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Sorghum Cluster INITIATIVE

Progress Report

SORGHUM CLUSTER INITIATIVE

ALTERNATIVE QUELEA CONTROL METHODS

JUNE 2024

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ALTERNATIVE QUELEA CONTROL METHODS

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1. INTRODUCTION AND BACKGROUND

The red-billed quelea (Quelea quelea) is a small weaverbird native to Africa. It is the most numerous bird species in the world, with an estimated population of over 1.5 billion birds. Quelea birds are a major agricultural pest and can cause significant damage to crops such as sorghum, millet, and rice. Quelea birds (*Quelea quelea*) are highly destructive pests that pose a significant threat to agricultural crops, particularly Sorghum, in regions such as Mpumalanga and Limpopo in South Africa. Their large flocks can cause substantial damage, resulting in substantial economic losses for farmers and impacting food security in the affected regions.

Traditionally, quelea birds have been controlled using pesticides, such as fenthion. However, the use of pesticides is often environmentally harmful, and can also be dangerous to human health, other methods such as scarecrows and noise-making devices, have proven to be ineffective in deterring Quelea birds due to their adaptive behaviour. Therefore, there is a need for innovative and sustainable approaches to manage these pest populations. In recent years, there has been increasing interest in developing alternative methods of quelea control, such as the use of repellents and drones.

The project aims to develop Biological repellents specifically designed to deter Quelea birds from Sorghum crops which are non-toxic and complies with food safety standards. These repellents will be formulated based on an understanding of the birds' behaviour, sensory responses, and foraging patterns. Additionally, the project will explore the use of drones equipped with advanced sensors and software to detect and monitor Quelea bird populations as well as to monitor the effectiveness of repellents by means of imagery and change detection.

By combining the development of effective biological repellents and the use of drone technology, the project seeks to provide an integrated solution for Quelea bird control.

This approach has the potential to reduce crop losses, enhance agricultural productivity, and promote sustainable farming practices.

The project will be conducted in collaboration with key stakeholders, including farmers, researchers, technology experts, and government agencies. It aims to leverage their expertise, resources, and knowledge to develop practical and scalable solutions.

Through this project, the goal is to contribute to the agricultural sector's sustainability, support local communities, and address the challenges posed by Quelea bird infestations. By developing innovative and environmentally friendly solutions, the project seeks to enhance food security, protect farmers' livelihoods, and promote the economic growth of the regions affected by Quelea bird populations.

Overall, this project holds great promise in mitigating the impact of Quelea birds on Sorghum crops and providing a sustainable alternative for bird control in agriculture.

2. PROJECT OVERVIEW

Aims

The project aims to develop effective Quelea bird repellents and utilize drone technology for monitoring their behaviour and the efficacy of repellent strategies. The devastating impact of Quelea birds (Quelea quelea) on agricultural crops, particularly sorghum, necessitates the development of targeted and sustainable solutions to mitigate their damage. By combining the development of repellents with drone-based monitoring, this project seeks to provide an integrated approach for effective Quelea bird management.

Objectives

a. Biological Repellent Development:

- Identify potential Quelea bird repellent compounds, both natural and synthetic, through literature review and initial screening.
- Conduct laboratory experiments to evaluate the efficacy of repellent compounds in deterring Quelea birds.
- Optimize the concentration and formulation of effective repellent compounds to maximize their efficacy and practicality.
- Assess the safety and environmental impact of the developed repellents.

b. Drone-Based Monitoring System:

- Identify suitable drone platforms and sensors for monitoring Quelea bird

behaviour and crop damage.

- Develop image processing algorithms and machine learning models for automated Quelea bird detection and tracking using drone imagery.
- Integrate real-time data acquisition and processing capabilities into the drone-based monitoring system.
- Ensure the system's usability, reliability, and ease of operation for field deployment.

c. Field Trials and Validation:

- Conduct field trials to evaluate the effectiveness of the developed repellents in deterring Quelea birds from sorghum crops.
- Deploy drones equipped with the monitoring system to collect high-resolution aerial imagery of sorghum fields.
- Analyze the drone imagery to monitor Quelea bird infestation patterns, feeding behaviours, and crop damage.
- Correlate the data from repellent application, drone monitoring, and crop damage assessments to validate the effectiveness of repellents.

d. Data Analysis and Integration:

- Analyze the drone imagery data, including Quelea bird density, distribution, and behaviour, using image processing techniques and machine learning algorithms.
- Integrate drone monitoring data with field observations, weather data, and repellent application records for comprehensive analysis.
- Identify patterns, trends, and correlations between Quelea bird behaviour, crop damage, and repellent effectiveness to optimize future management strategies.

e. Knowledge Dissemination and Recommendations:

- Communicate project findings, including repellent development, drone monitoring techniques, and data analysis outcomes, to farmers, researchers, and agricultural stakeholders.
- Provide practical recommendations and guidelines for the application of repellents and drone-based monitoring in Quelea bird management.
- Facilitate knowledge transfer and promote the adoption of effective strategies among farmers and relevant stakeholders.

3. DELIVERABLES

The project is expected to produce several outputs, including:

- A repellent that is effective in deterring quelea birds from feeding on crops.
- A Drone solution that is effective in monitoring and control of Quelea.
- A training program for farmers on how to use the repellent, estimated 100 farmers trained.
- A communication plan to raise awareness of the repellent among farmers and other stakeholders.

