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The Dilemma of Balancing between Benefits and Risks: Desert Locust Management Best Practices

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Abstract. While desert locusts threaten human security, their management can introduce unintended risks, leading to a normative dilemma. Therefore, this study sought to determine desert locust management best practices that can protect human security from pests and management practices in Kenya. The analysis used ex-post facto evaluation and cross-sectional survey designs. The target population included desert locust-affected persons. A multi-stage sampling approach using stratified and purposive random sampling techniques was used to target a sample size of 900 respondents. Structured questionnaires and focus group discussions (FGD) were used to collect quantitative and qualitative data. Quantitative data was analysed using frequencies and percentages. Qualitative data was analysed using thematic analysis and incorporated in the discussion. The findings revealed that there were several possible desert locust management best practices. The study concludes that the integrated pest management (IPM) approach presents the most preferred opportunity to build resilience against human resource, technical and financial challenges through the progressive use of readily available knowledge and skills during physical control before advancing to more sophisticated strategies such as biological and chemical control options. The study recommends that scholars, policymakers and practitioners develop a customised IPM strategy for desert locust management in Kenya.

Keywords: Best practices; Desert locust; Integrated pest management; Non-intervention.

INTRODUCTION

The biology, behaviour and migratory patterns of desert locusts are influenced by environmental factors, especially precipitation, temperature, soil texture and moisture, vegetation condition, wind direction and speed [11]. Managing desert locust upsurges and plagues is complex due to biological, meteorological and geographical factors that play different roles within the system. Due to the complexity, desert locust management as a national disaster is both resource-demanding and labour-intensive to the rural populace, governments and international partners [1].

Desert locust management as a multifaceted value chain encompasses triangulating surveillance activities, control operations and recovery programs. Each phase has challenges; hence, best practices could help reduce the complexity. Some published best practices in desert locust management include non-intervention, early intervention and IPM.

The authors [15] observed that from a global perspective, agricultural loss due to desert locusts is usually too small to warrant huge investment in reactive emergency control operations. As such, one of the potential desert locust management best practices is non-intervention. This entails permitting outbreaks to develop into upsurges, then build up to plague and run the natural cycle, ending in natural mortality and initiating recovery programs. Recovery programs would then compensate farmers for crop and livestock losses through food relief during the infestation or restitution using cash transfers or insurance. The argument underpinning this non-intervention approach is that recovery programs such as food relief, cash transfers, and insurance are cheaper than emergency responses to upsurges and plagues. However, assessing the practical application of non-intervention is crucial considering agrarian economies such as Kenya, where agriculture is the most significant contributor to Gross Domestic Product (GDP).

According to [17], insurance can be the more economically efficient corrective strategy for addressing desert locust-associated risks. Risk management analysis recommends insurance as an appropriate measure to protect against an event that has a low probability of occurring but has severe damage [5]. However, insurance against natural events, such as damage to crops and pasture by desert locusts, is still rare in developing countries [18]. With limited examples that would give estimates of administrative costs of insurance against desert locusts or farmers' willingness to pay premiums, it is not easy to assess the feasibility of such a policy. In addition, it can be hard to determine if insurance would be economically more efficient than reactive strategies where desert locusts are sprayed with expensive pesticides.

Early intervention is lauded as another best practice in desert locust management. Preventive control hastens the rapid return to recession status by averting the graduation of outbreaks to upsurges or plagues [4]. In Australia, it was discovered that outbreak control within recession areas through early intervention helped to contain infestation before gregarisation. However, effective prevention of gregarisation depends on the efficiency of outbreak suppression in breeding areas [14]. For example, the absence of proactive control facilitated the 2003-2005 upsurge [1].

Authors [15] believed that effective preventive control hinges on the efficiency of outbreak suppression in breeding areas. For example, preventive control thwarted a potential upsurge in 2007-2016, during which possible outbreaks were controlled promptly [14]. However, early intervention happens within a limited window of opportunity. This means that desert locust surveillance must be sustained to detect early incidents of outbreaks.

