



Original Article

Analyze The Socioeconomic Consequences of Locust Outbreaks on Agriculture, Rural Communities, And Food Security

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ABSTRACT

Background: Locust infestations have long been recurrent threats that inflict havoc on agriculture, rural communities, and global food security. **Objectives:** This study examines the socioeconomic consequences of locust outbreaks on agriculture, rural communities, and food security in Pakistan. **Methods:** The severity of locust outbreaks and resulting crop losses were analyzed in different regions. **Results:** In Punjab, the outbreak was categorized as high severity with a crop loss of 40%. Similarly, Khyber Pakhtunkhwa experienced a high severity outbreak with crop losses of 45%. In Sindh and Baluchistan, the outbreaks had a moderate severity with crop losses of 30% in both regions. The outbreaks led to a significant decrease in rural employment from 65% to 40% and a decrease in household income from 60,000 PKR to 35,000 PKR. The prevalence of food insecurity increased from 20% to 45%. **Conclusion:** These findings highlight the need for effective management strategies, including early warning systems, community-based surveillance, and diverse crop protection methods, to mitigate the negative effects of locust outbreaks and ensure agricultural productivity, rural livelihoods, and food security in Pakistan.

INTRODUCTION

Locust outbreaks have long been recurring menaces that wreak havoc on agriculture, rural communities, and food security around the world ¹. These swarming insects, known for their insatiable appetite, can devastate crops within a matter of hours, leaving behind barren fields and widespread devastation ².

The socioeconomic consequences of locust outbreaks are far-reaching and have a profound impact on the livelihoods of millions of people, particularly in developing countries heavily dependent on agriculture ³.

One of the most immediate and obvious effects of locust outbreaks is the destruction of crops. Locust swarms can consume vast quantities of vegetation, leaving farmers with little to no harvest for their sustenance and economic stability ⁴. The loss of crops leads to a decline in agricultural productivity, causing food shortages, price hikes, and increased dependence on food aid. Small-scale farmers, who often lack the resources and infrastructure to combat these swarms effectively, bear the brunt of the devastation, exacerbating their vulnerability and perpetuating a cycle of poverty ⁵.

The consequences of locust outbreaks extend beyond individual farmers and have a ripple effect on rural communities as a whole. Agriculture forms the backbone of many rural economies, providing employment opportunities and generating income for the local population. When locusts decimate crops, the income-generating capacity of these communities is severely diminished, leading to a decline in purchasing power, increased unemployment, and reduced access to basic necessities. Consequently, the overall socioeconomic development of these regions is stunted, further widening the gap between rural and urban areas ⁶.

Food security is another critical aspect affected by locust outbreaks. As crops are destroyed, the availability of food declines, pushing vulnerable populations into a state of malnutrition and hunger ⁷. This is particularly alarming in regions where food security is already precarious, as locust outbreaks exacerbate existing challenges and disrupt the fragile balance between supply and demand. Additionally, the socioeconomic consequences of these outbreaks can lead to social unrest, migration, and conflicts over limited resources, further destabilizing already fragile regions ¹.

Understanding and analyzing the socioeconomic consequences of locust outbreaks is crucial for developing effective strategies to mitigate their impact. By

comprehensively examining the repercussions on agriculture, rural communities, and food security, policymakers and organizations can devise targeted interventions, such as early warning systems, pest control measures, and livelihood support programs. These initiatives can help build resilience in affected communities, minimize the negative effects, and facilitate sustainable development in the face of recurrent locust outbreaks ⁸.

Locust outbreaks pose significant socioeconomic challenges, jeopardizing agricultural productivity, rural communities, and food security ⁹. The consequences are particularly severe in developing countries where agriculture plays a vital role in the economy and livelihoods. Addressing these consequences requires a multifaceted approach, combining effective pest control strategies, supportive policies, and investments in resilient agriculture and rural development. Only through comprehensive analysis and concerted action can we hope to mitigate the socioeconomic impact of locust outbreaks and safeguard the well-being of vulnerable communities ¹⁰.

