About Us

Innovate UK KTN exists to connect innovators with new partners and new opportunities beyond their existing thinking – accelerating ambitious ideas into real-world solutions.

Innovate UK
KTN

AgriFood Africa Connect

AgriFood Africa Connect brings innovative people and organisations across the UK and Africa together to address key AgriFood challenges in Africa.

GCRF

UKRI Innovate UK KTN

Event Purpose

- Learn about the challenge
- Hear about innovative solutions
- Discuss and connect with others

UKRI Innovate UK KTN

Agenda | 9:30 - 10:50

Introduction
What are quelea? *Bob Cheke*

Company perspective, *Habiba Suleiman*

Case Study - East Africa, *Moses Mafabi*

Case Study - Zimbabwe, *Shingirayi Nyamutukwa*

Exploring integrated approaches to control, *Aiko Watabe*

Community approaches and case studies of agriculture-conservation conflicts, *Nils Bunnefeld*

Panel Discussion: What do we want to see in the future

Networking
Break

UKRI Innovate UK KTN

Agenda | 11:00 – 11:50

Technical Session- Monitoring/ Forecasting

Integrating climate and species modelling to predict movements of quelea, *Rachel Dobson*

Approaches to small-holder farmer agriculture, *Samuel Macharia*

Discussion/ Networking

Innovate UK KTN

Agenda

Technical Session- Deterrents and Defence

Sound based deterrents, *John Swaddle*

Drone applications in bird challenges, *Aditya Paranjape*

Use of contraceptives for population control, *Giovanna Massei*

Networking

Break

UKRI Innovate UK KTN

Agenda | 12:00 – 12:30

Technical Session - Agronomic / Ecological Approaches

The role of crop breeding in preventing loss, Ephrem Habyarimana

Agronomic approaches to loss prevention, *Jonne Rodenburg*

Discussion/ Networking

Conclusions and Next Steps

UKRI Innovate UK KTN

What are quelea?

Professor Bob Cheke, Agriculture, Health and Environment Department, Natural Resources Institute

Apply your innovation to a new challenge - Reducing crop loss by quelea birds in Africa. Introduction to Quelea birds and their control

Robert A. Cheke
Professor of Tropical Zoology
Natural Resources Institute
University of Greenwich at Medway
(email: r.a.cheke@greenwich.ac.uk)

Webinar
Innovate UKRI KTN

25 April 2023

Natural Resources Institute

Topics to be covered

1. - What are quelea?
   Introduction to the red-billed quelea
2. - What is the scope of the challenge?
   Current control measures with fenthion

   (The Chemicals Review Committee (CRC) recommended fenthion to be listed in Annex III to the Rotterdam Convention as a severely hazardous pesticide formulation (SHPF)).

   No longer used in some countries e.g. Botswana
3. - Current alternative control measures

Considerations when looking at solutions- what is known / unknown?

3.1. Alternative pesticides
3.2. Explosions
3.3. Repellents
3.4. Cultural control
3.5. Mechanical Control: Nest destruction and chick harvesting
3.6. Mechanical Trapping: Adult Trapping for food

4. Summary of alternatives to fenthion and future research topics and management strategies

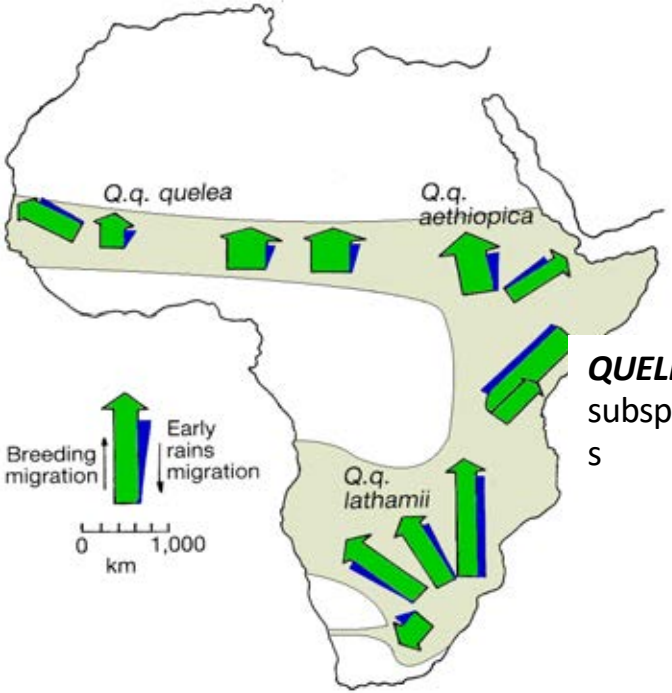
The red-billed quelea *Quelea quelea*

Probably the world's most numerous land bird

World's most numerous bird pest

Males are polymorphic

Distribution and migration patterns of Red-billed Quelea



QUELEA subspecies

Quelea Crop Damage

Annual losses in sub-Saharan Africa US$ 94.45 million at 2021 prices (Elliott 1989)

Dry Season
Irrigated crops affected e.g. wheat

Early rainy season, after "early rains migration" *Irrigated crops e.g. rice and early ripening rain-fed crops*

Rainy season
Rain-fed crops e.g. sorghum, millet

- Any small-grain cereal grown in semi-arid parts of Africa is a potential target
- Damage is especially likely when the birds' preferred wild food is unavailable
- Pesticides and explosions sometimes deployed without regard to economics of potential crop damage

The target: quelea breeding colonies (and roosts)

Control Organisations

- National Ministries of Agriculture
- Regional organisations with responsibilities for controlling quelea in member states:
  (a) Desert Locust Control Organisation for Eastern Africa (DLCO-EA)
  (b) International Red Locust Control Organisation for Central and Southern Africa (IRLCO-CSA)
- Commercial companies

Fenthion

Case for

- Relatively cheap and very effective if sprayed properly or used in combination with trap roosts
- Sprayed by aircraft or from vehicles
- Can be suitable for large areas (>5ha)

Case against

- No standardised training procedures
- Excessive dosages sometimes used
- Fatal or serious organophosphate poisoning of operators and non-target organisms
- Persistence in soil (half life 47 days)
- Unsuitable for use by small-scale farmers
- Cannot be used near water

Non-target fatalities

Alternative pesticides

Cyanophos not a suitable replacement for fenthion

- Also an organophosphate, but lower mammalian and avian toxicity than fenthion (lower oral LD50s)
- Killing action takes longer than fenthion, so could lead to more secondary poisoning than fenthion
- Persistent in environment like fenthion (still present in soil, at concentrations from 0.009 to 0.169 $\mu g.g^{-1}$, 41 days after a spray in Botswana)
- As damaging to non-targets as fenthion

Other alternatives: Phoxim and Mevinphos also too toxic

Explosions using petrol and diesel

Case for

- Can be used near water, unlike fenthion

Case against

- Adverse environmental effects and kill non-targets
- Extremely dangerous, needing specialised personnel for deployment and detonation
- High security risks
- Danger of bush fires
- Difficult at large scales (>5ha)

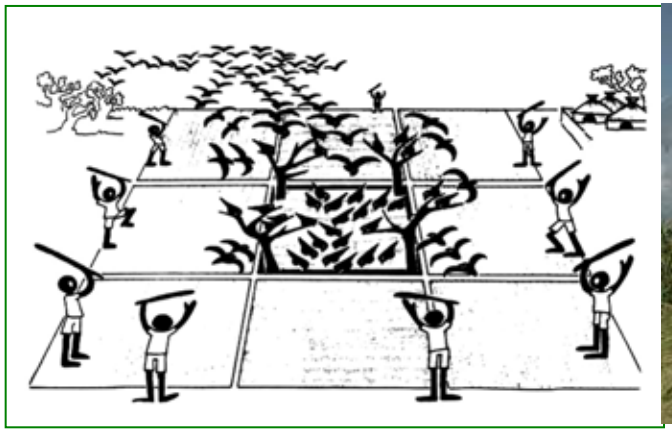
Repellents

- The narcotic Alphachloralose has been added to bait grain or water in South Africa. Birds weakened so that they can be picked up or killed, but it also affects non-target organisms. Could be used in urban areas.
- Mesurol (methiocarb) applied to crops doubled yields of sorghum in Senegal and in Sudan it reduced damage from 85 to 30% in experiments on sorghum and wheat. It is now banned by the EU.
- Other possible repellents include 4-aminopyradine, aluminium ammonium sulphate, curb (ammonium sulphate) and trimethacarb.
- All unsuitable for treating large areas
- New repellents? Suggestions at this webinar?