Authors [15] point out that effective surveillance to enable proper timing of early intervention needs to be clarified through further research. However, scholars and practitioners alike appreciate the increasing use of weather and Geographic Information Systems (GIS) as potentially effective means for enhancing the effectiveness of desert locust surveillance [12].

One practice that has facilitated early intervention is an effective early warning system using machine-learning algorithms [8]. This approach enables the prediction and determination of enormous areas which could provide desert locusts with favourable breeding grounds. Early warning translates into action through effective ground monitoring, timely preventive control and reactive recovery measures. More importantly, such model-based forecasting enables governments and other stakeholders to prepare for rapid response to desert locust infestations. However, the author [16] noted that despite precise weather-based forecasts, India and Pakistan ignored early warnings, leading to low preparedness to respond to the recent upsurge [16].

Australia noted that outbreak control within recession areas through early intervention could help to contain infestation before gregarisation, thus preventing upsurges and plagues [4]. Showler documented the importance of remote sensing in forecasting desert locust presence to trigger preventive control [13]. However, reliable forecasting means that surveillance must be continuous, strategic and effective in recession areas to enable early detection of initial incidents of gregarisation. The author [16] states that the increasing use of GIS and remote sensing of weather and vegetation conditions are critical for enhancing the effectiveness of desert locust surveillance, forecasting and early warning [16].

However, early detection to support precise and prompt early interventions against desert locusts is difficult and complex. This is because surveillance of desert locust ecology and behaviour is highly fluid, as it can change rapidly based on prevailing weather conditions, vegetation status and resource availability [2]. Over the years, surveillance has benefited from technological advancement; thus, predictive modelling can be achieved progressively. For instance, several technological innovations, such as unmanned aerial vehicles/drones and satellite remote sensing, support desert locust surveillance [12]. However, technology alone may not address all the surveillance, forecasting and early warning needs. Automated surveillance should also be complemented by trained scouts from the ground to identify areas where prevailing conditions favour outbreaks [3]. Surveillance data can also be obtained from local farmers, military personnel, administrative authorities, tourists and nomads [14].

Desert locust preventive control strategies can prevent outbreaks and slow down the rate of upsurge development [6]. All these preventive strategies are geared towards deterring desert locust plagues from occurring. Desert locust destructiveness can be managed if preventive control is successful before economic and injury threshold levels are reached. However, preventive control is seldom 100% successful [17]. This is because of the difficulty in monitoring remote and sparsely populated solitarious desert locusts in their natural habitats. In addition, in the past, human crises such as the war in Yemen have prevented the effective implementation of prevention control measures [3].

The alternative to prevention control has been waiting until gregarisation, when bands and swarms have emerged, calling for targeted response through reactive strategies [12]. At such a stage, reactive strategies through ground and aerial spraying of pesticides become inevitable to safeguard crops and pasture. However, chemical control poses health and environmental security threats. Therefore, maximising outcomes through correctly timing targeted chemical interventions is critical. The study thus aimed to determine the next best alternative faced with this normative dilemma.

Integrated pest management is the most appropriate best practice for many plant pests and diseases. The IPM entails identifying possible management practices, prioritising the effective ones and deploying them appropriately at different pest thresholds. The Global Good Agricultural Practice (GAP) recommends that IPM ensure conformity to phytosanitary standards that encourage judicious use of chemicals in agriculture. As such, physical/cultural practices always come first due to their availability and cost-effectiveness before biological and chemical control. Lecoq found that the existing desert locust control activities included the IPM approach [7]. In Pakistan, the author [16] noted that IPM involved the application of oil-based pesticides in combination with non-conventional control methods [16].

In India, Sharma acknowledged the role of indigenous knowledge in desert locust IPM, where traditional methods were practised in combination with chemical control [12]. However, these studies provide neither an economic nor injury threshold-based protocol for escalating desert locust management practices from physical/cultural to biological and chemical control methods. In addition, despite the availability of published evidence on IPM, limited research has assessed desert locust IPM practice in Kenya. This study used field experiences from practitioners and the general public to determine desert locust management best practices in Kenya.

