

Indicative Effectiveness of Migratory Locust Control in Reducing Food Crop Damage in East Sumba, Indonesia

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Abstract

Purpose— This study analyzes the indicative effectiveness of migratory locust (*Locusta migratoria*) control in reducing food crop damage in East Sumba Regency during 2022-2023 and examines its implications for local food security and the agricultural economy.

Research Methodology— A descriptive-comparative approach was applied to technical administrative data from the East Sumba Agriculture and Food Office, with support from Statistics Indonesia and the East Nusa Tenggara Provincial Agriculture and Food Security Office. Analysis used tabulation, percentage comparisons, commodity-level damage assessment, monthly control patterns, and indicative production-loss estimates.

Results— Total crop damage declined from 3,337.00 ha in 2022 to 790.69 ha in 2023, a 76.30% reduction. Maize remained the most affected commodity, although damage decreased from 2,804.76 ha to 547.99 ha. In 2022, maize damage accounted for 33.12% of the harvested area, with an indicative potential production loss of 8,150.63 tons.

Research limitations/Implications—Early control, priority protection of maize, and integrated pest data systems are important for local food security policy.

Originality— The study combines technical locust-control records with production and regional economic data to evaluate pest-control outcomes beyond agronomic damage.

Keywords: Migratory Locusts; Crop Damage; Food Security; Agricultural Economy.

Paper type: Research Article

1. Introduction

Food security is a development issue directly related to food availability, household access to food, and the sustainability of agricultural production. The Sustainable Development Goals (SDGs), particularly Goal 2 on Zero Hunger, place the elimination of hunger, improvement of food security and nutrition, and promotion of sustainable agriculture among global development priorities (United Nations, 2015). In agrarian regions, disruptions to food production may arise from climate change, extreme weather, drought, and plant pests. These disruptions become more serious in areas whose economic structure remains highly dependent on agriculture.

One rapidly spreading threat to agricultural production is migratory locust infestation. Locust outbreaks can develop when environmental conditions support reproduction and vegetation availability, allowing populations to increase and damage crops within a short period. Peng *et al.*, (2020) showed that historical and contemporary locust outbreaks are associated with global warming, vegetation dynamics, and food-security risks. FAO, (2021) likewise emphasized that locust control requires monitoring systems, early detection, and rapid field response because infestations can suppress both food-crop and livestock-feed production.

East Sumba Regency is characterized by a strong dryland agricultural system in which maize and paddy have important roles as sources of food and farm income. Supporting data show that in 2022, the harvested maize area in East Sumba reached 8,468 ha, with



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production of 24,611 tons, while the harvested paddy area reached 14,602 ha, with production of 52,284 tons of GKG (Dinas Pertanian dan Ketahanan Pangan Provinsi Nusa Tenggara Timur, 2024). In 2023, paddy production was recorded at 62,877 tons of GKG from a harvested area of 15,711.13 ha, with a productivity of 40.02 quintals/ha (Badan Pusat Statistik Provinsi Nusa Tenggara Timur, 2025a). These food commodities indicate that locust-related damage can affect local food availability and the economic conditions of farming households.

Administrative records from the East Sumba Agriculture and Food Office show that crop damage caused by migratory locusts reached 3,337.00 ha in 2022 and declined to 790.69 ha in 2023 (Dinas Pertanian dan Pangan Kabupaten Sumba Timur, 2023a, 2023c). Economically, the Agriculture, Forestry, and Fisheries sector contributed 26.71% of East Sumba's GRDP in 2022 and 27.16% in 2023 (Badan Pusat Statistik Kabupaten Sumba Timur, 2024, 2025). Thus, locust damage is not merely a technical crop-production problem but also a risk to the local economic base.

Recent studies provide important insights into the broader consequences of locust outbreaks. Peng et al. (2020) linked locust dynamics to climate change, food security, and mitigation strategies. Barasa *et al.*, (2023) found that desert locust invasion in Uganda affected household food consumption, while De Groote et al. (2023) assessed the economic impact of locust infestation on farmers and pastoralists in Kenya. FAO (2021) further emphasized the importance of monitoring and timely control as essential elements in managing migratory pest outbreaks.