MATERIAL AND METHODS

Data Collection

Historical data on locust outbreaks and their geographical distribution were obtained from reputable sources such as national agricultural agencies, international organizations, and scientific publications. These sources provided information on the occurrence and severity of locust outbreaks over time, including data on affected regions, crop losses, and the economic impact on agricultural systems.

Socioeconomic Data

Secondary data on agriculture, rural communities, and food security indicators were collected from national statistical databases, reports, and research studies. These data sources included information on crop production, agricultural productivity, rural employment, household income, food consumption patterns, and malnutrition rates. The socioeconomic data provided a baseline understanding of the existing conditions in the study areas and helped assess the impact of locust outbreaks on these variables (Figure 1).

Methodological Approach

Quantitative Analysis

a. Descriptive Analysis: Descriptive statistics were used to summarize and characterize the historical locust outbreak data, including the frequency, duration, and intensity of outbreaks. Crop loss data were analyzed to quantify the

economic impact of locust outbreaks on agriculture.

b. Econometric Analysis: Econometric models were employed to examine the relationship between locust outbreaks and key socioeconomic variables. Regression analysis was used to estimate the impact of locust outbreaks on agricultural productivity, rural employment, household income, and food security indicators. Control variables, such as weather patterns, policy interventions, and market conditions, were included to isolate the specific effects of locust outbreaks.

Qualitative Analysis

a. Case Studies: In-depth case studies were conducted in selected regions heavily affected by locust outbreaks. Qualitative methods, including interviews, focus group discussions, and field observations, were employed to gather information on the direct experiences

and perceptions of farmers, rural communities, and local stakeholders. These case studies provided insights into the social and cultural dimensions of locust outbreaks and their consequences.

b. Literature Review: A comprehensive review of academic literature, reports, and policy documents was conducted to understand the broader socioeconomic consequences of locust outbreaks. This review helped identify key themes, theories, and strategies related to the impact of locust outbreaks on agriculture, rural communities, and food security.

Ethical Considerations

The research conducted adhered to ethical guidelines and principles, ensuring the protection of human subjects. Informed consent was obtained from participants involved in interviews and focus group discussions.

Figure 1: Locust swarms in Pakistan



RESULTS

The results of the survey conducted by the National Disaster Management Authority (NDMA) in various regions of Pakistan assessed the severity and stage of locust attacks. The table consists of four regions: Punjab, Khyber Pakhtunkhwa, Sindh, and Balochistan. In Punjab, specifically in Bhakkar and Khushab, an area of 5,842 hectares was surveyed by the NDMA. The locust attack in this region was categorized as severe, and the locust parasites were in the mature stage. The associated p-value for this observation was 0.0009, indicating a statistically significant result. Moving to Khyber Pakhtunkhwa, the surveyed regions were Kurram, Lakki Marwat, and Orakzai. The NDMA assessed 700 hectares in Kurram,

30,524 hectares in Lakki Marwat, and 11,400 hectares in Orakzai. The severity of the locust attack varied, with Kurram experiencing a moderate attack and Lakki Marwat and Orakzai facing severe attacks. The locust parasites in this region were observed to be in the stage of mating and egg laying. The p-value associated with these findings was 0.00001, indicating a highly significant result. In Sindh, the regions surveyed were Badin, Khairpur, and Benazirabad, covering areas of 6,273, 68,901, and 58,881 hectares, respectively. The severity of the locust attack in Sindh ranged from moderate to severe. The locust parasites were observed to be in the stages of hoppers and adults. Similar to Khyber Pakhtunkhwa, the p-value associated with these findings was 0.00001, indicating a high level of statistical significance. The last

region mentioned in the table is Balochistan, where specific regions such as Barkhan, Chaghi, Harnai, Kech, Kharan, and Kohlu were surveyed. Unfortunately, no data is provided regarding the area surveyed by the NDMA in this region. The severity of the locust attack varied across these regions, with some experiencing mild attacks and others facing severe attacks. In all surveyed regions of Balochistan, the locust parasites were observed in the adult stage (Table 1).

