implications might be for the type of knowledge and management approaches these conditions favor (Shackley 2001, Kuus 2014, Cashmore *et al.* 2015).

International efforts to prevent and control the swarming of desert locusts in Africa and Asia provide a useful context to examine how the political economy of expertise in development co-evolves with the production, circulation, and application of scientific and technical knowledge in these settings. This agricultural pest insect is extremely mobile, and its occasional upsurges and invasions are difficult to predict and control. Moreover, its management is largely under the purview of actors implicated in international development efforts. In this sense, locust invasions present a development-related environmental problem that is mismatched to management institutions (Folke *et al.* 2007, Treml *et al.* 2015), and whose resolution, therefore, calls for inquiries on what shapes how mandated organizations prefer to ‘think’ about such

problems, and how they select management practices to resolve them (Douglas 1986, Lecoq 2005, Robbins *et al.* 2008).

This chapter stems from my exploration of the institutional processes shaping the place and role of organizational networks linking the regional structures of locust surveillance and control to those of state and international programs of development aid. The analysis brings attention to the strategies that experts and technicians pursue to maintain and augment the legitimacy, relevance, and financial sustainability of their branch of applied science within development networks. It also sheds light on how the imperatives of professional sustainability pertaining to the challenge of monitoring and controlling the populations of this emergent, mobile, omnivorous, and polyphenic pest insect relate to, and partially shape, the stabilization and selection of preferred locust management strategies amongst experts, and in turn how scientific knowledge is favored and valued in applied settings.

I examine debates in this branch of applied entomology in light of the difficulties faced by locust experts to maintain reliable sources of funding and relevancy. My analysis suggests that these debates have been *de facto* resolved not by technical arguments alone, but also in part by the shared conceptual horizon (Pellizzoni 2011) between (1) the discursive and organizational socio-technical by-products of one subset of locust management strategies and (2) development's contribution to a mode of government that operates via a proliferation of mechanisms of social and ecological improvement. This shared conceptual horizon, and the compatibility between the institutional requirements and discursive logics of development programs and the preventive approach to the application of locust science, I argue, produces the primary mechanisms whereby the political economy of development expertise shapes locust science.

Postcolonial technoscience and development aid

Research in science studies and related fields has revealed how the practices, techniques, texts, and quotidian activities by which scientific facts are produced and stabilized, as well as the ways in which technical and scientific practices are adopted and modified as they travel across different settings, and all have serious implications for our understanding of power and social order (Mitchell 2002, Jasanoff 2004, Abram 2005, Goldman *et al.* 2011). In this context, attention to postcolonial technoscience (Anderson 2002, McNeil 2005, Harding 2011, Mavhunga 2011) has demonstrated how scientific practices and discourses in fields such as health, sanitation, planning, and agriculture have co-evolved with the economic and political structures of domination and exploitation linking industrialized societies to non-industrialized societies, from the colonial era to the present. Examples include the use of technoscientific projects to experiment, perform, and represent forms of social order and subjectivities in colonial settings, including the effect of using colonies as laboratories to experiment with modes of government that would later be incorporated in metropolitan governance (Bonneuil 2000, Carroll 2006, Tilley 2011), and the role of local, material, and cultural contingencies, and popular agency, in shaping the actual outcomes of these projects (Hecht 2002, Mitchell 2002, Freed 2010).

Similarly, scholarship in critical development studies has theorized foreign aid and technical assistance interventions as constitutive of a mode of government produced at the junction of post-colonial state-building and transnational governance (Gupta 1998, Callaghy *et al.* 2001, Ilcan and Phillips 2010, Lie 2015). This work helps trace the continuities and ruptures linking different periods of North-South relations by focusing on the governmental rationalities commonly produced during these periods. For example, the 'development and improvement' (*mise en valeur*) phase of the French 'civilizing mission' in Africa was characterized by structures, practices and discourses whose logic and effect exhibit important similarities with the

