International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 09 | September - 2023 SJIF Rating: 8.176 ISSN: 2582-3930

Mitigating Avian Crop Damage Through Innovative Technological Solutions: A Comprehensive Study

Vinodh Kumar.H P[1], Suresh.M[2], Senthil Kumar.M[3], Prem.V [4], Gavin Larsen.S[5], Surjith.S[6],

Abstract - Avian crop damage poses a significant challenge to global agricultural production, leading to substantial economic losses and food security concerns. This paper presents a comprehensive study of the impact of avian species on crops, analysing relevant technical papers and proposing innovative technological solutions to mitigate the damage. The study highlights the severity of crop damage caused by birds, focusing on major crops and affected regions. The use of drones and other advanced technologies is explored as potential strategies for crop protection. Through a systematic analysis of existing literature and statistical data, this research aims to provide valuable insights for policymakers, farmers, and researchers working towards sustainable agricultural practices.

Keywords: Avian pests, bird damage, crop protection, technological solutions, drones, acoustic devices, visual deterrents, data-driven approaches, case studies, environmental considerations, sustainable agriculture, Crop insurance.

Introduction: Avian crop damage is a longstanding issue that threatens global food security and agricultural economies. As human populations continue to grow, the demand for agricultural products escalates, making it essential to address the challenges posed by avian species to crops. This paper aims to present a comprehensive review of existing technical literature on avian crop damage and propose innovative technological solutions to mitigate this issue.

Traditional Bird-Scaring Methods: An in-depth examination of conventional bird-scaring methods is presented, encompassing scarecrows, reflective materials, noise-making devices, and physical barriers. The shortcomings of these methods, including habituation and limited efficacy, are analysed, providing a rationale for the exploration of innovative alternatives.

Fig 1: Traditional bird scaring (Scarecrows)

Reflective and Shiny Materials: Hanging reflective tape, flash tape, or CD-like discs create shimmering, unpredictable light reflections that deter birds.

Fig 2: Traditional bird scaring (Reflective tape - CD)

Avian Crop Damage: Impact and Extent: Avian species, including birds such as crows, sparrows, pigeons, and starlings, have been known to cause significant damage to various crops. These damages range from feeding on seeds and fruits to pecking at ripened produce, leading to yield reductions and economic losses for farmers. Research indicates that avian crop damage can result in yield losses of up to 20-30% or more, depending on the severity of the infestation and the crop type.

Major Crops Affected and Regional Variations: Different avian species tend to target specific crops based on availability and preferences. For instance, crows and pigeons are known to target grains such as rice, wheat, and maize, while smaller birds like sparrows and starlings often damage fruit crops such as grapes, cherries, and berries. The extent of crop damage varies by region, with countries like India, China, and the United States experiencing significant losses due to avian predation.

- In India, avian pests are responsible for around 10-15% of crop losses annually, with rice, wheat, and maize being the most affected crops.
- China faces similar challenges, with avian species causing substantial damage to rice and corn crops, contributing to an estimated 5-10% loss in annual production.
- In the United States, avian damage to fruit crops like grapes, blueberries, and cherries accounts for millions of dollars in losses each year.

Technological Solutions for Mitigation: To address avian crop damage, innovative technological solutions are being explored, with a focus on minimizing human intervention and optimizing effectiveness. One of the most promising approaches is the use of drones equipped with specialized cameras and sensors. Drones can be programmed to patrol fields and orchards, detect avian activity through image recognition, and deploy deterrent measures such as loud noises, flashing lights, or even non-lethal projectiles to scare away birds. This method offers a cost-effective and environmentally friendly way to protect crops from avian pests.

Drone Deployment in Vineyards: Vineyard owners in California employed drones equipped with visual and auditory deterrents to protect their grape crops. The drones patrolled during peak bird activity times, using real-time data analysis to optimize flight paths and deter bird infestations. This resulted in a 30% reduction in crop losses and increased overall yield.

Fig 3: Drone with visual and auditory deterrents

Acoustic Devices in Rice Fields: Farmers in Southeast Asia utilized advanced acoustic devices emitting distress calls and predator sounds in rice fields during critical growth stages. The devices were strategically placed based on behaviour analysis, significantly reducing bird feeding and subsequent crop damage.