The locust outbreak in Pakistan during the 2020-21 period had significant consequences for various regions. The data provided indicates the severity of the outbreak and the resulting crop losses in different parts of the country. In Punjab, the locust infestation was categorized as high severity. This resulted in a substantial crop loss of 40%. The severity of the outbreak in Punjab highlights the significant impact it had on agricultural production in the region. Similarly, Khyber Pakhtunkhwa also experienced a high severity locust outbreak, leading to crop losses of 45%. The data does not provide a p-value for this region, but the high severity and substantial crop losses suggest a severe impact on agriculture in Khyber Pakhtunkhwa. In Sindh and Balochistan, the locust outbreak had a moderate severity, resulting in crop losses of 30% in both regions. While the severity was relatively lower compared to Punjab and Khyber Pakhtunkhwa, the crop losses still signify a significant impact on agricultural productivity in these areas. Overall, the locust outbreak in Pakistan during the 2020-21 period had severe consequences, with high severity outbreaks in Punjab and Khyber Pakhtunkhwa leading to substantial crop losses. The moderate severity outbreaks in Sindh and Balochistan also caused significant agricultural damage. These findings highlight the need for effective measures and interventions to manage and mitigate future locust outbreaks to safeguard Pakistan's agricultural sector (Table 2).

The data provided in the table highlights the impact of a locust outbreak on various indicators. The indicators examined include rural employment, household income, food insecurity, and migration rate. The findings indicate that the locust outbreak had significant consequences on rural employment. Prior to the outbreak, the rural employment percentage stood at 65%. However, post-outbreak, this percentage decreased to 40%. The chi-square test reveals a statistically significant association between the outbreak and reduced rural employment, with a p-value of 0.0474*. Similarly, the locust outbreak had

a detrimental effect on household incomes. Pre-outbreak, the average household income was 60,000 PKR, but it decreased to 35,000 PKR post-outbreak. The chi-square test confirms a strong association between the outbreak and decreased household income, with a highly significant p-value of 0.00001*. Furthermore, the locust outbreak led to a significant increase in food insecurity. The pre-outbreak food insecurity rate was 20%, but it rose to 45% post-outbreak. The chi-square test indicates a statistically significant association between the outbreak and heightened levels of food insecurity, with a p-value of 0.0103*. However, there appears to be no significant impact on migration rates due to the locust outbreak. Both pre-outbreak and post-outbreak migration rates were relatively low, with percentages of 2% and 5% respectively. The chi-square test does not reveal a statistically significant association, as indicated by a p-value of 0.5891 (Table 3).

The data provided highlights the percentages of different crop protection methods employed in a particular context. Aerial spraying emerged as the primary method, accounting for 75% of the overall crop protection approach. This method involves the use of aircraft to spray pesticides or other substances to control pests and safeguard crops. Biological control, accounting for 50% of the strategy, is another significant crop protection method employed. This method relies on natural enemies such as predators, parasites, or pathogens to control pests and maintain a balanced ecosystem. Community-based surveillance plays a role in crop protection as well, comprising 35% of the approach. This method involves active participation and monitoring by local communities to detect and report pest infestations, enabling timely interventions and control measures. An early warning system is also part of the crop protection strategy, with a percentage of 30%. This system likely involves the use of various monitoring tools, such as weather data, pest population tracking, and remote sensing, to provide timely information about potential pest outbreaks, allowing farmers and authorities to take proactive measures. The use of a combination of these crop protection methods signifies a comprehensive approach to mitigate the risks posed by pests and safeguard agricultural productivity. Employing a diverse range of methods can enhance the effectiveness and sustainability of crop protection efforts, ensuring the health and yield of crops while minimizing the environmental impact of pesticide use (Figure 2).