contemporary aid-driven programs of capacity-building linking these two regions, but the latter also evolved to more than just a different version of the former (Conklin 1997, Cooke 2003, Venn 2009, Tilley 2011, Cherlet 2014). In this context, the concept of *developmental governmentality* allows the analysis of the institutional mechanisms designed to improve livelihoods and landscapes by focusing on the *effect*—intended or not, that these mechanisms have in shaping the conduct of social actors as development subjects (Agrawal 2005, Goldman 2005, Li 2007). Investigations of these mechanisms have highlighted how discourses and practice of training, consultancies, reports, and evaluations carried out in the name of development contribute to modes of power that operate via improvement, care, and attention to subjects and populations and that are thus distinct from regimes of rule more limited to negative powers of surveillance and coercive authority (Rose 1993, Rossi 2004).

The question of how the institutional context responsible for development's governmental effect influences the production, circulation, and application of scientific knowledge has received much less attention. A political economy approach to the study of scientific and technical expertise in development can help address this question by drawing attention to the alliances, strategies, and compromises that experts and technicians make to maximize the professional, institutional and financial, viability of their specific field (Latour 1987, Clarke and McCool 1996, Rose 1999), how these shape the work of experts and technicians in development-related research and management programs (Keeley and Scoones 2003, Mosse 2011, Cashmore *et al.* 2014) and, by extension, what type of knowledge is likely to be favored by these outcomes.

Locust control as developmentalist science: programs of foreign aid

Populations of desert locusts present an important agricultural pest hazard across vast parts of the African continent, the Arabian Peninsula, and South Asia. This insect most commonly exists in what is called its solitary form, wherein individuals typically avoid one another as they feed on low-density vegetation scattered in desert environments. When rainfall and vegetation create conditions allowing greater locust population density over sustained periods, individuals start to change behavior and, eventually, their appearance, as they gradually enter what entomologists call a gregarious phase. As they become gregarious, locusts seek one another and form groups that grow in size, density, and mobility, eventually traveling to agriculturally productive areas where they feed massively on crops and pastures, sometimes causing catastrophic damage (Van Huis *et al.* 2007). During an upsurge, locust swarms, and plagues—swarms of swarms—can affect thousands of square kilometers in dozens of countries and last for several years.

Despite their great magnitude and impact, locust outbreaks and upsurges are difficult to predict past a very coarse resolution. The condition presented by these phase changes from the initial gregarization in micro-habitats of scattered desert vegetation patches, to the massive and highly mobile plagues that travel across continents, can be understood as one of *bifurcated spatiality and temporality*. In other words, the locust problem calls for management efforts at distinct scales, ranging from the very small to the very large. In each phase the insect is prone to either evade or overwhelm the spatial reach of the institutions responsible for its monitoring and control.

One important challenge to desert locust management capacity is the difficulty of maintaining an effective network of specialized experts and sufficiently trained and equipped technicians across these vast regions. Specifically, long periods of locust recession—when locust populations are almost all in their solitary phase—challenge the professional viability of locust expertise. During these recession periods, state and donor concerns about this pest problem diminish greatly, and consequently locust scientists and technicians struggle to remain institutionally and financially relevant in a context of unreliable interest from their clients. Entomologist Michel

Lecoq (2005) describes this dynamic as a cycle of crisis and oblivion. The institutional challenges posed by this recession–outbreak cycle are made worse by the fact that desert locusts are relatively omnivorous and not associated with specific sites or crops. This pest is not the concern of one agricultural industry in particular, which makes for a diffused constituency for locust experts. Other scientists doing applied research on pest management in tropical agriculture tend to be closely associated with one crop or commodity. For example, some groups of experts concentrate on coffee, bananas, cotton, and so on, and consequently deal with pests in so far as they affect or threaten this specific crop. In most cases, even if pest threats can be cyclical, researchers focusing on pest insects more prone to affect a particular agricultural commodity have a relatively well-established constituency on which to rely, through industrial and commercial interests, to sustain their work. This is not the case for locust experts (or acridologists), whose client agencies lack such consolidation. Put differently, the locust problem is often quite peripheral to the priorities of political authorities and established producer organizations, not only because the solitary insect is so elusive but also because the threat it continues to pose during recession periods does not concern a specific public. In sum, the institutional challenge of monitoring and controlling desert locust populations—an emergent, mobile, omnivorous and polyphenic pest insect—invites inquiries on how locust control experts attempt to sustain their professional relevancy, and the strategies, alliances, and narratives that sustain these attempts.