Cultural control: crop management and / or timings of planting arranged so that the grain can be harvested when there are few or no quelea present

- **Early-maturing crop varieties:** may not escape attack, but they will be vulnerable for shorter periods than late-maturing crops.
- **Water management**: irrigated crops can be timed for harvesting when there are no quelea. In Chad and Cameroon irrigated rice timed for mid-May to mid-June. In Ethiopia: irrigated sorghum planted in September can be harvested in December.
- **Alternative or resistant crops:** e.g. tannins in sorghum but poor efficacy and low consumer acceptance
- **Physical control methods:** weeding to reduce grass seeds, netting over crops and bird scaring, the most widely used method by small-scale farmers

Traditional bird scaring: Social costs, labour-intensive , ineffective



Commercial bird scarers – Bangalore bird scarer, Bird X-peller or Agrilaser

Any new ones?

Bird scaring with predators e.g. Lanner falcons

Bird scaring with drones

- Proposal by Dayoub *et al.* (2021) to use a swarm of drones to survey for *Quelea* and then to scare them off crops by emitting scaring noises.
- Three drones to cover 4 ha.

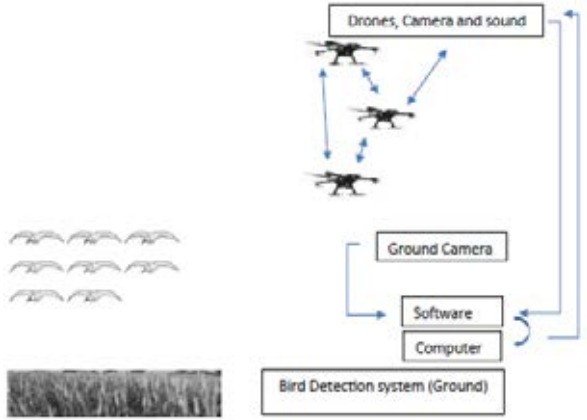


Fig. 1. System diagram of the proposed swarm drone bird

Mechanical Control without traps: chick harvesting for food and nest destruction

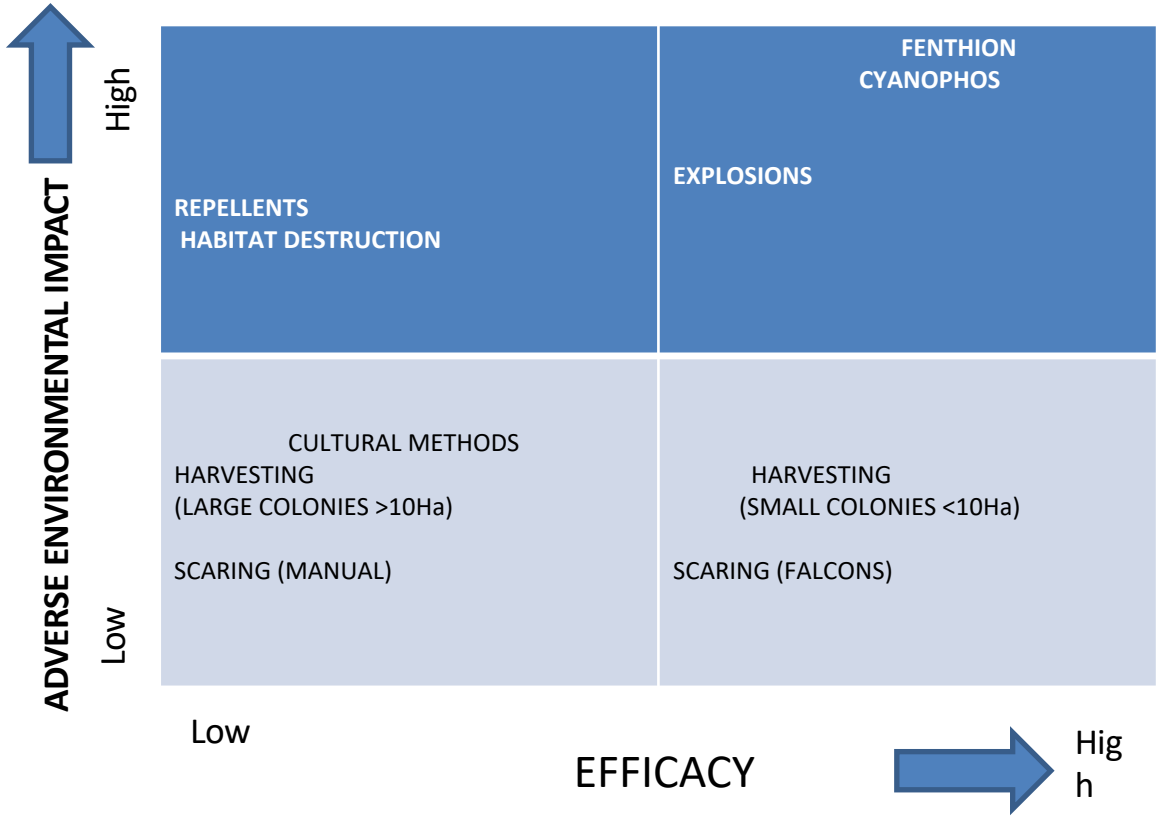
- Harvesting *Quelea* chicks for food, e.g. Tanzania, Zimbabwe, Chad. Suitable for small-scale farmers
  Up to 3.78 kg of chicks harvested per person per hour in Zimbabwe.

- Mechanical destruction of breeding and roosting habitat manually or using tractors dragging brushing equipment in South Africa

Mechanical trapping methods

1. Use of mist-nets (Elliott *et al*. 2014).
2. Chad method (Mullié 2000).
3. Tanzanian Basket traps
4. Synthetic versions of Tanzanian basket traps made of wire mesh

Comparison of quelea control methods



Recommendations for quelea control without fenthion

- ALL PRACTITIONERS: Only control quelea when they are threatening a crop and use correct minimal dosages of approved pesticides if necessary
- INTERNATIONAL: Improve forecasting and control planning – development of a Pan-African system akin to the FAO Desert Locusts forecasts
- NATIONAL: Promotion of cultural control and support for IPM
- NATIONAL: Decision support system development
- NATIONAL: Training of operators and maintenance and calibration of equipment
- NATIONAL: Promotion of small scale options e.g. trapping, harvesting, use of quelea as food

Future Research

- Research into:

  a) barriers against and opportunities for application of cultural control and trapping

  b) market analysis and promotion of quelea as a food

  c) exploitation of possibilities for reconnaissance, scaring and control with drones. Currently limited by maximum payload of about 80 litres

  d) Pan-African forecasting and control coordination

  e) biological methods such as avian contraception and attractants

  f) attaching trackers to birds for data on migrations

  g) new repellents

  i) new acoustic scaring methods

Thank you for listening

Company and Farmer perspective
Habiba Suleiman, Wacot Rice

Innovate UK
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WACOT RICE

QUELEA BIRDS IMPACT ON WACOT RICE'S OUTGROWER PROGRAM

April, 2023

To support an annual milling capacity of 240,000MT, Wacot Rice runs a structured outgrower program for over 10k smallholders

WACOT RICE MILL OVERVIEW

- Annual Milling Capacity of ~240,000MT of mill ready paddy
- Quality of finished rice at par with best global standards
- Direct and indirect employment for ~3,000 people. Working with over 30,000 farmers
- First Rice Mill in the country with Integrated effluent treatment facility to protect environment.
- First Rice Mill in Nigeria with captive Power Co-Generation facility.

WRL RICE OUTGROWER PROGRAM

- To secure supply of quality paddy for its mill, thousands of registered smallholder farmers are provided agri-inputs, capacity building trainings, mechanization support and dedicated extension services throughout the farming season.
- At harvest, WRL guarantees offtake of all harvested produce at prevailing market prices.
- Crop yield and farmer livelihoods have seen significant increase but certain risks like flooding, erosion and pest infestation remain incessant.

IMPRESSIONS

Unlike other risks associated with rice farming, Quelea birds remain a major challenge defying all available mitigants

- The WRL Outgrower program has actively worked to address poor yield and post harvest losses plaguing smallholder rice farmers in Nigeria. However, unlike other risks, damage caused by quelea birds remains a major threat to farmer livelihoods.
- Described by the FAO as the most important granivorous bird pests in Africa, quelea population is recorded to have increased from 10 to 100 times since the 70's.
- FAO also states that efforts to control quelea population have had poor successes and estimates the agricultural losses attributable to the quelea in excess of $50 million annually.
- In addition to agri-finance losses incurred by WRL due to quelea birds, many smallholders who depend on subsistence crop production for survival are unable to recover after devastating effects of quelea attacks destroying up to 100% of cultivated area for some farmers.
- So far mitigation efforts employed by farmers include felling of trees around farms to prevent birds' housing, early planting, scaring/visual devices, increased use of pesticides and noise making. All of these have proved largely ineffective, unsustainable and even detrimental to the environment and biodiversity.
- Government efforts are largely limited to aerial spraying of pesticides with limited success.
- The impact of continued damage caused by quelea birds threatens farmer incomes, livelihoods, crop production and food security at a national level.
- With current solutions doing very little to address the issue, there is a dire need for research into sustainable solutions that are both cost-effective and environmentally safe for farmers.