A technology transfer strategy will be developed to ensure that the repellent is widely available to farmers. The strategy will include a training program for farmers on how to use the repellent. The project team will also work with private sector companies to develop a distribution plan for the repellent. In collaboration with DALRRD cost effective drone technologies will be developed for community-based control.

The project team will work with a variety of stakeholders to ensure that the training program is accessible to all farmers, including women, youth, and people from previously disadvantaged communities. The project team will measure the impact of the project on transformation by tracking the following metrics:

- The number of direct local beneficiaries of the project.
- The demographics of the direct local beneficiaries of the project.
- The number of women, youth, and people from previously disadvantaged communities who are trained in the use of the repellent.

The project is expected to have several positive outcomes, including:

- Reduced crop losses due to quelea birds.
- Increased food security.
- Improved livelihoods for farmers.
- Increased transformation in the agricultural sector.
- Creation of jobs in the agricultural sector.
- Development of new technologies for controlling quelea birds.

The project team will work with private sector companies (Winfield United and Cropsystems) to establish a distribution channel for the repellent. The team will also develop a monitoring and evaluation plan to track the progress of the project and assess its impact.

4. PROGRESS

Deliverables	Brief Updates
Identify and test effective, environmentally friendly alternative control methods for Quelea birds to significantly reduce damage to sorghum.	Based on our research findings there are 4 potential candidates for repellents for which 3 are natural products and none of these have been registered elsewhere in the world. There are currently 2 registered products in South Africa as bird repellents, however there are other products sold under their own branding with the same active ingredients. A 1ha Sorghum crop (Mr Buster) has been planted just outside Komatipoort, 2 products have been chosen to test the current registered repellents once the crop reaches the correct age. Planting was done with Control blocks, Product A and Product B, during the first week of May bird activity started and repellents were applied, and activity monitored.
Enhanced understanding of Quelea bird behaviour and their interaction with sorghum crops through drone imagery analysis.	A ground-based weather station has been placed at the above crop to incorporate climate monitoring and a forecasting model to predict possible Quelea activity. Following CAA (Civil Aviation Authority) registration, rules, and guidelines 2 drone types will be used for the field trials, one being a multispectral and the other a thermal drone. Test flights are being conducted and sample imagery collected weekly, this while the crop is still growing, this allows for calibration testing as well as processing evaluations. During the field trails the multispectral drone will collect weekly images of the crop growth stage and point out any stresses, ground truthing will allow us to visit stressed areas in the field and collect data. Evaluations of processing software packages is ongoing. The thermal collect crop data, bird monitoring in the field as well as Quelea roosting sites for size estimations, during July and August our team will accompany DALRRD to roosting sites at commercial crops for evaluations.

The table below shows the overarching objective, deliverable and ABIPP KPI for the Sorghum Cluster initiative over a **five-year period**.

Objectives	Deliverables	ABIPP KPI
To test alternative quelea control methods	- Cost-effective, environmentally friendly alternative quelea control methods.	- Number of proactive interventions for diagnostics, surveillance, monitoring and early warning systems supported (1)

5. DETAILED PROGRESS

(Do note that the data / graphs are still preliminary based on findings, actual data and graphs will be displayed in the final report)

Multispectral Drone Flights:

First three test fights on ABIPP were done on the 6th of March 2024, the hights that was flown were 100m, 81m and 19m. The team concluded after the processing was done that, we fly at 19m high. The reason why we decided to fly at this low level was due to the crop being very young. The crop was at emergence stage at that time. We decided to keep low level of flights up until the crop reached soft dough in the beginning of May. During all the flights we tested the overlaps from 60-80%.

We noticed that morning flights work the best as the temperature is not too high on the operation causing the drone batteries to drain slower in the mornings rather than quicker in the afternoons. While we are entering the winter season the morning flights started to become more difficult as there is a lot of fog in the mornings. Flights must be postponed to late mornings or late afternoons to be effective.

Videos were taken of the bird activity that was seen in the sorghum fields. As soon as the drone flies in the air the birds start to get very active and tend to exit and re-enter the sorghum field. The birds were followed with the drone to a possible roosting site close to the sorghum field. A ground survey is also being conducted daily of the sorghum field as various birds have been seen in the area.

Please see the following flight data that was captured thus far for the multispectral flights:

MULTISPECTRAL	Height	Growth Stage	Date
Sorghum Flight 1 - ABIPP03	19m	Emergence	06-03-2024
Sorghum Flight 2 - ABIPP06	18m	Three Leaf	15-03-2024
Sorghum Flight 3 - ABIPP09	18m	Five Leaf	15-03-2024
Sorghum Flight 4 - ABIPP10	18m	Growing Point Differentiation	30-03-2024
Sorghum Flight 5 - ABIPP11	18m	Flag Leaf Visibility	05-04-2024
Sorghum Flight 6 - ABIPP12	18m	Boot	12-04-2024
Sorghum Flight 7 - ABIPP13	20m	Boot	17-04-2024
Sorghum Flight 8 - ABIPP	18m	Soft Dough	02-05-2024
Sorghum Flight 9 - ABIPP14	64m	Soft Dough	09-05-2024
Sorghum Flight 10 - ABIPP14	64m	Between Soft and Hard Dough	14-05-2024
Sorghum Flight 11 - ABIPP14	45m	Hard Dough	23-05-2024
Sorghum Flight 12 - ABIPP14	45m	Hard Dough	30-05-2024
Sorghum Flight 13 - ABIPP14	35m	Hard Dough	06-06-2024

Research Links:

Heights to fly on crops. / Growth Stages

Thermal Drone Flights:

Images were taken with the thermal drone to see heat signatures of possible bird infestation in the sorghum field. A late afternoon flight was conducted to record a video for possible roosting sites close to the river. Heat signatures of tree branches and the rocky terrain was still high in the late afternoon. More thermal flights will be conducted throughout the project.