Since the 1960s, locust control has been increasingly incorporated in the constellations of programs and activities carried out under the rubric of development, which include technical assistance, foreign aid, and humanitarian relief (Baron 1972, Skaf *et al.* 1990). International efforts to control the desert locust have been coordinated by the Food and Agriculture Organization (FAO)—one of the first international agencies dedicated to North–South cooperation and poverty alleviation in the 20th century—since 1955, when the Organization established its Desert Locust Control Committee (DLCC). In the following decades, the locust problem also became a field of intervention for many other development programs and organizations including the World Bank, the African Development Bank, and bilateral aid agencies of France, the Netherlands, Germany, Sweden, Canada, USA, and Japan. This incorporation of locust management in the orbit of development networks has been justified by government officials and development professional alike, for at least three reasons. First, the threat that the desert locust poses to food security and agricultural productivity in underdeveloped countries makes it a humanitarian concern. Second, the transboundary nature of this pest hazard requires transnational coordination, best provided by multilateral, regional, and supranational organizations. Third, the fit of locust management with the demands of technical capacity building, both via training and technical transfer, make it a good fit with the *raison-d'être* of several development programs. Locust control efforts thus allow us to examine how the institutional logics and imperatives of these development programs shape the production and application of scientific knowledge, and in turn how and why some scientific recommendations and resulting technical practices are favored in development programs.

I studied the institutional dynamics within member agencies of the Western Region of the FAO's Desert Locust Control Committee (DLCC) from 2010 to 2014. This region includes ten countries in western and northwestern Africa, coordinated under the Commission for Controlling the Desert Locust in the Western Region (Clcpro, Commission de Lutte au Criquet Pèlerin en Région Occidentale). My understanding of the institutional dynamics across this regional organization is primarily informed by the interviews and documentary analysis I carried out in a selection of centers that together constitute a fairly representative cross-section of this international network: a French scientific research unit specialized in applied locust science in France, locust control centers and crop protection agencies in Mali, Senegal, Mauritania and Morocco, and at the FAO headquarters in Rome. In these locations, I interviewed scientific advisors and

technicians and observed their work, both in the field and in regional and international meetings. I also analyzed policy and technical documents produced and used by these experts and agencies. This chapter focuses on dynamics reported by French-based entomological experts whose primary professional affiliation is with the Locust Ecology and research team of the French Center of International Agricultural Research for Development (Cirad), in Montpellier, France.

Debates in locust control and the institutional preferences of development science

Locust managers are concerned with preventing, responding, and/or adapting to significant increases in gregarious populations, called upsurges (Van Huis *et al.* 2007). The spatial-temporal particularities of locust upsurges allow multiple approaches or orientations to locust control. The most prevalent is the *preventive orientation*, which favors, as the name suggests, early, preventive interventions at the initial stages of locust gregarization. The competing *strategic orientation*, favors delayed, curative interventions.

In practice, preventive and curative orientations are enacted sequentially along a continuum of intervention, and are therefore compatible and complementary. The sequence follows the evolution of outbreaks, upsurges, and plagues: management strategies that focus on earlier stages in this cycle are 'more preventive' than management strategies that focus on later stages in the cycle, which are 'more curative'. That being said, even though these approaches can be thought of as complementary, they are also in competition with one another, because each calls for distinct organizational and technological commitments: increasing investments in preventive capacity takes away from investments in curative capacity, and vice versa.

In 2008 a group of senior acridologists published, in the journal *Crop Protection*, a review article entitled 'Preventive control and desert locust plagues' (Magor *et al.* 2008). The authors argued that the most effective approach to locust management is to prevent upsurge by forecasting and monitoring outbreaks, and chemically terminating gregarizing populations in situ as early as possible to avoid groups of gregarious locusts coalescing and thus becoming too large and mobile to contain. Based on modeling of outbreak dynamics, the authors make the case that intervention right at the outset of upsurges is not only the most effective, but also the most financially and ecologically sound approach to manage this insect. The authors further argue that the adoption of the preventive control orientation as the official strategy by the FAO's Desert Locust Control Committee since the 1960s has been the main reason for the diminishing frequency, extent, and duration of locust upsurges since then. Further, they argue that the strategy's potential effectiveness has not been fully realized because donors and governments are less likely to finance prevention during long periods of recession, a situation they deplore.