Case Study- East Africa

Moses Mafabi, Research Officer, Desert Locust Control Organization for Eastern Africa

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A Regional Perspective of the Quelea Bird Pest

Moses Muwanika Mafabi
Senior Research Officer,
DLCO-EA
and
Joseph O. Ndege
Executive Coordinator
CREMMPEA

Introduction

- Desert Locust Control Organization for Eastern Africa (DLCO-EA) is a regional organization, with its headquarters in Addis-Ababa, Ethiopia.
- The organization was established in 1962 to among others conduct;

  - Aerial surveys & control of migrant pests

  - Conduct applied research on migrant pests

  - Offer forecasting & early warning services on migrant pests in the region

  - capacity building of member countries' staff on the management of transboundary pests

- The most important and frequent control operations is agonists quelea Birds and Desert
- The organization operates in 9 Members countries
- These are Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan, Tanzania and Uganda
- The organization has Control Reserve Base offices in each member country to facilitate migrant pest control operations
- The organization is specialized in aerial control and as such has a fleet of fixed wing aircraft at its operation coordination offices at Wilson Airport in Nairobi, Kenya.

Current status quelea birds in the region

The quelea burden in the region has been growing over the years and this

may be attributed to:

- Environmental modifications such as irrigated small grain production agriculture that create ideal conditions for quelea birds
- Shrinking of their natural habitats due to increased human population and settlement
- Increased Agricultural industrialization (intensive agriculture)
- Climatic change which is pushing the birds venture into new habitats
- Deforestation and Desertification; creating new suitable habitats

Experience from select Member Countries

Ethiopia

- Recently introduced irrigated wheat production in the lowland areas (Afar, Somali and SNNP regions) as an import substitution strategy for wheat
- Quelea birds have invaded the newly established farms
- In the past, there were definite Quelea outbreak seasons following the rainy seasons and cropping calendar. So forecasting outbreaks & control was easy
- There were two quelea control campaigns May-June and Mid Sept – Nov/Dec.
- Of recent, due to irrigation and presence of crop throughout the year, birds are occurring all year round.

Tanzania

- Tanzania quelea control operations used to take a few months progressively from the southern, central and northern regions of the country
- Of recent, simultaneous outbreaks occur in different regions especially for central, southern and N. western regions
- The coastal region eg., Dar-es-salaam has of recent become a quelea prone area and so is the Kagera region in the N.W part of Tanzania.
- This is a result of more areas opening up to small grain cultivation of especially rice and sorghum
- Therefore, operations continue almost throughout the year (lasting up to 9-10 months in total each year).

Kenya

- In general, Kenya has not had a marked agricultural transformation in as far as small grain production is concerned.
- The Quelea outbreak seasons and areas remain very predictable.

Concluding remarks

- Forecasting for quelea bird outbreaks has become complex partly due to climate change and microclimatic modifications through irrigation
- As countries venture into more improved and modern production of small grain crops including through irrigation; the survival, reproductive success and spread of quelea birds is being enhanced.
- The most effective avicide for aerial control of quelea birds in the region is Fenthion which easily knocks down populations to save farmers crop
- However, it is on the verge of being listed with no equivalent alternative.
- This calls for research into alternative ways of managing the infestations
- Below is a statistical picture of the quelea problem in the region for consideration as policies for management of the birds are being developed.

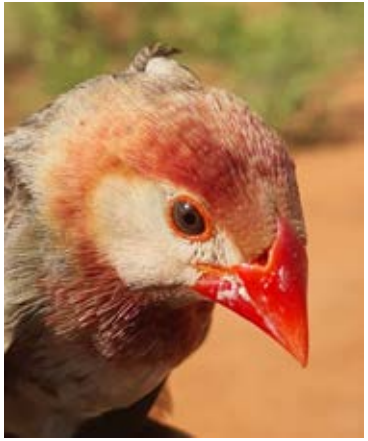
DLCO-EA Quelea control statistics for the last decade

Year	Tanzania	Kenya	Ethiopia	Uganda	Eritrea	Total number controlled	Amount of crop potentially damaged/day (T0nnes)	Value of crop saved/day (US $)	Estim. loss if not controlled per season (US $)	Est Loss per year US $
2010/11	137.8	16.5	25.2	0	0	179.5	1,795	1,795,000	44,875,000	89,750,000
2011/12	101	7	16.05	0	0	124.05	1,240.50	1,240,500	31,012,500	62,025,000
2012/13	130	28.8	26.7	0	9.75	195.25	1,952.50	1,952,500	48,812,500	97,625,000
2013/14	188	67	71	2	0	328	3,280	3,280,000	82,000,000	164,000,000
2014/15	115	22	50	0	0	187	1,870	1,870,000	46,750,000	93,500,000
2015/16	92	13	31	0	0	136	1,360	1,360,000	34,000,000	68,000,000
2016/17	88	49	54	0	0	191	1,910	1,910,000	47,800,000	95,600,000
2017/18	88	21	75	0	0	184	1,840	1,840,000	46,000,000	92,000,000
2018/19	153	12	39	0	0	204	2,040	2,040,000	51,000,000	102,000,000
2019/20	32	0	37	0	0	69	69	69,000	1,725,000	3,450,000
2021/22	41.9	0	147.3	0	0	189.2	1,892	1,892,000	47,300,000	94,600,000
										962,550,000

Case Study- Zimbabwe

Shingirayi Nyamutukwa, Director, Migratory Pests and Biosecurity Control Department, Zimbabwe

Apply your innovation to a new challenge – Reducing crop loss by quelea birds in Africa



Nyamutukwa S

Migratory Pests and Biosecurity Control

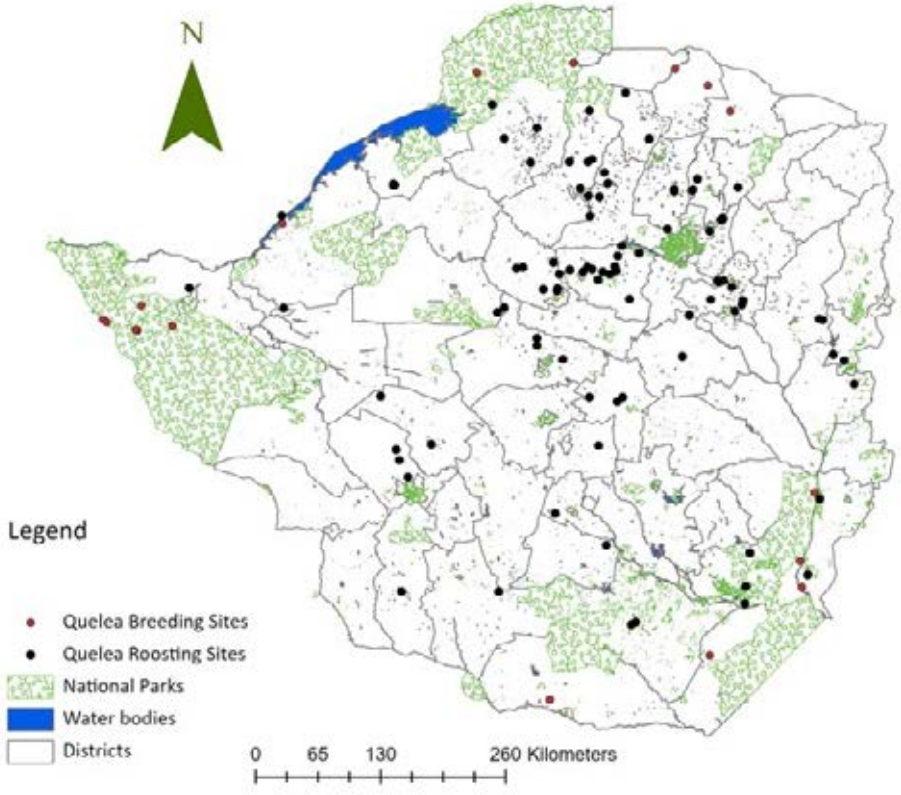
Ministry of Lands, Agriculture, Fisheries, Water and Rural development - Zimbabwe

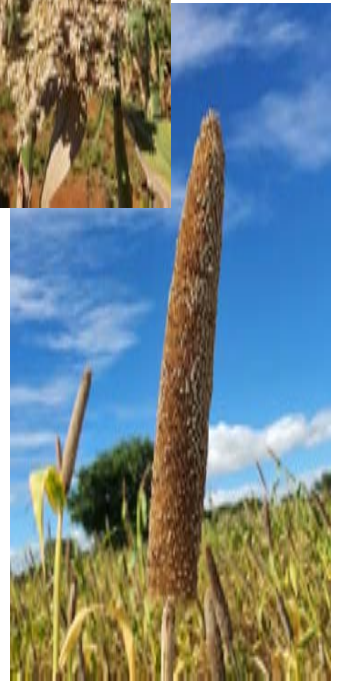
25 April 2023

Introduction

- Quelea birds are a serious pest of traditional grains (sorghums and millets) and wheat causing losses of up to 100% and also maize (25% loss).
- Zimbabwe surpassed its target of wheat production in 2022 season becoming a record yield in its history (79000 ha)
- This 2023 season target is 85000 ha and its means zero damage from quelea birds.