METHODOLOGY

The study employed a mixed methods approach using ex-post facto evaluation and cross-sectional survey designs. The study site was Kenya, one of the countries that experienced the 2019-2022 upsurge in the east and horn of Africa. Kenya was specifically unique because, being an invading country, it had not experienced such a devastating infestation in over seven decades. The target population included people who were affected and/or participated in desert locust management.

The respondents included community members, national government officers, county government employees and members of non-governmental organisations. A multi-stage approach using purposive, stratified and systematic random sampling techniques was used to target a sample size of 900 respondents from 30 counties. The respondents were invited to complete an online questionnaire. Some 96 questionnaires were excluded from the analysis for lacking more than 75% of responses, while 28 were excluded as duplicates. After data cleaning, 779 (86.6%) questionnaires were considered for analysis.

A mixed methods concurrent approach was used during data collection. Structured questionnaires and FGD were used to collect quantitative and qualitative data. Quantitative data was analysed through descriptive statistics using frequencies and percentages. Qualitative data was analysed using thematic analysis. Both quantitative and qualitative datasets were triangulated to provide a corroborative discussion of the findings.

RESULTS AND DISCUSSION

Desert locust management best practices were contextualised regarding non-intervention, early intervention through physical and chemical control, and IPM strategy. Constructs of determining desert locust management best practices included systematic approaches against all potential risks, several systematic approaches against desert locust risks only, several ad hoc methods of controlling the pest, control using bio-pesticides, spraying with synthetic pesticides, physical methods of killing the insects, and non-intervention where nothing is done until the pest population naturally declines. Each of the constructs of determining desert locust management best practice was assessed by respondents on a 5-point Likert scale, and the results are presented in Figure 1.

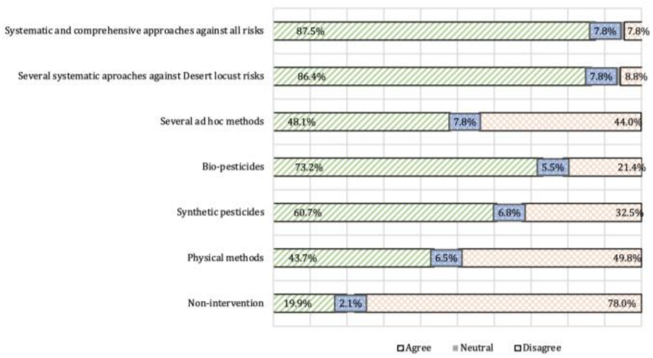

Figure 1 – Percentage response to constructs of determining desert locust management best practices

Of the 779 participants who successfully responded to the study, 682 (87.5%) considered systematic and comprehensive approaches against all risks as a preferred desert locust management best practice. In addition, 673 (86.4%) and 375 (48.1%) respondents agreed with several systematic approaches and ad hoc control measures against desert locust risks as best practices, respectively. Similarly, 570 (73.2%) and 473 (60.7%) considered using biological and synthetic pesticides as desired desert locust management best practices. 340 (43.7%) respondents also viewed physical control as a desert locust management best practice. Of the sampled respondents, 155 (19.9%) felt that non-intervention was a possible desert locust management best practice.

Results for desert locust management best practices regarding IPM, chemical control, physical control, and non-intervention were summarised (Figure 2).

The findings revealed that IPM received 34% support from respondents as a desert locust management best practice. Early intervention through chemical control received 28% support from respondents as a desert locust management best practice. Early intervention through physical control received 24% support from respondents as a desert locust management best practice. Non-intervention received 14% support from respondents.