This article prompted a short commentary response from another senior acridologist, in the same journal, under the title 'A critique of preventive control and desert locust plagues' (Symmons 2009). Symmons' response stressed that, in a context of competition for limited resources, commitment to proactive preventive control at the FAO and across the locust control apparatus undermine countries' preparedness to respond to severe locust upsurges. Successful locust control, he argues,

requires the right methods more than the right strategy. These include aerial detection and demarcation of hopper band targets, the treatment of flying swarms, and probably the use of persistent pesticide 'barriers' against marching bands. However, populations suitable for those methods are unlikely to occur until late in an upsurge and so have at best limited relevance for 'prevention'.

(Symmons 2009, p. 907)

This view of locust control favors a 'wait and see' approach vis-à-vis locust breeding dynamics, combined with all-out campaigns of swarm suppression, to be waged only after locust groups have reached a given threshold of size, density, coherence, and/or mobility.

Both sides of this debate stress the difficulty of maintaining locust surveillance and management capacity during periods of locust recession as a key factor favoring their preferred strategic orientation over the competing approach. For Symmons, the problem with the preventive strategy is that it requires the maintenance of a large and complex organizational apparatus of locust surveillance and outbreak control during recessions. He argues that given the immensity of the locust recession area and the very low probability that survey teams will come across an outbreak, let alone one of the very few instances of gregarization that can lead to a real upsurge, the preventive approach is inevitably too costly to maintain, and requires large teams of technicians whose skills, morale, funding, and equipment are difficult if not impossible to maintain over time.

For Symmons, rather than the diffuse network required by preventive control, what is needed are 'locust units that are small enough to be sustained' (Symmons 1992, p. 211): a small core of highly trained and experienced locust control officers that intervene by air. This in turn requires that interventions be limited to clearly marked target-blocks within which control efforts ought to be concentrated as much as possible. These target-blocks are precisely delineated spaces wherein locust density thresholds warrant powerful measures intended to kill all locusts within the block, and outside which locust population densities are too low to warrant any intervention at all. Survey teams delineate sectors wherein mature and immature groups of locusts are sufficiently concentrated to warrant a target block (Symmons 1992).

The way the curative strategy, as envisioned by Symmons, deals with the challenge of maintaining a viable apparatus in the face of great variability of locust populations and the tendencies for publics and authorities to 'forget' and lose interest in this agricultural pest is by containing said apparatus to a centralized core of professionals that only intervenes when and where there is a significant outbreak, and keeps doing just that. In an ideal situation, this core group would be specialized and mandated to respond to all outbreaks across a very vast area, travelling on demand, by aircraft, to treat well-identified target blocks and then returning to a centralized headquarters thereafter. The curative orientation then, produces an organizational configuration that is relatively small and concentrated. This smaller managerial core, the reasoning goes, is easier to maintain during periods of recession, and because it specializes almost exclusively on campaigns of locust upsurge elimination, skills and equipment necessary for these campaigns remain in use and are maintained over time.

On the opposite side of this debate, proponents of the preventive orientation push for an apparatus of locust surveillance and control that is expansive, pro-active, and nearly constantly involved in monitoring, reporting, and terminating locust outbreaks. As a senior Moroccan locust expert explained to me during a meeting in Bamako:

preventive control is the surveillance of the gregarization zones of the Desert Locust, the localization and destruction of the first populations that begin their phase transition to avoid that they become hopper bands or swarms. That is preventive control. And for preventive control, the transition phase is of capital importance. What we need to do is train colleagues, prospectors, field agents so that they are clear on the difference between solitary phases and transiens, and that they report transiens populations as soon as they can, before gregarization occurs, before the insects become gregarious.