Quelea breeding and roosting sites in Zimbabwe





Quelea management in Zimbabwe

- Chemical - Fenthion 640 ULV and Falcolan 500 ULV – official control (Min of Agric and Parks and Wildlife staff
  - Motorised backpack sprayers
  - Vehicle mounted motorized sprayers
  - Drone applied
  - Aerial sprays
- Physical trapping using nets – more of this in future (youths)
- Bird scaring (Drones)
- Destruction of roosting sites and breeding sites (tree cutting??? - communities
- Bird repellents – Bird Ness (Anthraquinone) - farmers
- Harvesting nestlings during breeding season - communities
- Laser technology, automated trapping – UNDP/PEGARA
- Urimbo – latex from *Euphobia* ssp. And wax from *Colophospermum mopane* - communities

Management

- Physical barriers to protect the maize cobs from bird attack - Applicable on small areas of maize crop - farmers
- Bird scaring - beating metals (children – school???)

Quelea control in Future for improved management

- Artificial Intelligence or innovations in
  1. Area estimation of breeding and roosting sites
  2. Counting of birds in flocks and nests in breeding sites
  3. Bird tracking and movement behaviour – EWS
  4. Field loss calculations
- Nets for physical trapping (automated) with use of cages – source of income
- Mobile Application for real-time reporting –by farmers and extension staff
- Use of bird reflectors

Thank you

Exploring integrated approaches to control

Aiko Watabe, Product Manager, Pegara Japan G.K.

Development of technology to protect crops from pests

25th Apr 2023
Pegara Japan G.K.

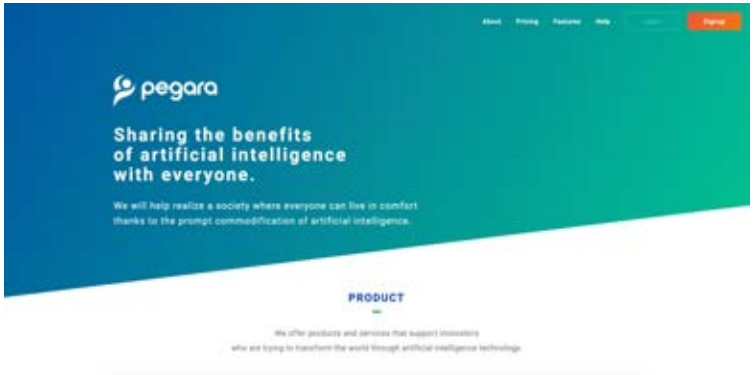
About Us

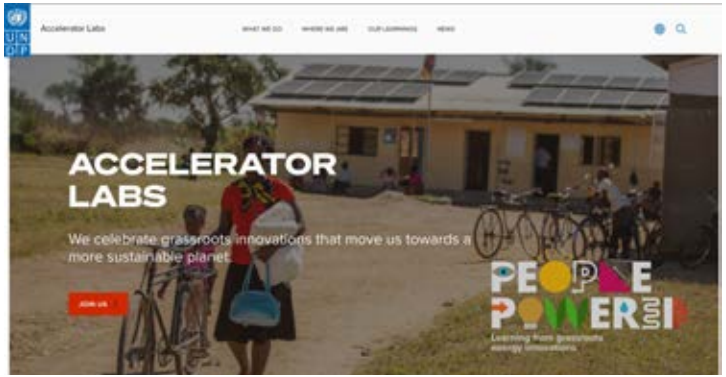
Pegara Japan G.K.

- AI model development/research for image recognition based on deep learning
- AI development consulting/joint R&D/product development

Background of this project

- We are participating in a program called "Japan SDGs Innovation Challenge," in which the UNDP Accelerator Lab is collaborating with Japanese private companies to devise solutions to challenges in developing countries.



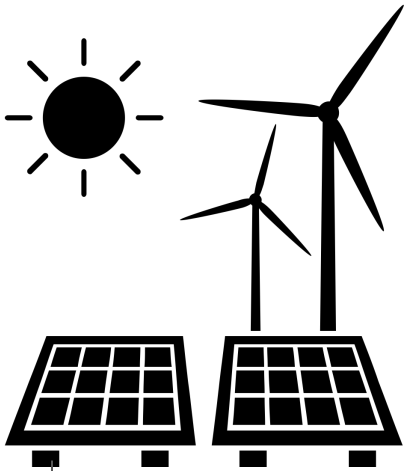


Damage to grain caused by Quelea

Initially proposed solution

24-hour automatic laser pest control system using AI image recognition technology.

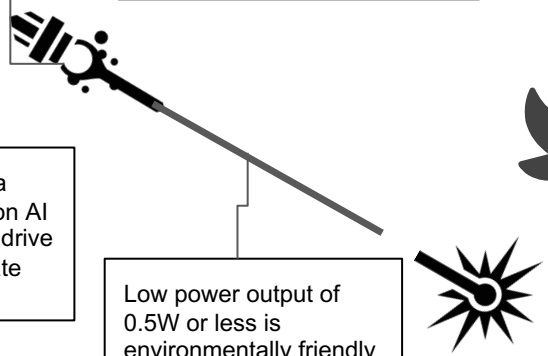
→This solution proved ineffective during the March fieldwork.



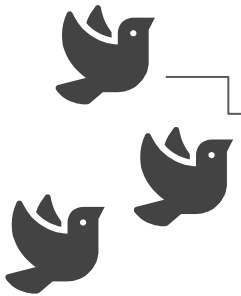
Power supply using renewable energy (wind & solar). Charged energy is used at night.

- Infrared camera
- Pest Recognition AI
- Programmable drive unit that can rotate 360 degrees

Automatic environmentally friendly green laser irradiation



Low power output of 0.5W or less is environmentally friendly
・Restrictions apply to irradiation of people, aircraft, etc.



Pest birds that recognize green lasers as objects and disperse.

Low power and harmless to the environment, no impact on people or grains.

Solutions in 3 Steps

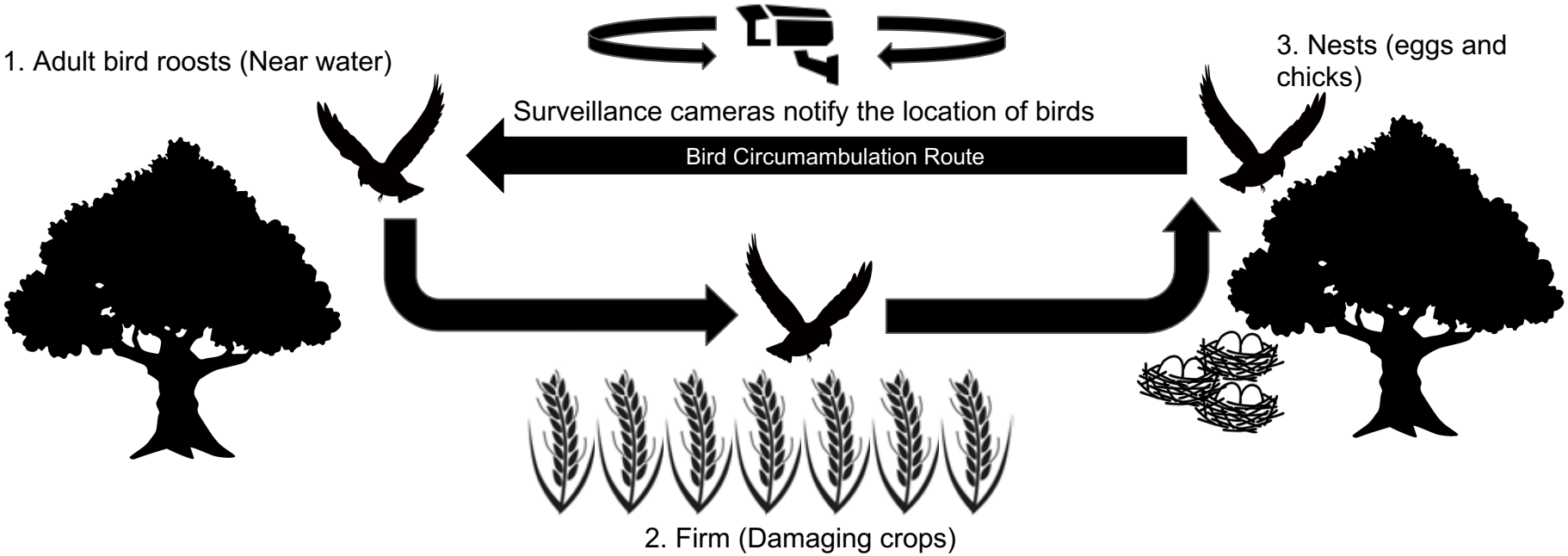
(1) Locating the birds
- Identify how many birds are living in a bed, nest, or farm