Nevertheless, the available studies primarily discuss locust outbreaks at broad international scales or assess socioeconomic effects in African settings, while locally grounded evidence that combines district-level technical control records with crop damage, food-production exposure, and regional economic indicators remains limited in the East Sumba context. The available East Sumba data are administrative and cover only two principal years, so they are insufficient for a full causal evaluation. They are, however, suitable for a descriptive-comparative assessment of whether the observed pattern is consistent with improved control outcomes.

Accordingly, this study asks three related questions: how did total and commodity-specific crop damage caused by migratory locusts change between 2022 and 2023; what temporal, spatial, and control patterns characterized the infestation; and what do these patterns imply for local food security and the agricultural economy? The study aims to compare crop damage in 2022 and 2023, identify the most affected commodities and locations, describe the pattern of control operations, estimate indicative production-loss risks, and formulate policy implications. Its originality lies in combining technical data from the East Sumba Agriculture and Food Office with supporting production and regional economic data to move the analysis beyond pest control alone toward local food security and the agricultural economy.

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature and explains the analytical framework. Section 3 describes the research method and data analysis. Section 4 presents the results and discussion, and Section 5 provides concluding remarks, policy recommendations, limitations, and directions for future research.

2. Review of Literature

2.1 Migratory Locust Outbreaks and Food-Production Risk

Migratory locusts are pests that can move rapidly and attack food crops over wide areas. Under certain conditions, locust populations may form large groups that damage crops, particularly when climate and vegetation are favorable. Peng *et al.*, (2020) explained that locust outbreaks are shaped by interactions among climate change, vegetation availability, population dynamics, and weaknesses in mitigation strategies. When such outbreaks occur in agricultural areas, they can disrupt production and increase the risk of food insecurity.

The implications of locust outbreaks therefore extend beyond biological crop damage. Food-security risk emerges when infestation reduces the production of locally important staples or affects the income of households that depend on farming. In dryland regions such as East Sumba, this risk is particularly relevant because maize and paddy are important components of the local food system and agricultural economy.

2.2. Socioeconomic Impacts of Locust Infestation

The socioeconomic consequences of locust infestation have been documented in several studies. Barasa *et al.*, (2023) found that desert locust invasion in Uganda affected household food consumption and highlighted the importance of effective control interventions. De Groote *et al.*, (2023) assessed the economic impact of the 2019-2021 desert locust infestation on farmers and pastoralists in Kenya. These studies reinforce the understanding that locust outbreaks are not solely plant-protection problems but are also issues of agricultural economics, food security, and household welfare.

For East Sumba, this perspective is relevant because damage to maize and paddy can potentially influence farm income, food availability, and the need for post-outbreak support. The importance of agriculture in the regional economy further strengthens the case for examining locust-control outcomes through both production and economic lenses.

2.3. Early Control, Monitoring, and Integrated Pest Data

Control of migratory pests requires rapid response, institutional coordination, and reliable data systems. FAO, (2021) emphasizes the importance of monitoring infestation locations, field reporting, and timely intervention. In the locust context, control during the nymph or instar phase is especially important because locust mobility is relatively limited compared with the adult stage. When control is delayed, populations can spread more widely, potentially increasing both control costs and the scale of crop damage.

This control logic provides the basis for examining the timing of East Sumba's infestation and control activities. Monthly damage patterns, the number of control points, the developmental phase of the locusts, and the commodities or districts affected can be used together to provide a descriptive picture of how control activities corresponded with changes in crop damage.

2.4. Analytical Framework and Research Expectation

The analytical framework of this study treats control effectiveness as indicative rather than causal. The central descriptive expectation is that improved control conditions should be accompanied by a smaller area of crop damage, particularly for the most exposed commodities, and by a temporal pattern in which control is undertaken before, during, and after the peak infestation period. This expectation is examined by comparing total damage, commodity shares, monthly damage, district-level concentration, control-point activity, and indicative production-loss estimates. Because the study uses a descriptive-comparative design based on two years of administrative data and does not employ an experimental design, a control group, a regression model, or an inferential statistical test, no formal statistical hypotheses are proposed. The literature is therefore used to guide interpretation rather than to support causal hypothesis testing.