Please see the following flight data that was captured thus far for the thermal flights:

THERMAL	Height	Growth Stage	Date
Sorghum Flight 1 - ABIPP01	18m	Soft Dough	02-25-2024
Sorghum Flight 2 - ABIPP02	55m	Between Soft and Hard Dough	14-05-2024
Sorghum Flight 3 - ABIPP02	41m	Hard Dough	23-05-2024
Sorghum Flight 4 - ABIPP02	40m	Hard Dough	30-05-2024
Sorghum Flight 5 - ABIPP02	30m	Hard Dough	06-06-2024

Thermal Drone Research Links:

Evaluating the use of a thermal sensor to detect small ground nesting birds.

Applications:

The Sorghum block was planted on 22/02/2024. The cultivar that was planted is Mr Buster. On the planting date the block received Fertilizer. The first insecticide application was sprayed on the 27th of February. After the 27th of February each week the Sorghum block received a pesticide application. Please see the following information for the applications that were applied to the Sorghum block.

Fertilizer:

Fertilizer was applied when the sorghum was planted on 22/02/2024. Please see the following fertilizer information that was applied:

Fertilizer	2.3.4 - 375kg/ha	22/03/2024

Insecticides:

The following insecticides have been applied to the sorghum field thus far:

Insecticide	Tolla - 1.5l/ha	27/02/2024
	Cheetah - 1l/ha	
	Akito - 0.3l/ha	
	Warlock - 1l/ha	05/03/2024
	Belt - 0.25l/ha	
	Metalosate Boron 1l/ha	
	Emma - 300g/ha	18/03/2024
	Masta - 250g/ha	
	Masta - 250g/ha	27/03/2024
	Steward - 300ml/ha	
	Coragen - 150ml/ha	02/04/2024
	Steward - 300ml/ha	
	Warlock - 1l/ha	12/04/2024
	Simipleo - 250ml/ha	
	Azur Top - 500ml/ha	
	Warlock - 1l/ha	18/04/2024
	Simipleo - 250ml/ha	
	Coragen - 150ml/ha	25/04/2024
	Steward - 300ml/ha	
	Simipleo - 250ml/ha	06/05/2024
	Dipel - 500g/ha	
	Masta - 250g/ha	17/05/2024
	Steward - 500ml/ha	

Repellents:

Once the sorghum reached soft dough in the beginning of May we noticed some bird activity. Once we saw the first scout birds flying in the area, we started to apply two products that are registered bird repellents according to Agri Intel. On the control blocks we did not apply any bird repellents. Please see the following information for the repellent applications that took place:

Bird Repellents	Product A	02/05/2024
	Product B	
	Product A	16/05/2024
	Product B	
	Product A	06/06/2024
	Product B	

Map and keys for the Sorghum plot layout:

The Sorghum block was divided into nine spray rows. The rows for product A and B were placed in between the controlled rows as we did not want the different products to be right next to each other. Please see the keys and map as follow that will show which line is Controlled, Product A and Product B.

C = Control Block

A = Product A

B = Product B

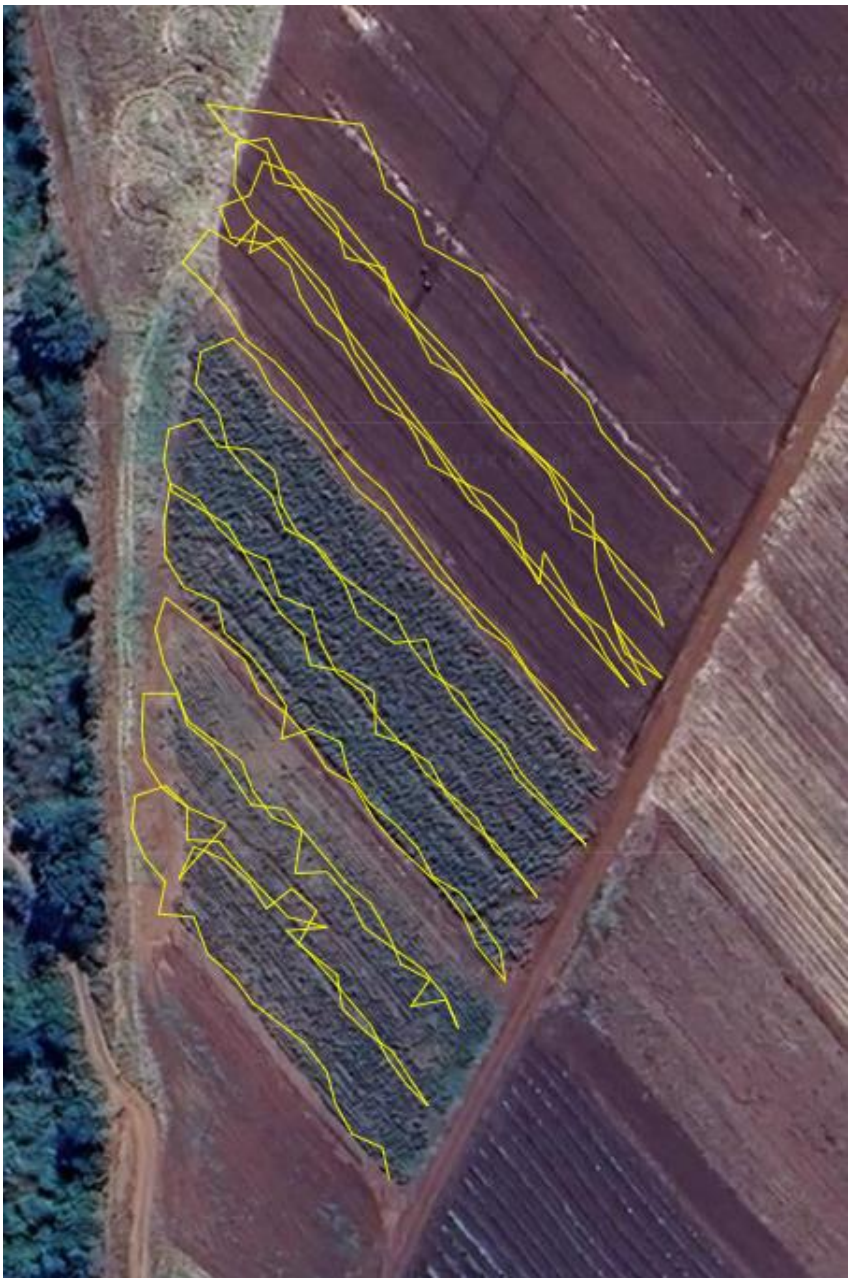
After our second repellent application on 16th May we noticed that there is a lot of birds in the area and that the feeding damage was getting worse. Although preliminary findings indicate that more feeding occurs on the Control blocks, feeding does take place on both the applied product rows We will continue to spray the repellents based on the product labels on row A and B up until harvest takes place.