(2) Driving the birds away
- Hundreds of birds need to be chased away before grain is damaged.

(3) Capturing birds
- Breeding cycles are fast, so it is necessary not only to drive birds away, but also to capture them to reduce their numbers

(1) Locating the birds

Birds have a fixed migration route and stay at: 1. a sleeping area (a tree near water), 2. a field (a place to attack), and 3. a nest (at least 20 km away). At these three locations, the drone will track and locate the birds using "AI image recognition + camera + Starlink or 3G".



(2) Driving the birds away

Speaker

https://www.monotaro.com/g/05923700/

Water canon

High Power Laser

https://kvant.jp/gallery/videogallery/products/811.html

Drone

Three ways that might work, as we found out from interviewing local farmers.

- AI Camera + Drone + **Speaker**
- AI Camera + Drone + **Water canon**
- AI Camera + Drone + **High Power Laser**

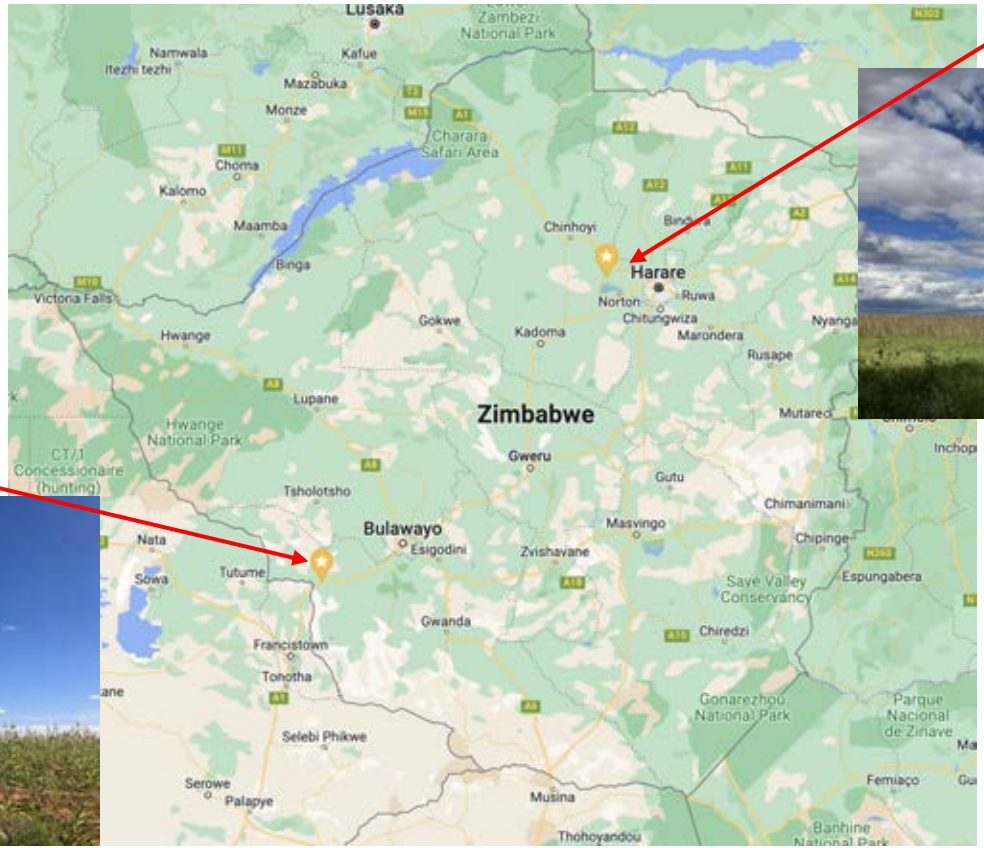
(3) Capturing birds

Quelea must not only be driven away, but also captured and killed. Quelea are an important source of protein, so after they are captured, they are sold at the market. Larger farms use large nets, and even smaller farms use handmade nets to catch quelea, and it is working.

In order to capture even larger numbers of birds efficiently, technology-based systems need to be developed.

https://agri.mynavi.jp/2020_09_10_131035/

Next fieldwork: June to August



Community approaches and case studies of agriculture-conservation conflicts

Professor Nils Bunnefeld, Biological and Environmental Sciences, University of Stirling

UKRI Innovate UK KTN

Community approaches and case studies of agriculture-conservation conflicts

Nils Bunnefeld

UNIVERSITY of STIRLING

eklipse

www.sti-cs.org

https://eklipse.eu/

ConFooBio

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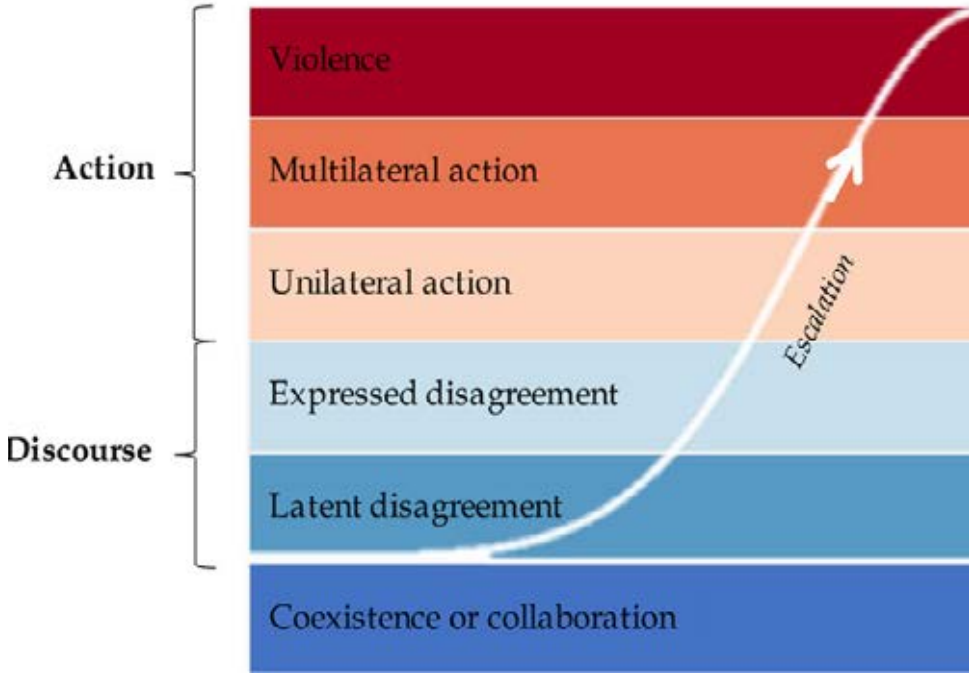
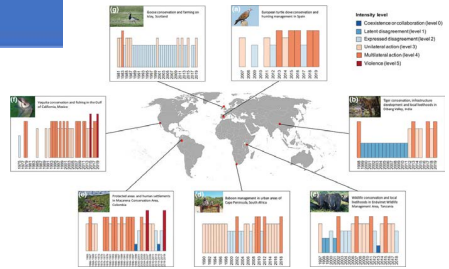
European Research Council

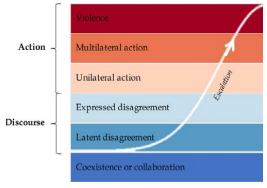
Trade-offs between biodiversity conservation and agriculture can lead to conflicts that are damaging to people and nature