3. Research Methodology

This study uses a descriptive-comparative approach with a simple evaluative orientation. Descriptive analysis is used to portray the area of crop damage, affected commodities, temporal patterns of damage, and migratory locust control operations. Comparative analysis is used to compare conditions in 2022 and 2023. The evaluative orientation is used to interpret the indication of control effectiveness from changes in damaged area, but it is not used to test statistical causality.

The study area is East Sumba Regency, East Nusa Tenggara Province. The principal analytical period is 2022-2023. The year 2022 is treated as the baseline because it recorded

a high level of crop damage, while 2023 serves as the comparison year after control operations became more directed. The main data were obtained from the East Sumba Agriculture and Food Office. Supporting data were obtained from Statistics Indonesia (BPS) of East Sumba Regency, Statistics Indonesia (BPS) of East Nusa Tenggara Province, and the East Nusa Tenggara Provincial Agriculture and Food Security Office.

The data include crop damage in 2022 by commodity, district, and damage category; crop damage in 2023, including affected area, crop-failure area, and control area in the T, P, and LP administrative format; daily and monthly migratory locust control records for 2022-2023; food-crop harvested area, productivity, and production; the number of maize-farming households reported in the 2023 Agricultural Census; and Agriculture, Forestry, and Fisheries GRDP data for 2022-2023.

Data analysis was conducted in Microsoft Excel using tabulation, pivot tables, charts for internal data checking, percentage comparisons, and indicative production-loss estimates. The percentage decline in damage was calculated by comparing 2022 and 2023 damaged areas relative to the 2022 baseline. Commodity shares were calculated as commodity damage divided by total damage. Damage exposure was calculated as damaged area divided by harvested area. Indicative potential production loss was estimated by multiplying the damaged area by crop productivity; productivity, reported in quintals per hectare, was converted to tons per hectare by dividing by 10. These estimates are indicative rather than realized final losses because actual damage intensity may differ across light, moderate, severe, and crop-failure categories.

Microsoft Excel was selected because the research design is descriptive and does not involve regression, causal tests, or time-series analysis. Statistical software such as Stata was therefore not required for the principal analysis, although it could be used as an additional tool for documentation and consistency checks.

The study has several limitations. The data cover only two principal years, no control group is available, and the administrative formats differ between 2022 and 2023. Accordingly, the findings should be interpreted as an indication of control effectiveness rather than as full causal evidence.

4. Results and Discussion

4.1 Research Result

Data from the East Sumba Agriculture and Food Office show that total crop damage caused by migratory locusts fell from 3,337.00 ha in 2022 to 790.69 ha in 2023. This represents a decline of 2,546.31 ha, or 76.30%. Descriptively, the change indicates a substantial reduction in crop damage in 2023, although climate, cropping patterns, vegetation, and locust population dynamics may also have influenced the observed change.

Table 1. Crop damage by commodity in East Sumba, 2022-2023

Commodity	Damage 2022 (ha)	Damage 2023 (ha)	Reduction (%)	Share 2022 (%)	Share 2023 (%)
Paddy	524.24	240.55	54.11	15.71	30.42
Maize	2,804.76	547.99	80.46	84.05	69.31
Groundnut	8.00	2.15	73.13	0.24	0.27
Total	3,337.00	790.69	76.30	100.00	100.00

Source: Dinas Pertanian dan Pangan Kabupaten Sumba Timur (2023a, 2023c), processed by the authors.

Maize was the most affected commodity in both years. In 2022, maize damage totaled 2,804.76 ha, accounting for 84.05% of the total. In 2023, maize damage declined to 547.99 ha but still represented the largest share, at 69.31%. The decline in maize damage was approximately 80.46%. Despite this improvement, maize remains a critical focus because the 2023 Agricultural Census recorded 17,144 maize-farming households in East Sumba (Badan Pusat Statistik Provinsi Nusa Tenggara Timur, 2025b). The risk therefore extends beyond production to household income and food security.