Bird Damage Monitoring:

On the 2nd of May we noticed scout birds in the area when the Sorghum entered the Soft Dough stage. Repellent Applications were implemented as soon as we saw the first scouting birds in the area and noticed that there is a lot of feeding damage all over the entire Sorghum block. Determining feeding damage and bird presence is being done in the field.

Tracking Path:

The following tracking path shows how the scout is walking in the field for the visual survey of the bird damage.



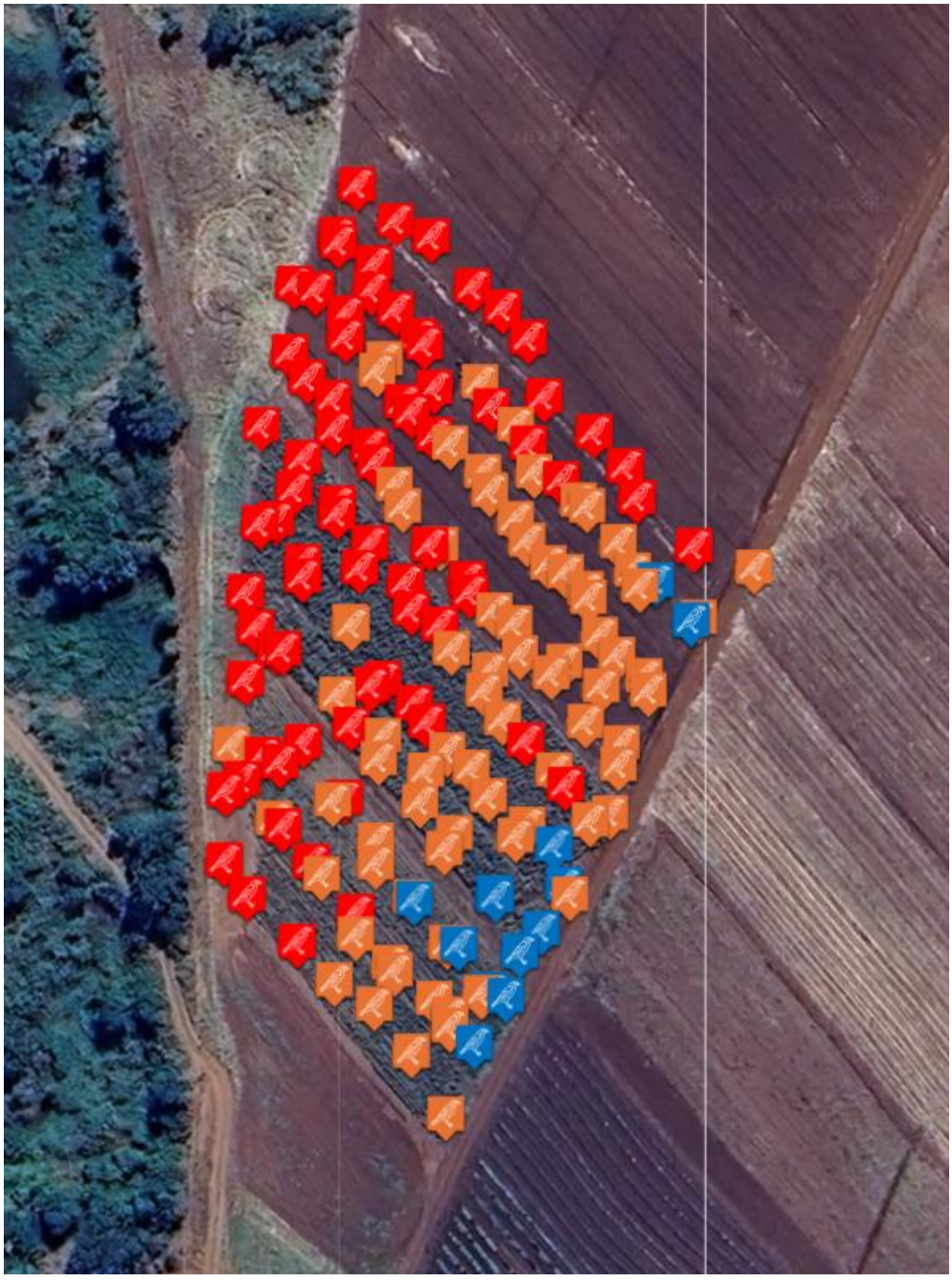
Bird Damage:

The following image shows plots of where visual scouting was done for feeding damage. Each plot represents an area that was visually scouted and rated for the damage. Feeding damage was noticed on each plot:

Blue = Low

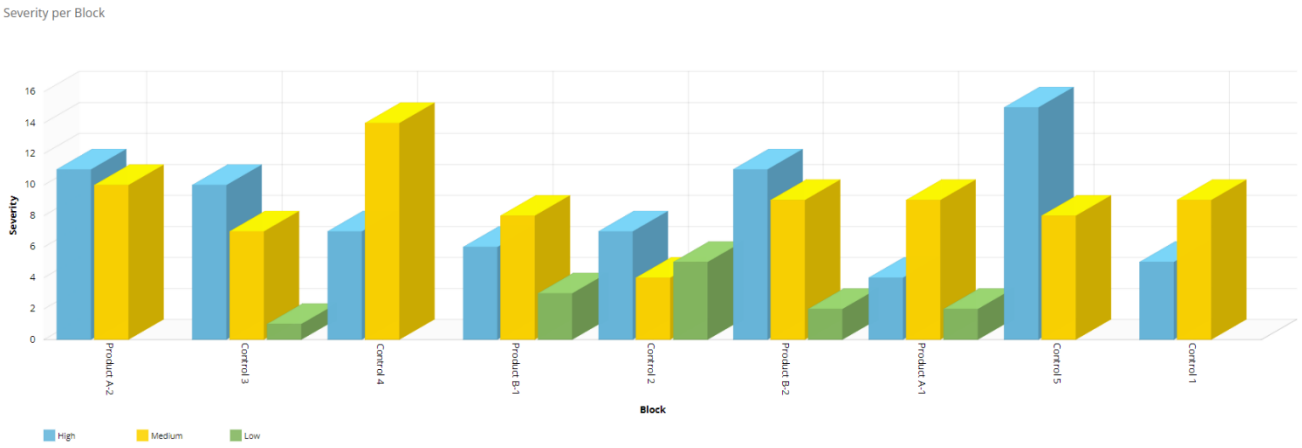
Orange = Medium

Red = High



Severity per Block:

The following graph indicates the severity of bird damage on each block:



Block Number	Low	Medium	High
A1	2	9	4
A2	0	10	11
B1	3	8	6
B2	2	9	11
Control 1	0	9	5
Control 2	5	4	7
Control 3	1	7	10
Control 4	0	14	7
Control 5	0	8	15

Images:

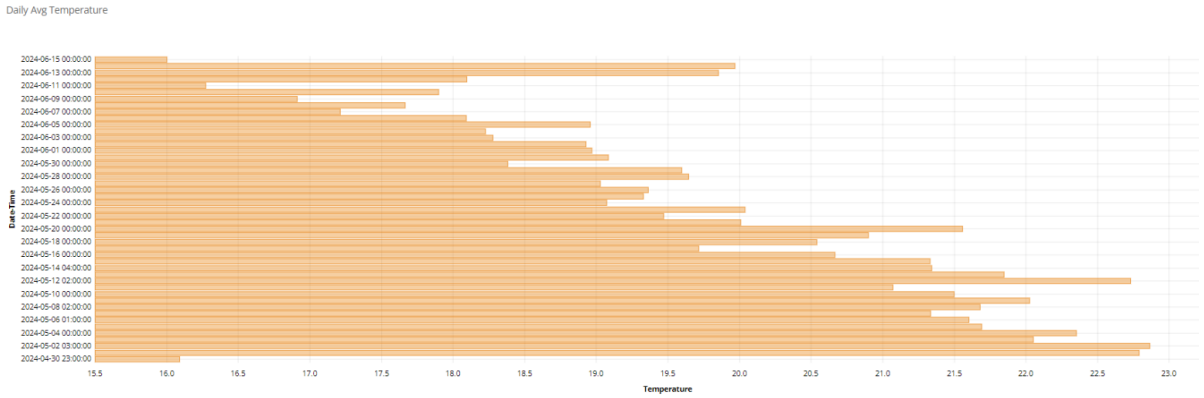
The following images were taken in the Sorghum block to indicate bird and feeding damage:

Bird Damage Weather Data:

An ground based automated weather station is located at the Sorghum block. This weather station is collecting data on an hourly basis. Please see the following data and graphs for the weather data at the Sorghum block.

Daily Average Temperature:

The graph displays the average temperature for the month of May & June while the Bird Damage surveys took place.