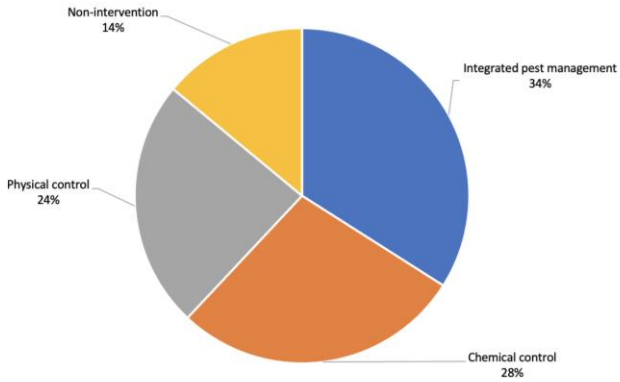

Figure 2 – Rating for desert locust management best practices

The discussion for determining desert locust management best practices was organised regarding non-intervention, chemical control interventions, physical control, and IPM.

Non-intervention to desert locust outbreaks, upsurges and plagues as a best practice. Non-intervention was assessed regarding doing nothing and letting desert locusts die due to predation and/or unfavourable weather. Out of the 779 successful participants who successfully responded to the study, 155 (19.9%) of respondents felt that non-intervention was a possible desert locust management best practice. The limited support of non-intervention as a desert locust management best practice could have been due to the realisation of the human security risks that the pest poses. Doing nothing would, therefore, seem irresponsible.

During the national FGD, one participant cautioned: "Instead of wasting a lot of money purchasing costly pesticides and equipment to contaminate the environment with hazardous chemicals, the money could have been used to protect the affected communities against immediate effects from desert locusts through relief food and cash-transfers. This could have also avoided risks of contaminating the environment with pesticide residues". The statement acknowledges that using pesticides in desert locust management is expensive and could adversely affect people and the environment.

Besides the hazardous effects of pesticides, most other interventions negatively affect human security. Non-intervention would eliminate the risk of unintended threats. From these considerations, the participant could have felt that doing nothing and refocusing efforts and resources on adaptive measures could have been the best option. This approach would address desert locust risks through therapeutic and rehabilitative measures rather than surveillance and control of the pest.

In addition, non-intervention can address some of the challenges of desert locust management by bypassing surveillance and control to address livelihood recovery and environmental rehabilitation. The above perspective is supported by Showler *et al*. report that one of the desert locust management approaches could be letting outbreaks develop into upsurge, then build up to plague, and finally allow the pest to run the natural cycle to natural mortality [15]. This is because ecosystems have a natural means of balancing biodiversity by regulating the population of organisms.

Early intervention to desert locust outbreaks as a best practice. Early intervention can be implemented through physical and/or chemical control measures. Physical control was assessed based on traditional community-based methods to kill desert locusts and mechanical killing of the pest. 340 (43.7%) respondents considered physical control a suitable desert locust management best practice. This is because, by intuition, the first control strategy by subsistence farmers against any pest involves killing them using mechanical methods because these are readily available, cost-effective and have little inadvertent risks. A farmer in one of the counties explained: "We saw the locusts pushing their abdomen into the soil. Agriculture officers told us they were laying eggs. So, we decided to plough the entire area with Jembes to expose the eggs and prevent them from hatching, which worked".

"Jembe" is the Swahili word for Tilling hoe. The quote indicates that community members initiated control measures on their own. Besides physical control being a readily available option, it is also cheap. Physical control also reduces human security risks emanating from desert locusts. It also reduces the risk of unintended threats from interventions, especially the use of chemical pesticides. In addition, physical control would help address the human resource, technical, and financial challenges of desert locust management by using cheap and readily available knowledge and skills. Using affordable and readily available knowledge and skills builds resilience against human resource, technical and financial challenges. However, physical control measures can only be financially and technically feasible against small-scale infestations of desert locusts.

Chemical control was assessed based on the use of biological and synthetic pesticides. 570 (73.2%) and 473 (60.7%) respondents believed using biological and synthetic pesticides could be a desert locust management best practice. This can be associated with pesticides being agriculture's most commonly used pest control products. One locust expert reemphasised the primary role of chemical control, saying: "The only way to win the war against desert locusts is through chemical control. The rest are just good time stories that cannot pass the test of effectiveness".