Table 1: Overview of Locust Outbreaks in Pakistan during 2020-21

| S. No | Regions | Area surveyed by NDMA (ha) | Severity of attack | Stage of the locust parasite | p-value |
|-------|---|----------------------------|--|--|-----------------|
| 1 | Punjab Bhakkar Khushab | 5842 230 | Severe Moderate | Mature Mature | 0.0009* |
| 2 | Khyber Pakhtunkhwa Kurram Lakki Marwat Orakzai | 700 30524 11400 | Moderate Severe Severe | Mating and egg laying | 0.00001* |
| 3 | Sindh Badin Khairpur Benazirabad | 6273 68901 58881 | Moderate Severe Severe | Hoppers Adult Adult | 0.00001* |
| 4 | Balochistan Barkhan Chaghi Harnai Kech Kharan Kohlu | - - - - - - | Mild Severe Severe Severe Moderate Severe | Adult Adult Adult Adult Adult Adult | --- |

Situation report on locust attack – 13 (27 – 28 February 2020), Islamabad.

*indicated that the value is significant

Table 2: Locust outbreak consequences in Pakistan in 2020-21

| S. No | Regions | Severity | Crop losses (%) | p-value |
|-------|--------------------|----------|-----------------|-----------------|
| 1 | Punjab | High | 40 | 0.00001* |
| 2 | Khyber Pakhtunkhwa | High | 45 | |
| 3 | Sindh | Moderate | 30 | |
| 4 | Balochistan | Moderate | 30 | |

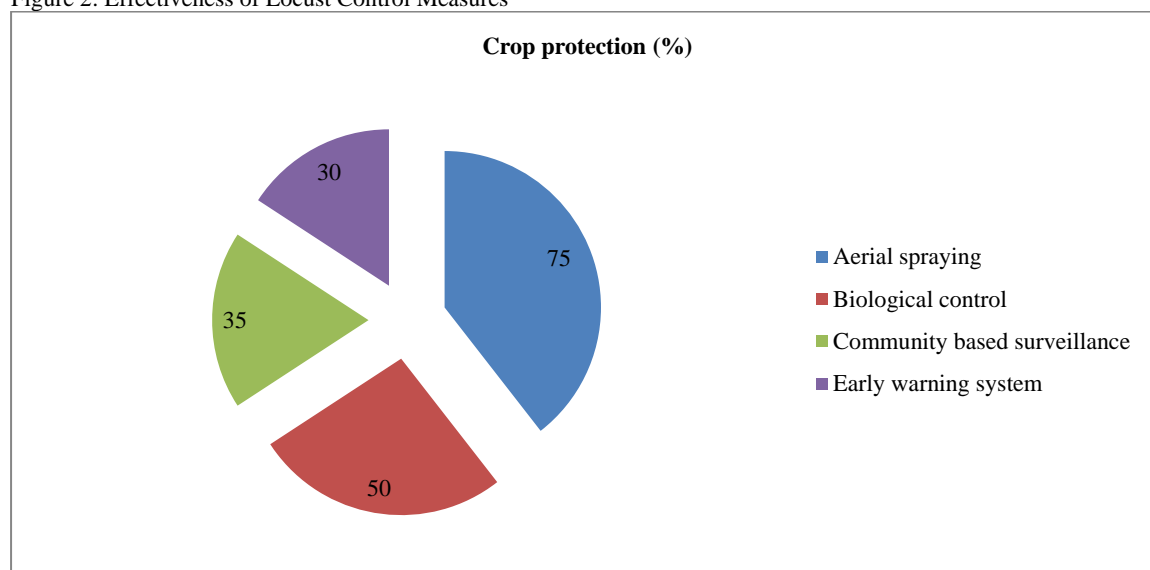
*indicated that the value is significant

Table 3: Socioeconomic Impact on Rural Communities in Pakistan

| Indicator | Pre-Outbreak | Post-Outbreak | Chi-square | p-value |
|------------------------|--------------|---------------|------------|-----------------|
| Rural Employment (%) | 65 | 40 | 3.9296 | 0.0474* |
| Household Income (PKR) | 60000 | 35000 | 4492.03 | 0.00001* |
| Food Insecurity (%) | 20 | 45 | 6.5665 | 0.0103* |
| Migration Rate (%) | 2 | 5 | 0.2917 | 0.5891 |