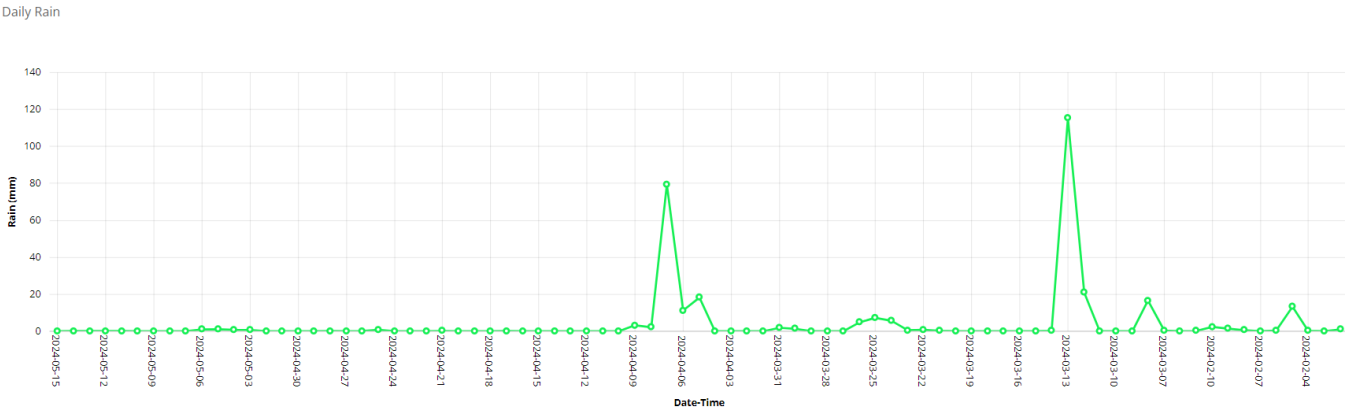


Date	Avg Temp in Celcius
01-05-2024	22,7
02-05-2024	22,8
03-05-2024	22,05
04-05-2024	22,3
05-05-2024	21,6
06-05-2024	21,6
07-05-2024	21,3
08-05-2024	21,6
09-05-2024	22
10-05-2024	21,4
11-05-2024	21
12-05-2024	22,7
13-05-2024	21,8
14-05-2024	21,3
15-05-2024	21,6
16-05-2024	20,6
17-05-2024	19,7
18-05-2024	20,5
19-05-2024	20,8
20-05-2024	21,5
21-05-2024	20
22-05-2024	19,4
23-05-2024	20
24-05-2024	19
25-05-2024	19,3
26-05-2024	19,3
27-05-2024	19
28-05-2024	19,6
29-05-2024	19,5
30-05-2024	18,3
31-05-2024	19

Date	Avg Temp in Celcius
01-06-2024	18,9
02-06-2024	18,9
03-06-2024	18,2
04-06-2024	18,2
05-06-2024	18,9
06-06-2024	18
07-06-2024	17,2
08-06-2024	17,6
09-06-2024	16,9
10-06-2024	17,9
11-06-2024	16,2

Daily Rain:

The graph displays the daily rain over a timespan from May and June while Bird Damage Surveys took place.



Date	Rain in mm
01-05-2024	0
02-05-2024	0
03-05-2024	0
04-05-2024	0
05-05-2024	0
06-05-2024	0
07-05-2024	0
08-05-2024	0
09-05-2024	0
10-05-2024	0
11-05-2024	0
12-05-2024	0
13-05-2024	9,38
14-05-2024	0,27
15-05-2024	0
16-05-2024	0,1
17-05-2024	2,2
18-05-2024	0,1
19-05-2024	0
20-05-2024	0
21-05-2024	0
22-05-2024	0,1
23-05-2024	2,5
24-05-2024	0
25-05-2024	0
26-05-2024	2,9
27-05-2024	0
28-05-2024	0
29-05-2024	0,4
30-05-2024	0,4
31-05-2024	1

Date	Rain in mm
01-06-2024	0
02-06-2024	0,1
03-06-2024	0,6
04-06-2024	0,2
05-06-2024	0
06-06-2024	0,1
07-06-2024	0,1
08-06-2024	0,7
09-06-2024	0,1
10-06-2024	0,3
11-06-2024	0,3