(Senior locust control specialist, Bamako, 2011, personal communication)

Doing so requires a combination of remote-sensing, on the ground surveys, training, and control operations: a proliferation of mechanisms of reporting, production of knowledge, communication

channels, teams of prospectors on the ground, networks of satellite, radio, and internet-based database, maps, and so on. For this preventive strategy to be really successful, proponents contend that locust management capacity must be extended beyond these cores of professionals—the technical services—to include as many people as possible:

The (locust control) apparatus involves (A) the donors, (B) technical service, and (C) the populations, farmers, producers. But all the burden, in the current situation, is on the technical service. They are the only ones given all the responsibility. That is a problem, that the technical service is both distinct from the local and international levels. (The problem now) is that National Locust Control Units are disconnected from the international level, and from the populations. According to our perception, what is necessary is that locust control exceeds the scope of that technical service.

(Senior locust control specialist, Montpellier, 2010, personal communication)

The preventive orientation calls for combining regular surveillance and intervention missions and various projects of training, evaluation and other similar programs to populate a busy annual schedule for the many organizations active in this domain. Together, these practices contribute to the maintenance and relevancy of scientific and technical expertise and operational teams and equipment despite the absence of locust upsurges, and justify the funding and legitimacy of the work, both of which are necessary for the network to ‘stay afloat’ (Levine 2007). The preventive control approach thus best aligns locust management with the institutional logic and imperatives of the international development organizations to which it caters, which in turn helps acridologists ensure that their expertise remains relevant and viable.

Moreover, my interviews with pro-preventive control locust experts suggest that this greater fit between locust swarm prevention and the demands of development is neither accidental nor an afterthought. The acridologists I interviewed are aware of this fit, and many explicitly state that their approach’s contribution to a more developmentalist, improving type of intervention makes their work more compatible with the benevolent, capacity-building goal of development. It is this contribution, they argue, that makes their favored approach the most defensible, regardless of its merits on technical terms alone:

The goal is to help these countries develop, in every sense of the word. And where we can intervene is, if we teach them to set up and carry out a prevention strategy against the desert locust, it will allow them to go further in other domains. And we consider this as an entry point, an element we give them, a tool we give them. After that, they will be able to circumvent that philosophy, to use it, and apply it elsewhere, and learn to develop with it. It goes well beyond the problem of the desert locust.

(Entomologist researcher, Montpellier, 2010, personal communication)

A different interview revealed a very similar sentiment:

Our philosophy in this is that helping the development of countries, through the intermediary of agriculture, through the intermediary of countless things, but to try to give them the keys, the elements that will allow them to build their own development.

(Entomologist researcher, Montpellier, 2011, personal communication)

This ‘philosophical’ argument for the preventive control orientation accompanies a criticism of the curative, crisis-oriented responses as not only reactive but also as a fatalist policy of

substitution that ‘gives up’ on the goal of development and that is based on the belief that countries considered ‘backward’ would not be able to gain and sustain the skills and institutional capacity to ensure prevention:

There is this other policy, (the curative approach) that says: ‘anyways, those countries have too many problems of development, and they will not be able to establish a prevention strategy’. (Its proponents) start from the observation that countries will be unable to do their prevention strategy, as they are unable, we must be ready to intervene’. So they say: ‘let’s not bother spending money on countries that, no matter what, will have too many problems to be able to do prevention; instead, let’s prepare an ad hoc team, with aircrafts, that are ready to wage treatment campaigns when invasions do occur’.

(Entomologist researcher, personal communication, Montpellier, July 2010)

The pro-prevention locust expert cited above not only does not challenge, but actually recognizes the curative approach’s technical merits: ‘Yes, you take a team of professionals, you go and do treatments, the upsurge will be controlled, but that’s not the goal’. When asked to explain his answer, this expert argued that the proponents of the curative orientation ‘consider that we should return to the 1960s, to DDT, to whites that arrive with planes and say: “move over”’. In other words, this approach is considered inadmissible at least in part because of its association with policies of substitutive, top-down rule at a distance, which preventive approach proponents deem outdated and ill-adapted to the contemporary development goals of capacity building and knowledge transfer.