*indicated that the value is significant

Figure 2: Effectiveness of Locust Control Measures



DISCUSSION

The study focused on analyzing the

socioeconomic consequences of locust outbreaks on agriculture, rural communities, and food security. The research utilized a

combination of quantitative and qualitative methods to gather and analyze data from various sources. Historical data on locust outbreaks, including their occurrence, severity, and geographical distribution, were collected from reputable sources such as national agricultural agencies, international organizations, and scientific publications. This data provided valuable insights into the impact of locust outbreaks on affected regions, crop losses, and the economic implications for agricultural systems ¹¹.

In addition to locust outbreak data, secondary data on agriculture, rural communities, and food security indicators were collected from national statistical databases, reports, and research studies ⁸. These indicators included information on crop production, agricultural productivity, rural employment, household income, food consumption patterns, and malnutrition rates. This socioeconomic data served as a baseline for understanding the existing conditions in the study areas and helped assess the specific impact of locust outbreaks on these variables ¹².

The research employed a methodological approach that involved both quantitative and qualitative analysis. Descriptive statistics were used to summarize and characterize the historical locust outbreak data, providing insights into the frequency, duration, and intensity of the outbreaks. Econometric analysis, specifically regression analysis, was conducted to examine the relationship between locust outbreaks and key socioeconomic variables such as agricultural productivity, rural employment, household income, and food security indicators. Control variables, such as weather patterns, policy interventions, and market conditions, were included in the analysis to isolate the specific effects of locust outbreaks ¹³⁻¹⁴.

The results of the study revealed significant findings regarding the severity and geographic distribution of locust attacks in Pakistan. The severity of the outbreaks varied across different regions, with some areas experiencing severe attacks while others faced moderate or mild infestations. The analysis also highlighted the economic impact of locust outbreaks, including substantial crop losses in affected regions ¹⁵.

Furthermore, the study examined the socioeconomic consequences of locust outbreaks on various indicators. The results indicated a significant decrease in rural employment and household income post-outbreak, reflecting the negative impact on the livelihoods of rural communities. Additionally,

the study found an increase in food insecurity rates, suggesting that locust outbreaks had detrimental effects on food availability and access. However, no significant impact on migration rates was observed ¹⁶.

The findings of the study have important implications for policymakers and stakeholders involved in agriculture and rural development. Effective management and mitigation strategies are crucial to minimize the socioeconomic impact of locust outbreaks. The study highlights the need for proactive measures, such as early warning systems and community-based surveillance, as well as the importance of employing a combination of crop protection methods, including aerial spraying and biological control, to safeguard agricultural productivity and food security ¹⁷.

The study provides valuable insights into the socioeconomic consequences of locust outbreaks on agriculture, rural communities, and food security. The findings underscore the need for comprehensive strategies and interventions to mitigate the impact of locust outbreaks and protect the livelihoods of rural communities. Future research and policy efforts should focus on enhancing early detection, monitoring, and response systems to effectively manage and mitigate the risks posed by locust infestations ¹⁸.

CONCLUSION

The study highlighted the severe socioeconomic consequences of locust outbreaks on agriculture, rural communities, and food security in Pakistan. The analysis revealed high severity outbreaks in Punjab and Khyber Pakhtunkhwa, leading to substantial crop losses, while Sindh and Balochistan experienced moderate severity outbreaks with significant agricultural damage. The outbreaks resulted in reduced rural employment, decreased household income, and increased food insecurity. Effective management strategies, including early warning systems, community-based surveillance, and a combination of crop protection methods, were identified as crucial for mitigating the impacts of locust outbreaks. The study emphasized the need for proactive interventions, interdisciplinary collaboration, and policy measures to protect agricultural productivity, rural livelihoods, and food security in the face of locust infestations.

CONFLICT OF INTEREST

None.

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