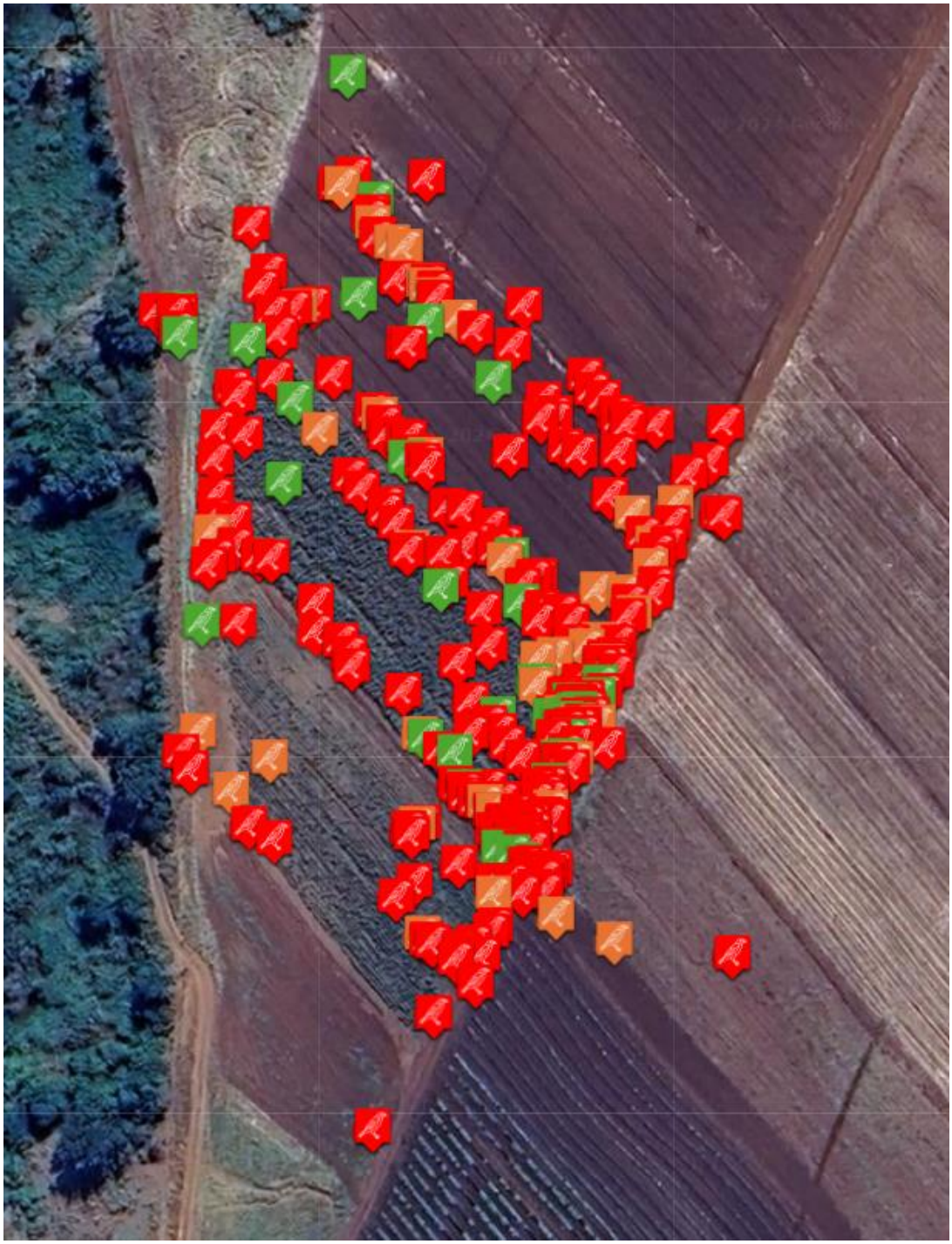
Bird Activity Monitoring:

Bird Activity Monitoring started on the 28th of May. Birds are visually being monitored to see how long they feed on the different blocks. Please see the following information that we have gathered thus far.

Green = Leaving

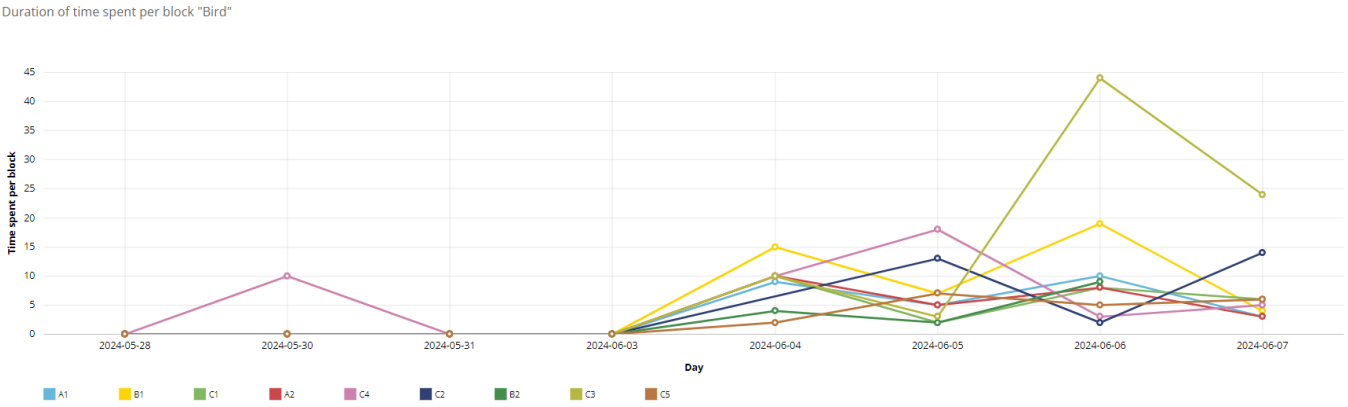
Orange = Changing Blocks

Red = Entering



Duration spent on each block:

Time was kept when Birds entered and left each block. Please see the following information for the total time birds spent on the different sorghum blocks:

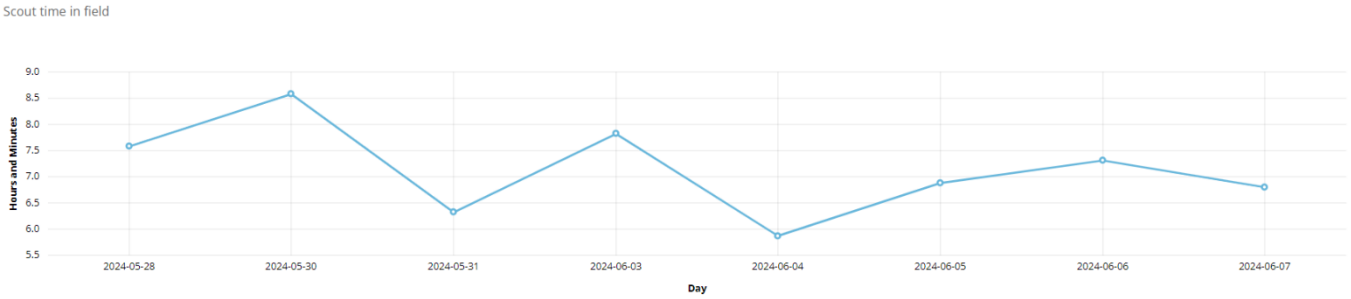


Date	Block Number	Total time spent in Minutes
28-05-2024	A1	0
	A2	0
	B1	0
	B2	0
	C1	0
	C2	0
	C3	0
	C4	0
	C5	0
30-05-2024	A1	0
	A2	0
	B1	0
	B2	0
	C1	0
	C2	0
	C3	0
	C4	10
	C5	0
31-05-2024	A1	0
	A2	0
	B1	0
	B2	0
	C1	0
	C2	0
	C3	0
	C4	0
	C5	0
03-06-2024	A1	0
	A2	0
	B1	0
	B2	0
	C1	0
	C2	0
	C3	0
	C4	0
	C5	0

Date	Block Number	Total time spent in Minutes
04-06-2024	A1	9
	A2	10
	B1	15
	B2	4
	C1	10
	C2	0
	C3	10
	C4	10
	C5	2
05-06-2024	A1	5
	A2	5
	B1	7
	B2	2
	C1	2
	C2	13
	C3	3
	C4	18
	C5	7
06-06-2024	A1	10
	A2	8
	B1	19
	B2	9
	C1	8
	C2	2
	C3	44
	C4	3
	C5	5
07-06-2024	A1	3
	A2	3
	B1	4
	B2	0
	C1	6
	C2	14
	C3	24
	C4	5
	C5	6

Scout time in Field:

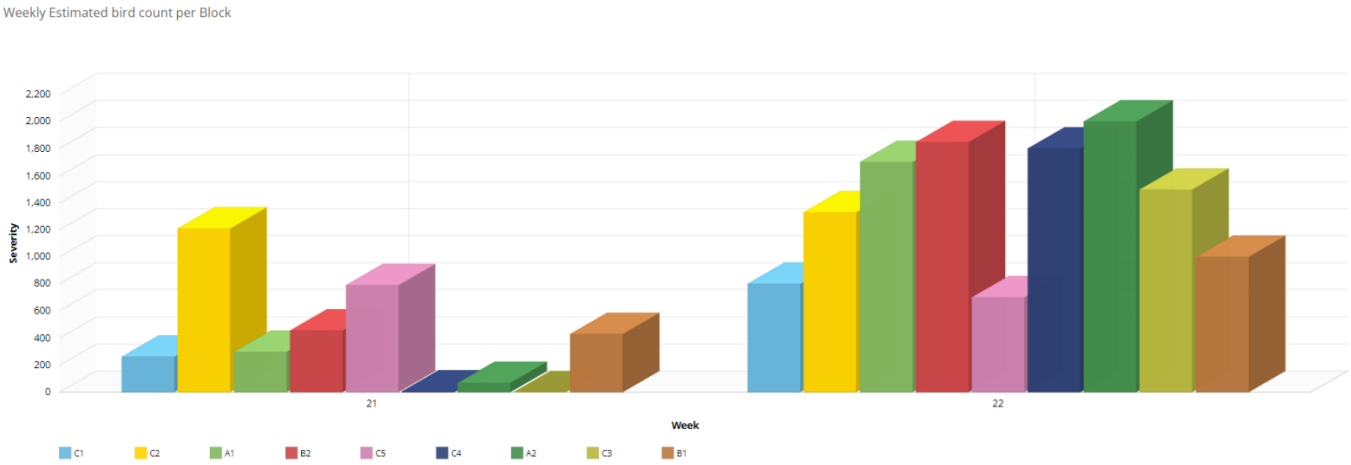
The following graph shows the total Estimated Time the scout spent surveying for bird activity:



Date	Estimated Time spent in Hours and Minutes
28-05-2024	07:58
30-05-2024	08:58
31-05-2024	06:32
03-06-2024	07:45
04-06-2024	05:47
05-06-2024	06:45
06-06-2024	07:31
07-06-2024	06:45

Weekly estimated bird counts:

Please see the following information on the total estimated counts of birds per week:



6. PRELIMINARY CONCLUSION

Bird Activity monitoring started on the 28th of May. From early morning to late afternoon two teams rotate for shifts. Data is being collected on the birds as they enter, and on which blocks they eat and if they move from one block to another. Early morning and late afternoon flights are also being scheduled for the thermal drone to calculate how big roosting sites are that are located close to the sorghum field. Due to the Sorghum being close to harvest time no Insecticides or repellents will be applied until harvest as harvesting will happen in two weeks' time. Samples of the harvested Sorghum will be taken to labs for residue analysis. Estimated harvest vs actual harvest will be calculated for each block and we will calculate how much of the crop is lost for each block. Once we are done collecting the above-mentioned data, we will present all our findings in detail.

We complied a video showcasing the work being done which was verified and approved by DSI, please follow this YouTube link to view the video:

https://www.youtube.com/watch?v=IeP-QY6G6kg