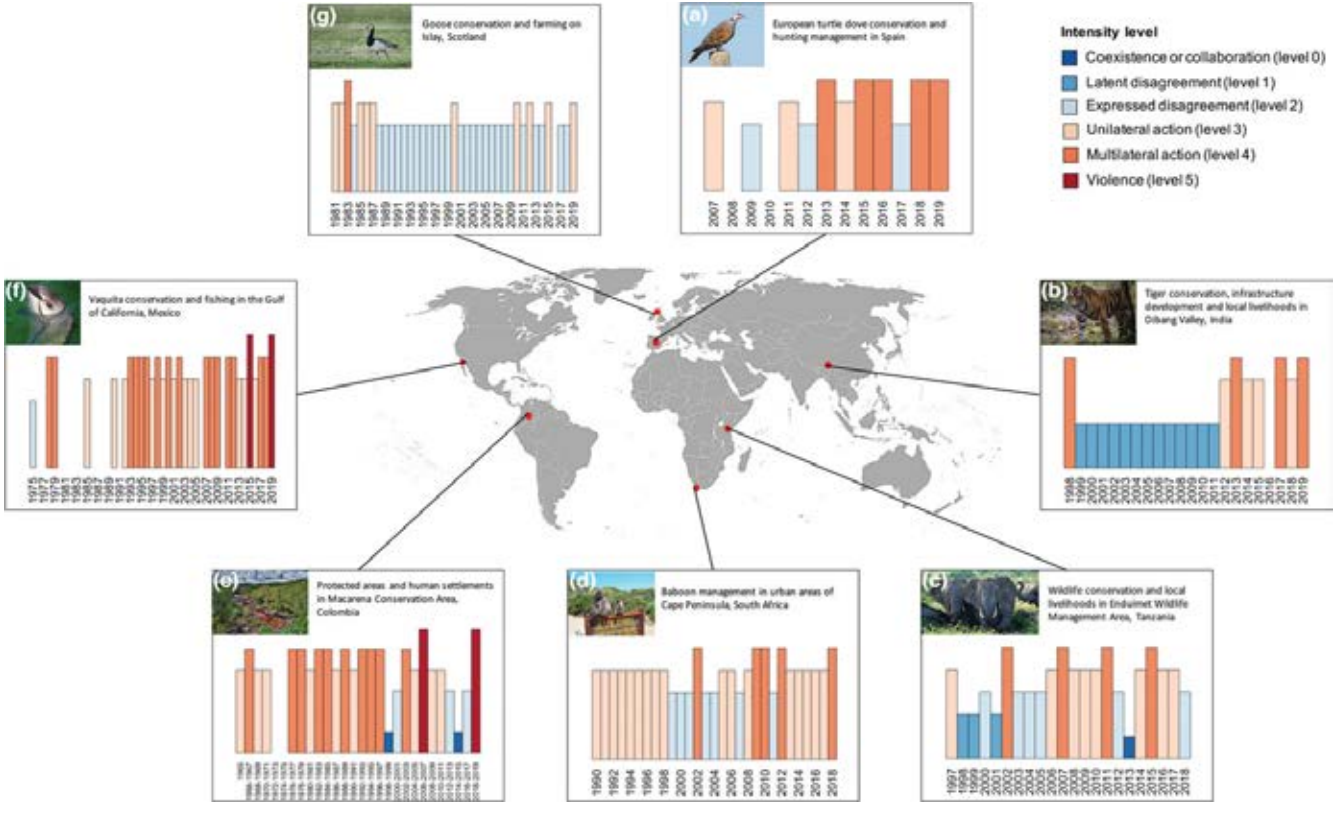




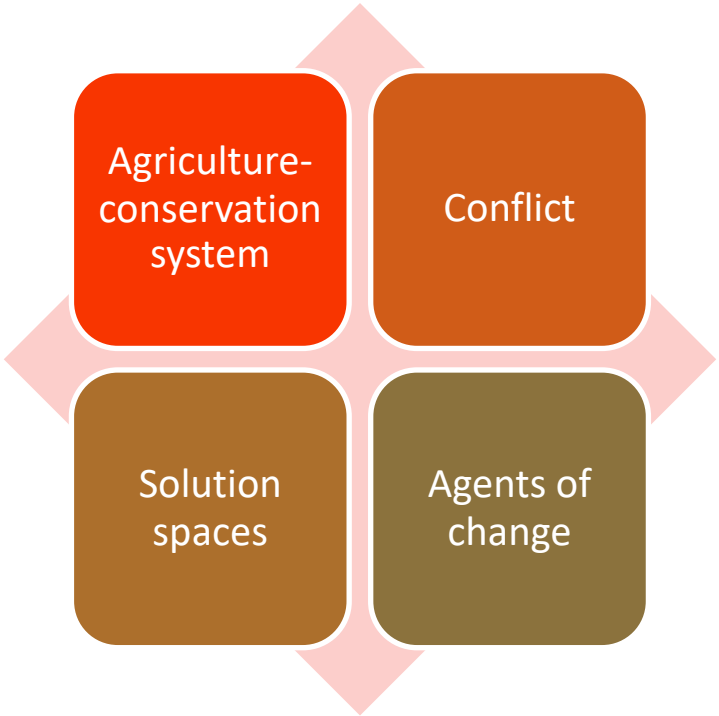
Cusack et al. Conservation Letters, Volume: 14, Issue: 3, First published: 11 January 2021, DOI: (10.1111/conl.12783)