4.1.1 Monthly Pattern of Crop Damage in 2023

The 2023 infestation matrix shows that crop damage was concentrated at the beginning of the year. January recorded 453.95 ha of damage and February 334.94 ha. Damage in March was only 0.56 ha, while the July-December recap recorded no new damage. The pattern indicates that January-February was the most critical period and highlights the importance of early control before and during this window.

Table 2. Monthly pattern of crop damage in 2023

Month/period	Damage (ha)	Share of official total (%)	Note
January	453.95	57.41	Peak damage at the beginning of the year
February	334.94	42.36	Damage remained very high
March	0.56	0.07	Damage declined sharply
Administrative reconciliation difference	1.24	0.16	Requires validation between monthly and commodity totals
July-December	0.00	0.00	No new damage recorded in the recap
Official total	790.69	100.00	Official total crop damage in 2023

Source: Migratory locust infestation matrix for East Sumba Regency, 2023, processed by the authors.

The pattern underscores the practical importance of intervention while locusts are still in the nymphal (instar) stage, when their mobility is relatively limited compared with that of adults. If control is delayed until populations have spread widely, pesticide requirements, labor needs, and operational costs may increase.

4.1.2 Spatial Concentration of Damage in 2022

The 2022 data show that the largest areas of crop damage were concentrated in several districts. Kambata Mapambuhang and Haharu were the two most affected districts, with 521.26 ha and 506.60 ha, respectively. Together, they accounted for approximately 30.80% of total damage in 2022. This spatial concentration is useful for identifying priority areas for risk mapping and future control operations.

Table 3. Ten districts with the largest crop damage in 2022

Rank	District	Damage (ha)	Share of total (%)
1	Kambata Mapambuhang	521.26	15.62
2	Haharu	506.60	15.18
3	Kota Waingapu	271.33	8.13
4	Karera	270.20	8.10
5	Kanatang	247.80	7.43
6	Rindi	211.85	6.35
7	Wulla Waijelu	211.10	6.33
8	Lewa	199.60	5.98
9	Pandawai	160.63	4.81
10	Kambera	130.61	3.91

Source: Dinas Pertanian dan Pangan Kabupaten Sumba Timur (2023a), processed by the authors.

4.1.3 Migratory Locust Control Operations

Control operations were implemented by the Plant Protection Brigade of the East Sumba Agriculture and Food Office. The records show 23,990 control points in 2022 and 10,161 in 2023. The lower number of control points was accompanied by a decline in damaged area, which can be interpreted descriptively as indicating lower or more controlled infestation pressure in 2023 than in 2022.

In 2022, the largest number of control points occurred in April, May, July, and August. In 2023, relatively high control activity occurred in February, March, May, and July. This pattern indicates that control was not limited to the peak period of crop damage but

continued afterward to suppress locust populations. Technical records also report the use of pesticides such as Confidor 200 SL and Penalty 50 SC and control actions targeting both nymph/instar and adult phases (Dinas Pertanian dan Pangan Kabupaten Sumba Timur, 2023b).

Table 4. Number of migratory locust control points by month, 2022-2023

Month	Control points 2022	Control points 2023
January	2.540	1.280
February	1.690	1.970
March	1.790	1.430
April	3.780	510
May	3.020	1.630
June	0	990
July	2.990	1.210
August	2.580	680
September	0	431
October	2.330	30
November	2.080	0
December	1.190	0
Total	23.990	10.161

Source: Migratory locust control-operation records of Dinas Pertanian dan Pangan Kabupaten Sumba Timur (2023b), processed by the authors. Months absent from the recap are recorded as 0.

4.1.4 Implications for Local Food Security

Supporting production data were used to assess the extent of locust damage relative to East Sumba's food production capacity. In 2022, maize damage totaled 2,804.76 ha, equivalent to 33.12% of the harvested maize area. This was substantially larger than paddy damage, which was equivalent to 3.59% of the harvested paddy area. The maize exposure indicates that locust infestation posed a particularly important risk to a strategic local food crop.