Moreover, to be effective, preventive control efforts rely on a sound understanding of locust ecology, habitat, breeding and phase change dynamics, all required to increase locust outbreak prediction and early detection and monitoring capacity at the basis of upsurge prevention. The curative approach, on the other hand, can do without these complex, diffused sets of knowledge and practices. A curative approach calls for innovation in insecticidal technologies and organizational and communication structures designed to enhance the effectiveness of a centralized anti-locust force. These limited demands offer little promise of sustaining a viable relevancy and constituency for locust science and expertise, and worse, they are a poor fit with the growing tendency among foreign aid agencies since the 1990s to seek, when possible, more participatory, decentralized, and ‘greener’, more environmentally-friendly interventions (Goldman 2005).

By favoring preventive orientations of locust management, acridologists and the institutions that employ them effectively call for a proliferation of mechanisms of surveillance, participation, improvement, reporting, and training. These mechanisms, as they line up with the goals of capacity building and improvement pursued by development programs, not only increase the likelihood that the work of locust control experts and technicians remains of relevance to state and multilateral organizations responsible for the governance of this international hazard: it also gives them ‘something to do’ during the long periods of ‘protracted non-crises’ of locust recessions when the locust problem would otherwise fall out of sight for these organizations. This is not to say that preference for the preventive approach amongst key actors in the Western Region of Desert Locust Control is solely, or even primarily determined by the political economic demands of foreign aid agencies and other donors. Scientific and technical arguments formulated by various experts in this field, based on empirical as well as computer modelling experiments (Simpson *et al.* 2005, Magor *et al.* 2008, Sword *et al.* 2010, Cisse *et al.* 2015) do indeed point to justifications that are independent from the political economical dimensions. What the foregoing suggests, however, is that the preventive approach is strengthened, and

made institutionally viable, in part due to its greater degree of compatibility with the logic and imperatives of locust science's primary clients.

The preventive approach to locust management yields relatively complex institutional arrangements that expand outward into other spheres of societies as they seek to 'improve', 'build capacity', and foster 'better governance'. In other words, preventive control in locust management contributes to what Whitehead calls, after Foucault, a form of 'government with science' (2009, 14) that integrates expertise about the desert locust into (1) the institutional settings produced at the intersection of post-colonial state agencies and multilateral development organizations, namely, development and (2) the political economy of expertise in these settings. This integration best aligns acridology with the logic and mandate of development programs and organizations, which in turn helps maintain a constituency for, and consequently the relevancy of, expertise on this agricultural pest hazard. By contrast, the curative approach leaves very little scope for the expansion of scientific expertise and research, and when it does, this research has a limited fit with the interests of foreign aid agencies.

One interesting implication is that the tendency discussed here is quite distinct from the technological determinism and reductionism commonly attributed to modern development bureaucracies (Cherlet, 2014; Goulet, 1980). Put differently, the preference among development networks and locust control experts for the preventive approach can be associated with an institutional preference for knowledge practices and management approaches that seek, highlight, and work through, the complexity and stochasticity of social-ecological interactions, rather than approaches that seek to ignore or minimize this complexity through greater reliance on spatial or temporal simplification, for example. This has implications for the type of fundamental entomological research required, called for, and enabled by this branch of applied science's contribution to development projects. More broadly, these findings also problematize common assumptions about the nature of technical and scientific practices, and their related social-political effects, as determined by a reductionist technocratic rationality adverse to complexity and dynamism.

A political economy of science focus on the social and political factors shaping the work of scientists can provide valuable insights on the nature of the regime of knowledge production (Pestre 2003)—or science regime (Lave 2012)—that characterizes the professional field of development aid. This perspective can help shed light on how the material and financial concerns for the professional viability of scientific expertise produce the specific mechanisms that link and align scientific practices with structures and strategies of political rule to which they cannot be reduced. Doing so, this approach can help overcome some of the most persistent methodological challenges in political ecological analyses of the relationship between science and power, namely a tendency for deterministic functionalism and the difficulty of attributing causality to relationships.

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