The statement connotes that the use of pesticides in desert locust management is inevitable. The mention of other control options being "good time stories" meant that alternatives to pesticide application during desert locust management could be ineffective and thus worsen human security risks from the pest. The perception that pesticides form a core part of desert locust management acknowledges the human security risk the pest could cause if rapid control is not done.

Control of desert locusts depends highly on using pesticides because they are fast-acting and can reduce the pest population rapidly [17]. However, pesticides, especially synthetic chemicals, could adversely affect human security through poisoning and loss of biodiversity due to the death of non-target organisms. Biological pesticides are therefore recommended as a safer alternative [9]. Other than protecting human security from risks associated with desert locusts, biological pesticides can reduce unintended hazards that would come from the use of synthetic pesticides. However, biological pesticides are slow-acting, which can frustrate farmers who wish to see immediate results. Biological control options are also expensive and may not be readily available.

Integrated pest management in desert locust control as a best practice. The IPM strategy was assessed by constructs framed as applying many desert locust control methods in no particular order, using several but carefully combined approaches, and deploying several but carefully mixed methods to remedy any risk associated with the pest and subsequent control activities.

682 (87.5%) respondents considered systematic prioritisation of multiple approaches against all potential hazards (from the pest and control activities) as a preferred desert locust management best practice. There were also 673 (86.4%) and 375 (48.1%) respondents who agreed with several systematic approaches and ad hoc control measures against desert locust risks, respectively, as best practices.

During the national FGD, one participant explained the justification of IPM in desert locust management: "In-country breeding can be controlled through customised IPM approaches to reduce injection of synthetic pesticides into the environment. Cultural practices such as disrupting the breeding cycle by ploughing breeding sites, burning the pest, trapping hoppers using trenches, harvesting adults and converting them into food, feed and fertiliser could be practised. The second defence against invasion-country-breeding of desert locusts could be biopeptides such as *Metarhizium acridum* and predators such as birds and ants. Natural disruptive techniques such as using pheromones and insect growth regulators could also be used before using synthetic pesticides".

The statement recognises the existence of various pest control options that can be combined to reduce risks from desert locusts. The participant explained a systematic manner in which desert locust IPM can be deployed, starting with physical options, biological control and, as a choice of last resort, using chemical methods to control the pest. The quote also acknowledges that the detrimental effects of using synthetic pesticides are well known. Therefore, there should be careful selection and judicious use of chemical pesticides based on safety levels during the deployment of IPM programs.

The IPM strategy provides an opportunity to reduce human security risks emanating from desert locusts and unintended threats from interventions, especially synthetic pesticides. In addition, IPM addresses human resource, technical and financial challenges during desert locust management by initially using readily available knowledge and skills at a lower cost during physical control. The results corroborate the findings of the author [10] that the IPM strategy involved physical/cultural practices due to their availability and cost-effectiveness, followed by biological control and then judicious use of chemical pesticides. The support of IPM is attributable to the fact that respondents recognised the importance of deploying all possible, readily available, cost-effective, practical, efficient, and safe control measures to manage desert locusts.

CONCLUSIONS

The findings revealed that there were several possible desert locust management best practices. Despite non-intervention being the safest control method where desert locusts take a natural course of self-destruction, respondents perceived it as irresponsible. The study concludes that the IPM approach presents an opportunity to build resilience against human resource, technical and financial challenges. This can be achieved by progressively using readily available knowledge and skills during physical control before advancing to more sophisticated strategies, such as biological and chemical control options. The study recommends that scholars, policymakers and practitioners develop a customised IPM strategy for desert locust management in Kenya.

Authors' Contribution

GEB did the research work, including collecting data and drafting the article for his PhD program. AMS and GOO supervised the research study reviewed and edited the article.

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