Table 5. Food-crop production and locust damage exposure in 2022

Commodity	Harvested area (ha)	Productivity (q/ha)	Production (tons)	Damage (ha)	Damage / harvested area (%)
Paddy	14.602	35.81	52.284	524.24	3.59
Maize	8.468	29.06	24.611	2.804.76	33.12
Groundnut	54	9.26	50	8.00	14.81

Source: Dinas Pertanian dan Ketahanan Pangan Provinsi Nusa Tenggara Timur (2024) and Dinas Pertanian dan Pangan Kabupaten Sumba Timur (2023a), processed by the authors.

Damage affecting approximately one-third of the harvested maize area in 2022 demonstrates the relevance of migratory locusts to local food security. Maize functions as a local staple, a household consumption commodity, and a source of farm income. Protecting maize therefore also means protecting the food base of dryland farming households.

4.1.5 Indicative Potential Production Loss

Indicative potential production loss was estimated by multiplying damaged area by crop productivity. This calculation does not represent final realized loss because the intensity of damage varies across light, moderate, severe, and crop-failure categories. It is nevertheless useful for illustrating the scale of production risk associated with locust infestation.

In 2022, the indicative potential loss of maize production reached approximately 8,150.63 tons, much higher than the estimated paddy loss of 1,877.30 tons of GKG. In 2023, the indicative paddy loss was 962.68 tons of GKG. If 2022 maize productivity is used as a temporary proxy, maize damage in 2023 indicates a potential loss of approximately 1,592.46 tons. The 2023 maize figure should be updated if confirmed current year productivity data become available.

Table 6. Indicative potential production loss, 2022-2023

Year	Commodity	Damage (ha)	Productivity (tons/ha)	Potential loss (tons)	Note
2022	Paddy	524.24	3.581	1,877.30	Based on 2022 productivity
2022	Maize	2.804.76	2.906	8.150.63	Based on 2022 productivity
2022	Groundnut	8.00	0.926	7.41	Based on 2022 productivity
2023	Paddy	240.55	4.002	962.68	Uses BPS paddy productivity for 2023
2023	Maize	547.99	2.906	1.592.46	Indicative; uses 2022 maize productivity and requires validation
2023	Groundnut	2.15	0.926	1.99	Indicative; uses 2022 groundnut productivity and requires validation

Source: Processed from data from Dinas Pertanian dan Pangan Kabupaten Sumba Timur, BPS Provinsi Nusa Tenggara Timur, and Dinas Pertanian dan Ketahanan Pangan Provinsi Nusa Tenggara Timur.

4.1.6 Implications for the Local Economy

The economic significance of migratory locust damage can also be understood in light of agriculture's share in East Sumba's GRDP structure. The Agriculture, Forestry, and Fisheries sector contributed 26.71% of GRDP in 2022 and 27.16% in 2023. Its nominal value increased from IDR 1,822.92 billion in 2022 to IDR 1,990.14 billion in 2023. Although the agricultural sector continued to grow, locust-related crop damage remained a risk to farm income and the stability of local food production.

Table 7. Agriculture, Forestry, and Fisheries GRDP in East Sumba, 2022-2023

Year	Current-price GRDP (IDR billion)	Constant 2010-price GRDP (IDR billion)	Contribution to GRDP (%)	Real growth (%)
2022	1,822.92	966.15	26.71	4.40
2023	1,990.14	1,004.52	27.16	3.85

Source: Badan Pusat Statistik Kabupaten Sumba Timur (2024, 2025), processed by the authors.

The size of the agricultural sector shows that locust control is also part of protecting the local economy. When damage affects maize and paddy, the consequences may include production losses, lower farm income, increased demand for seed assistance, and disruption to household food consumption. Pest-control policy should therefore be connected with policies for post-outbreak farm recovery.

4.2 Discussion

The results indicate a strong descriptive signal of improved migratory locust control outcomes in East Sumba. Total crop damage declined by 76.30%, maize damage declined by 80.46%, and damage to paddy and groundnut also decreased. This pattern is consistent with the literature emphasizing rapid response, monitoring, and early control of migratory pests (FAO, 2021; Peng et al., 2020). However, the finding should not be interpreted as proof that control activities alone caused the decline, because the study does not isolate other influences such as rainfall, vegetation, cropping patterns, and locust population dynamics.