Conflict intensity – examples and case studies



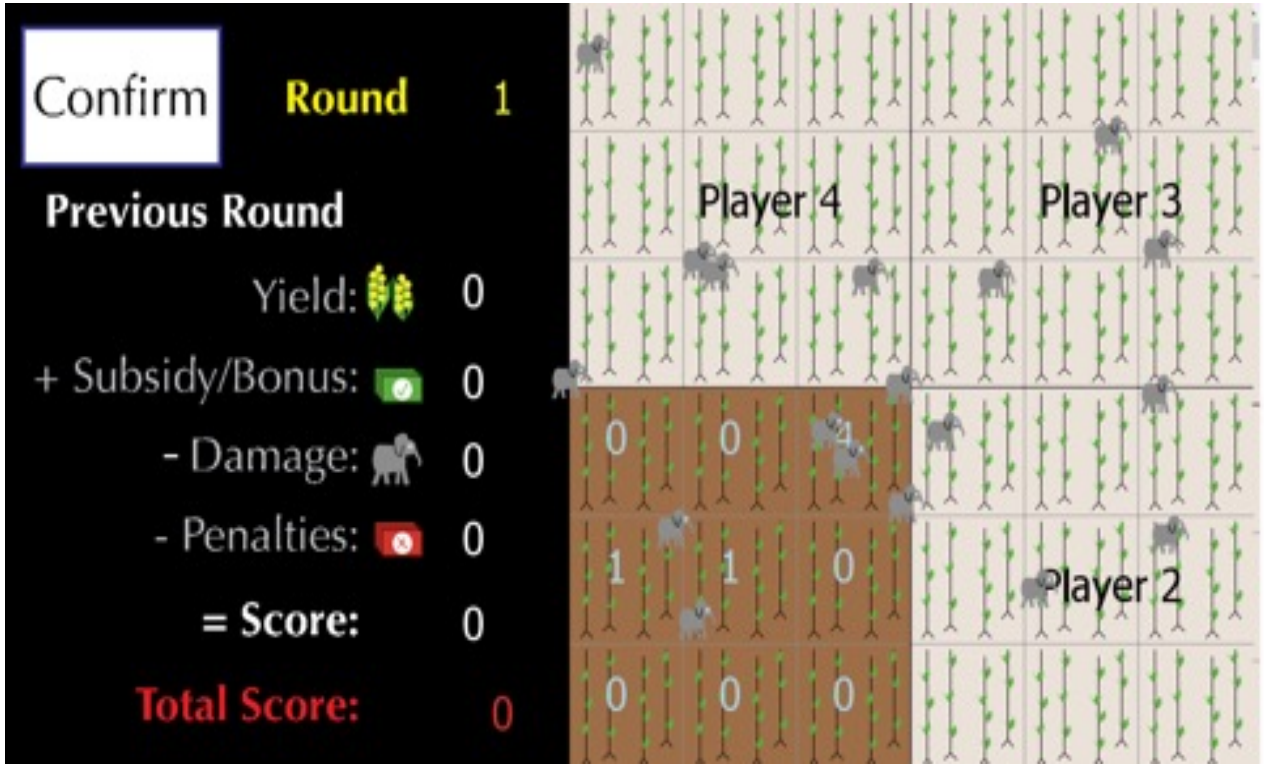


Community based solutions to agriculture-conservation conflicts



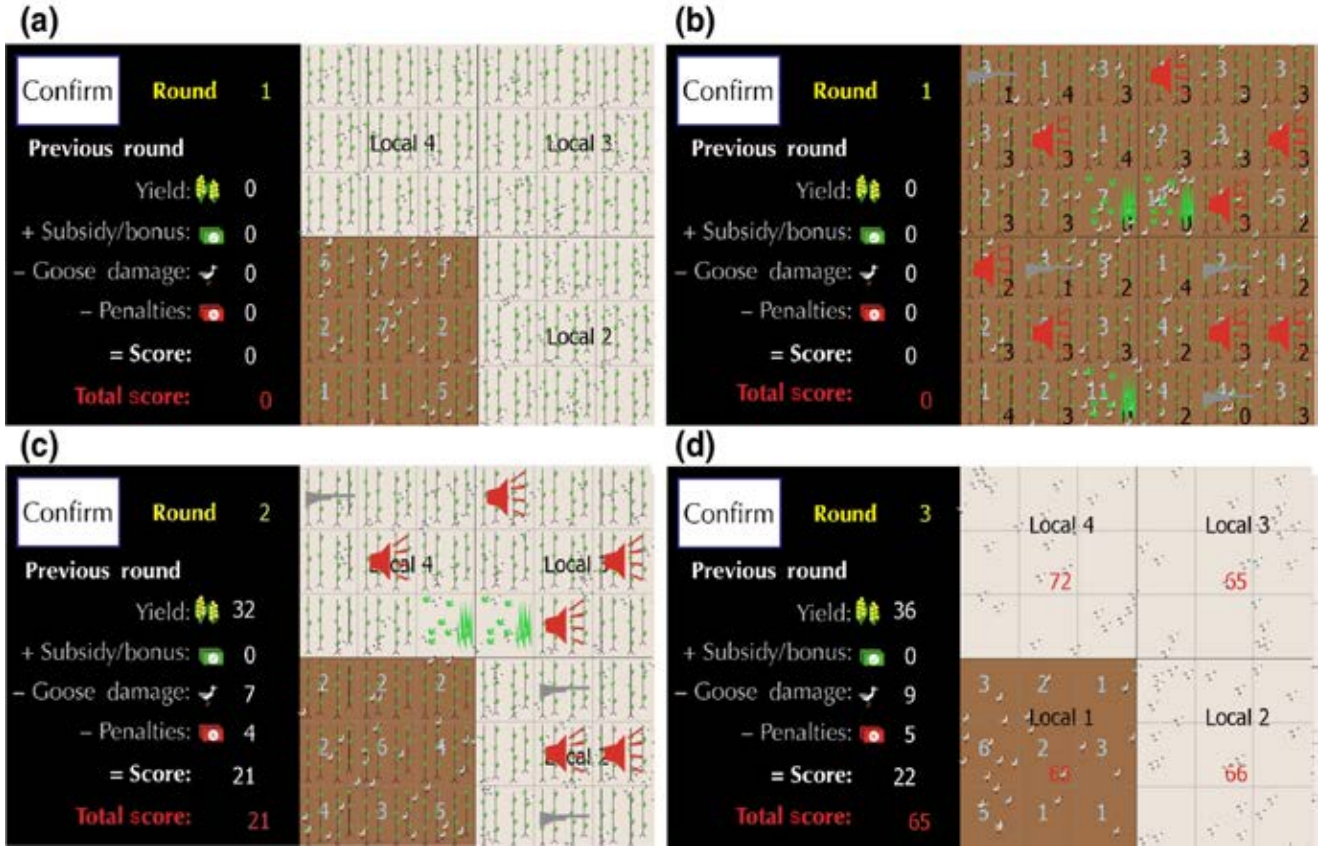
Adapted from Skrimizea et al. (2020) Sustainable agriculture: recognizing the potential of conflict as a positive driver for transformative change. Advances in Ecological Research 63:255

Case studies: playing games with farmers about elephants in Gabon and geese in Scotland and their impacts on agriculture

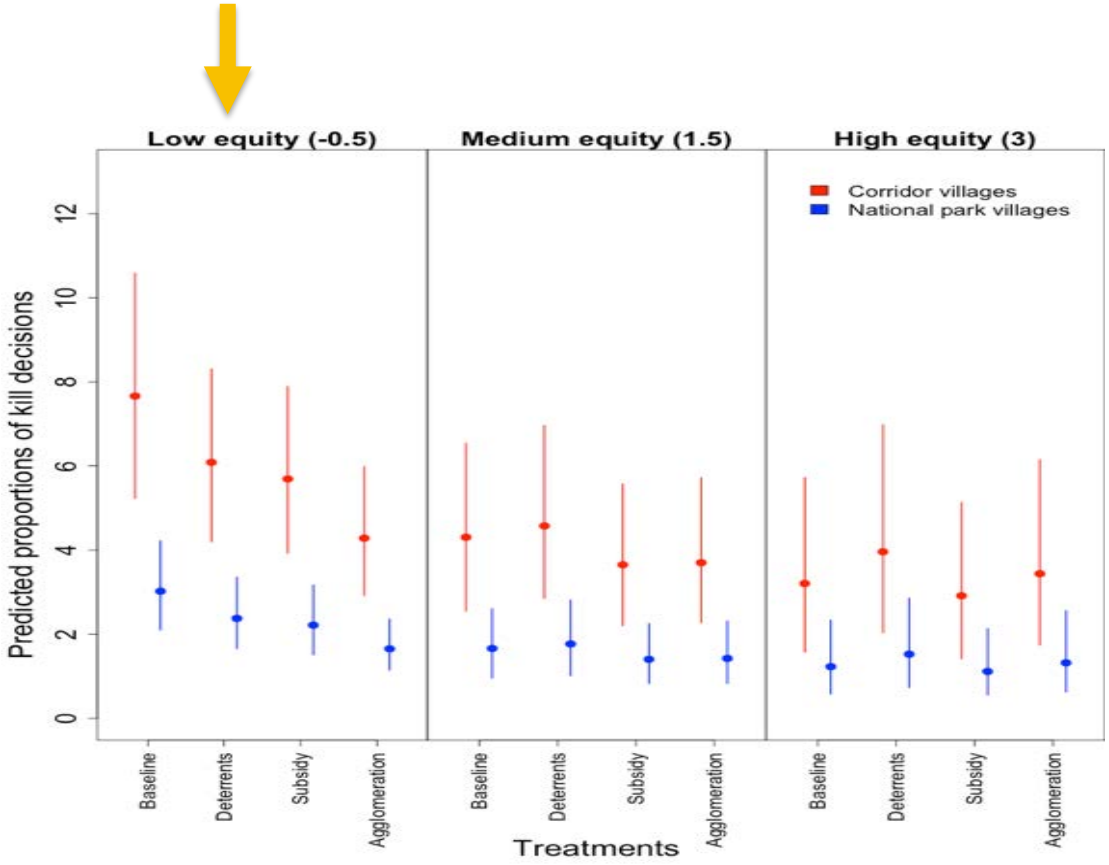


Experimental game framed around farmer land use decisions and played in a group of four households using tablet computers linked via a mobile hotspot

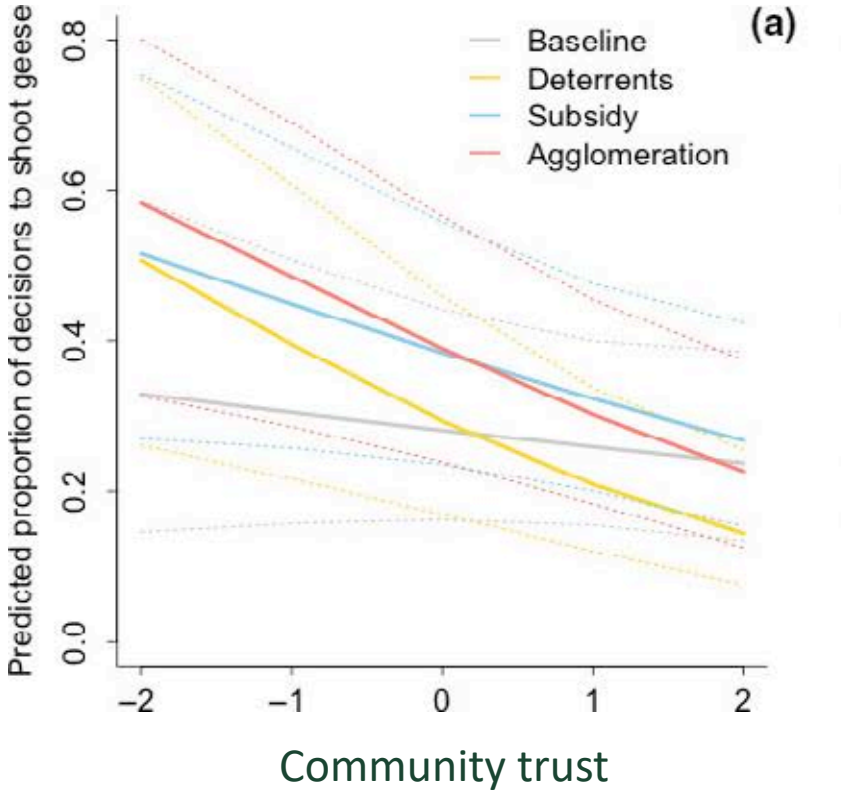
Scotland: 21 games with 84 farmers
Gabon: 65 games with 260 farmers