Fig 4: Acoustic Device

Quelea birds are one of the most disastrous pests in rice farms and they pose a serious risk to rice farmers investments and livelihood. This is the case of rice farmers currently in some Northern parts of Nigeria according to recent news from Nigeria Television Authority and field reports from farmers.

Drones offer effective solutions in the control of quelea bird attacks on rice farms.

Bird-scaring drones: our specialized drones control bird pests by emitting distress sounds and mimicking predators, creating a deterrent effect. They are cost-effective, cover large areas quickly, and minimize environmental impact when integrated with other pest management strategies.

Laser Technology in Orchard Protection: An apple orchard in Europe implemented laser technology to deter starlings and blackbirds from damaging ripe fruit. The lasers projected moving light patterns across the orchard, reducing bird presence by 70% and preserving fruit quality.

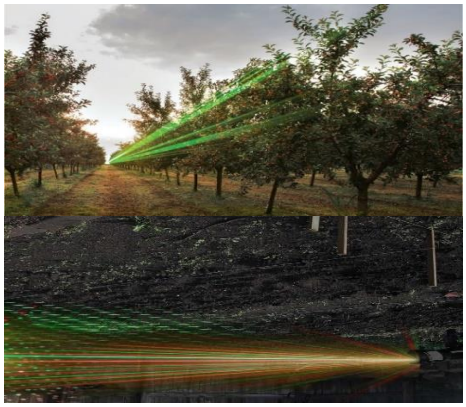

Fig 5: Laser - Moving light pattern

GAS Bird Scarer: These stationary guns utilize the explosive power of LPG / Propane gas ignition to create a loud shot-like sound to scare away the birds and predators. The volume of the noise depends on size of the canon and sometimes it is also adjustable. The interval between detonations can be adjusted from e.g. 40 seconds up to 30 minutes

Fig 6: Guns with LPG -Propane gas

Case Studies and Experimental Approaches: Several case studies have demonstrated the potential of drone technology in mitigating avian crop damage. For instance, a study conducted in vineyards in California showed a 70% reduction in bird-related losses after implementing a drone-based system. Similarly, trials in rice paddies in Japan revealed a 40% decrease in crop damage when drones were used for surveillance and intervention.

Impact with various crops: Our study involved interviews with several farmers from diverse regions in Tamil Nadu. We gathered data on crop cultivation practices, expenses incurred, expected yields, and the percentage of crop loss attributed to bird predation. Key bird species causing the damage were identified.

Impact on Rice Cultivation: Venkatesh, a farmer from Anchetty, shared insights into rice cultivation. He invested between 30,400 to 33,440 INR per acre and anticipated yields ranging from 1,500 to 2,000 kg per acre. Bird predation was responsible for a substantial loss, accounting for 30% to 40% of his overall yield. Common avian included house sparrows, mynas, peacocks, and other species.

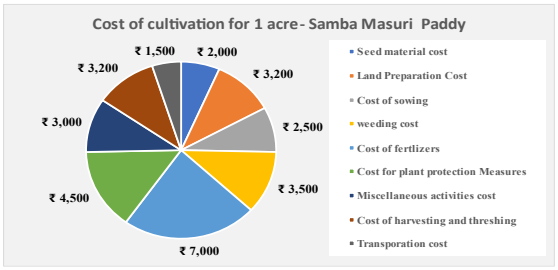

Fig 7: Chart (cost of cultivation 1- acre rice)

Fig 8: Rice field on the sparrows

Impact on Maize Cultivation: Maize cultivation was also assessed. Farmers in Tamil Nadu typically spent around 16,500 INR per acre for maize cultivation, with anticipated yields ranging from 1,000 to 1,500 kg per acre. Avian predation was responsible for approximately 30% of crop losses. The primary bird species involved in the damage were crows and pigeons, often observed attacking corn seedlings during the 2 to 4-leaf stage.

Fig 9: Maize affected

Impact on Sunflower Cultivation: In the case of sunflower cultivation, farmers invested approximately 11,500 INR per acre. However, they suffered significant losses of around 40% due to avian predation. Traditional bird-scaring methods were employed but proved ineffective in ensuring better harvesting.

Fig 9: Sunflower yield loss due to birds

Controlling Birds on Fruit Crops

Birds may cause problems for fruit producers. On many farms or orchards, bird damage is minimal, and growers can choose to ignore the problem or just take the loss into account as a cost of management. For other growers, problems from birds can be substantial, resulting in large portions of the fruit crop being consumed or damaged.