The temporal pattern strengthens the practical relevance of early intervention. Most recorded damage in 2023 occurred in January and February, while later periods showed

very limited or no new damage in the available recap. At the same time, control operations continued beyond the peak damage period. This suggests the importance of preparedness before the early-year outbreak window, including field surveillance, reporting, equipment readiness, pesticide availability, and intervention during the nymph or instar phase when locust movement is more limited.

From a food-security perspective, maize is the principal point of vulnerability. In 2022, the damaged maize area accounted for 33.12% of the harvested maize area, and the indicative potential production loss was approximately 8,150.63 tons. This finding is consistent with (Barasa *et al.*, 2023; De Groote *et al.*, 2023), which show that locust outbreaks can affect household food consumption and economic welfare in agrarian communities. In East Sumba, the importance of maize to dryland households means that locust control should be understood as both a plant-protection measure and a local food-security intervention.

The spatial concentration of damage also has policy relevance. Kambata Mapambuhang and Haharu together accounted for about 30.80% of the total damage in 2022, while several other districts also recorded substantial areas affected. Combining historical damage records with control locations can therefore support a district- or village-level risk map and help prioritize surveillance and resource allocation. The same logic applies to data management: a standardized system that links affected area, crop failure, control area, locust phase, pesticide use, location, and commodity would improve the quality of future evaluations.

Finally, the economic context reinforces the importance of pest control. Agriculture, Forestry, and Fisheries accounted for approximately 26-27% of East Sumba's GRDP in 2022-2023. Damage to food crops can therefore have implications for farm income, local production stability, and recovery needs. The study's contribution is to connect technical pest-control records with food-production and regional-economic indicators, thereby providing a broader basis for local policy even though causal effects cannot be established with the available data.

5. Concluding Remarks and Recommendation

This study examined the indicative effectiveness of migratory locust control in reducing food-crop damage in East Sumba Regency during 2022-2023 using a descriptive-comparative approach. The analysis shows that total crop damage declined from 3,337.00 ha in 2022 to 790.69 ha in 2023, a decrease of 76.30%. Maize remained the most affected commodity, although its damaged area fell from 2,804.76 ha to 547.99 ha. Damage in 2023 was concentrated in January and February, emphasizing the importance of early-year preparedness. In 2022, maize damage accounted for 33.12% of the harvested maize area and corresponded to an indicative potential production loss of about 8,150.63 tons.

The findings have practical and policy implications for East Sumba. Local government should strengthen early control during the nymph or instar phase, establish a January-March vigilance calendar, prioritize protection of maize and paddy, prepare district- and village-level risk maps, standardize integrated infestation and control data, and ensure the availability of pesticides, spraying equipment, protective equipment, transportation, and operational resources before peak infestation periods. Post-outbreak support should also include seed assistance, food support where required, and production recovery for areas experiencing severe damage or crop failure. Collaboration among local government, extension officers, farmers, and universities can strengthen monitoring, education, and evaluation.

The study is limited by its two-year coverage, the absence of a control group, and differences in administrative data formats between 2022 and 2023. The results should therefore be understood as an indication of effectiveness rather than as full causal evidence. Future research should use longer time-series data and finer spatial information, including village-level records, geographic coordinates, rainfall, temperature, and vegetation indicators. Household surveys are also needed to measure direct effects on income, food consumption, and adaptation strategies. If comparable controlled and non-

controlled areas become available, future studies may apply difference-in-differences or other causal approaches, together with cost-benefit analysis comparing control expenditures with the value of production losses potentially avoided.

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CONFLICTS OF INTEREST

The author declares no conflict of interest.

DECLARATION OF GENERATIVE AI STATEMENT

During the preparation of this work, the author used generative artificial intelligence tools to support the scientific writing process. Grammarly was used to check grammar, refine writing style, and improve clarity in scientific writing. All interpretations, analyses, and conclusions presented in this study are the sole responsibility of the author.

AUTHOR'S CONTRIBUTION

JFS: Writing-Original Draft, Corresponding Author, Revision. **MPJG:** Methodology. **AEL:** Investigation, Writing Review, and Editing. **MADDB:** Data Curation, Validation. **SL:** Visualization, Validation, Resource & Editing. **EML:** Supervision, Formal analysis.

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