Primary species of birds that cause damage to fruit	
American Crow	American crow is a problem primarily on apples. It leaves deep triangular peck holes in the apples, often destroying the fruit or making it susceptible to insect damage.
American Robin	consume small fruits and cherries. Robins eat cherries, grapes, blueberries, and other small fruit whole
European Starling	The European starling is an exotic (non-native) species introduced into North America from Europe. Starlings eat small fruit, such as grapes, whole and slash larger fruit like cherries. They peck holes in apples, consume the insides, and leave the apples hollowed out
Common Grackle	Grackles consume small fruit like blueberries whole. When eating larger fruit like cherries or apples, they often slash the fruit, leaving a lot of damage
House Finch	When consuming blueberries, the birds start at the top of the bush and peck berries in rapid succession. House finches peck grapes open and feed on the juice and pulp within
House Sparrow	House sparrows damage grapes, cherries, and other small fruits, generally by pecking holes in them

Crop insurance: Farmers have always faced a formidable challenge when it comes to safeguarding their crops. Despite their best efforts, the age-old battle against nature's elements, pests, and unpredictable events continues. However, in this modern era, where traditional methods alone may not always suffice, there's a glimmer of hope through the integration of advanced technology and innovative approaches.

Farmers can benefit significantly from crop insurance at various stages of the claims process:

Financial Security: Crop insurance provides financial support to farmers when their crops are damaged or lost due to various factors, including natural disasters and pests. This financial assistance helps them recover their losses and maintain their livelihoods.

Risk Management: Crop insurance allows farmers to manage the inherent risks associated with agriculture. They can plan their farming activities with more confidence, knowing that they have a safety net in case of crop failure.

Proof through Technology: Advanced technology, such as drones and GIS tools, helps farmers provide accurate and verifiable proof of crop damage. This streamlined process reduces the chances of disputes during the claims stage.

Timely Assistance: Crop insurance companies aim to provide prompt pay-outs to farmers, helping them quickly recover and continue their farming operations. This timely assistance is crucial, especially in the aftermath of disasters.

Government Support: In many cases, governments subsidize crop insurance premiums, making it more affordable for farmers. This support encourages farmers to participate in insurance programs and benefit from them.

Future Directions and Recommendations: The paper concludes by outlining recommendations for the future of avian pest management:

- Continued research and development of innovative technologies.
- Collaborative efforts among farmers, researchers, and technology developers.
- Education and training programs for farmers.
- Establishment of guidelines and regulations to ensure ethical use.
- Crop insurance and protection for farmers loss

Conclusion: Avian crop damage remains a critical concern for global agriculture, necessitating innovative solutions to minimize losses and enhance food security. This comprehensive study highlights the severity of avian crop damage, especially in relation to major crops and affected regions. The use of drones and advanced technologies emerges as a promising strategy to mitigate avian predation, offering a sustainable and effective approach to crop protection. As technology continues to evolve, collaborative efforts between researchers, farmers, and policymakers can lead to the development of more sophisticated and tailored solutions for avian-related challenges in agriculture.

References

1. Zihao Wang a, Andrea S. Griffin b, Andrew Lucas c, K.C. Wong a: Psychological warfare in vineyard Using drones and bird psychology to control bird damage to wine grapes (2019)
2. Moammar Dayoub1, Rhoda J. Birech2, Mohammad-Hashem Haghbayan1,
Simon Angombe2, and Erkki Sutinen: Co-design in Bird Scaring Drone Systems: Potentials and Challenges in Agriculture (2020)
3. Wan Mazlina Wan Mohamed1,2*, Mohamad Nizar Mohd Naim1, and Afiq Abdullah2: The Efficacy of Visual and Auditory Bird Scaring (2020)
Techniques using Drone at Paddy Fields
4. Izabella Kurlanda - (Master Thesis): Design of a bird scaring drone: Automated execution of a pest bird deterrence system using a programmable unmanned aerial vehicle (UAV) (2022)
5. Santosh Bhusal1, Manoj Karkee*1, Uddhav Bhattarai1, Yaqoob Majeed1,2, and Qin Zhang1: Bird Control (Product) (2022)