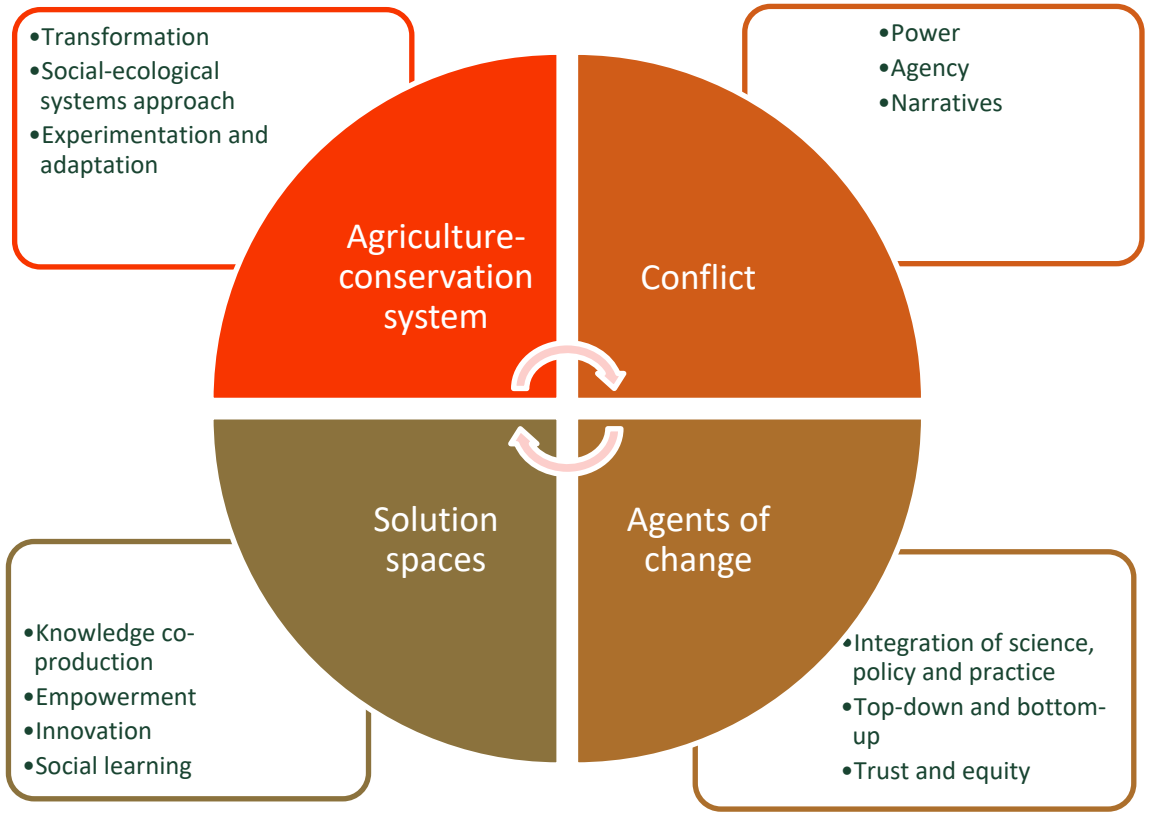
Game results (Gabon): at low fairness/equity perception, kill decisions increase in corridor villages outside national park when no conservation investments are applied



Game results (Scotland): community trust lowers geese shooting decisions



Framework for community based management of agriculture-conservation conflicts



Adapted from Skrimizea et al. (2020) Sustainable agriculture: recognizing the potential of conflict as a positive driver for transformative change. Advances in Ecological Research 63:255

Conclusion

- Equity and trust are important enablers of community based approaches to manage conflicts between agriculture and biodiversity conservation

- Community approaches underused in global to local policy and management

Panel Discussion

‘What do we want to see in the future’

- Bob Cheke
- Habiba Suleiman
- Moses Mafabi
- Shingirai Nyamutukwa
- Aiko Watabe
- Nils Bunnefeld

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Networking

- Invited to join a random breakout room
- Please put your camera and microphone on
- Briefly introduce yourself to the group- name, organisation, interest in the event

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Break

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Monitoring and Forecasting

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KTN

Developing an early-warning system to forecast red-billed quelea distribution

Rachel Dobson, Sustainability Research Institute, University of Leeds

UKRI Innovate UK KTN

Developing an early-warning system to forecast red-billed quelea distribution

Rachel Dobson, Post-graduate Researcher at University of Leeds

NERC-funded PhD research, supervised by Martin Dallimer, Andy Challinor, Bob Cheke, Stewart Jennings and Steve Willis

@RachelDobson98

UNIVERSITY OF LEEDS

Natural Environment Research Council

Application of forecasting for quelea management

Early-warning system:
Quelea will be **abundant** in **specific area**
at **time of the year**

Management opportunities:

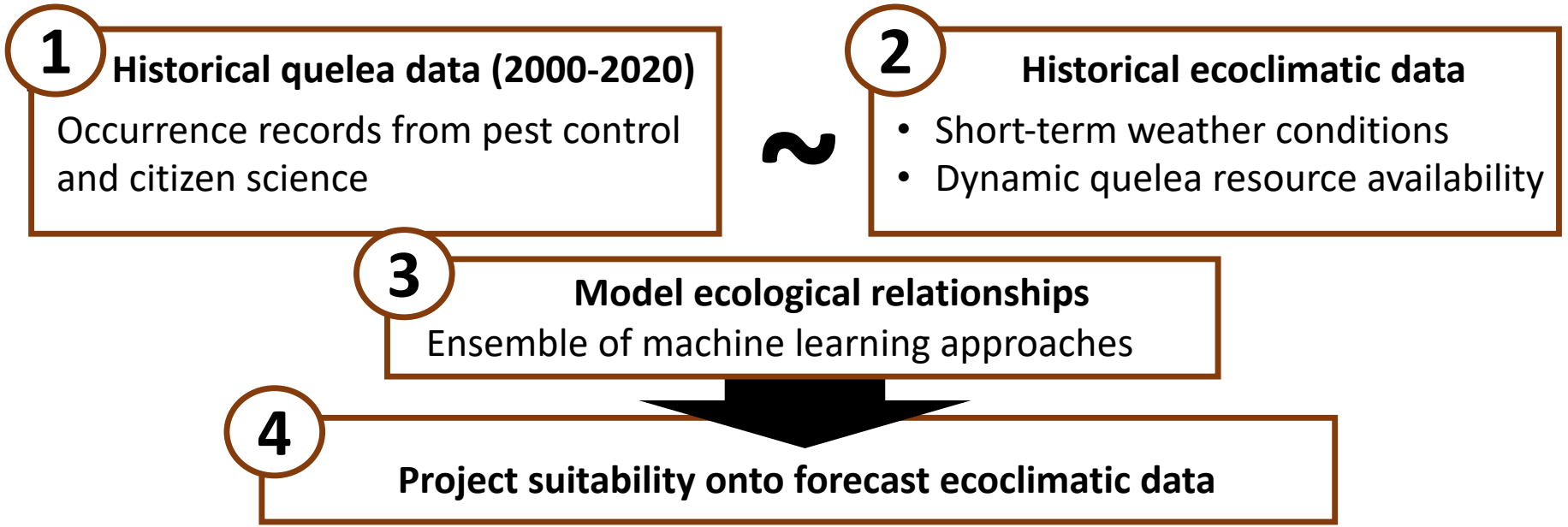
- **Switch to quelea resistant crop varieties or species**
- **Alter planting dates to create timing mismatch with quelea presence**
- **Begin surveys early for quelea colony formation**

Benefits:

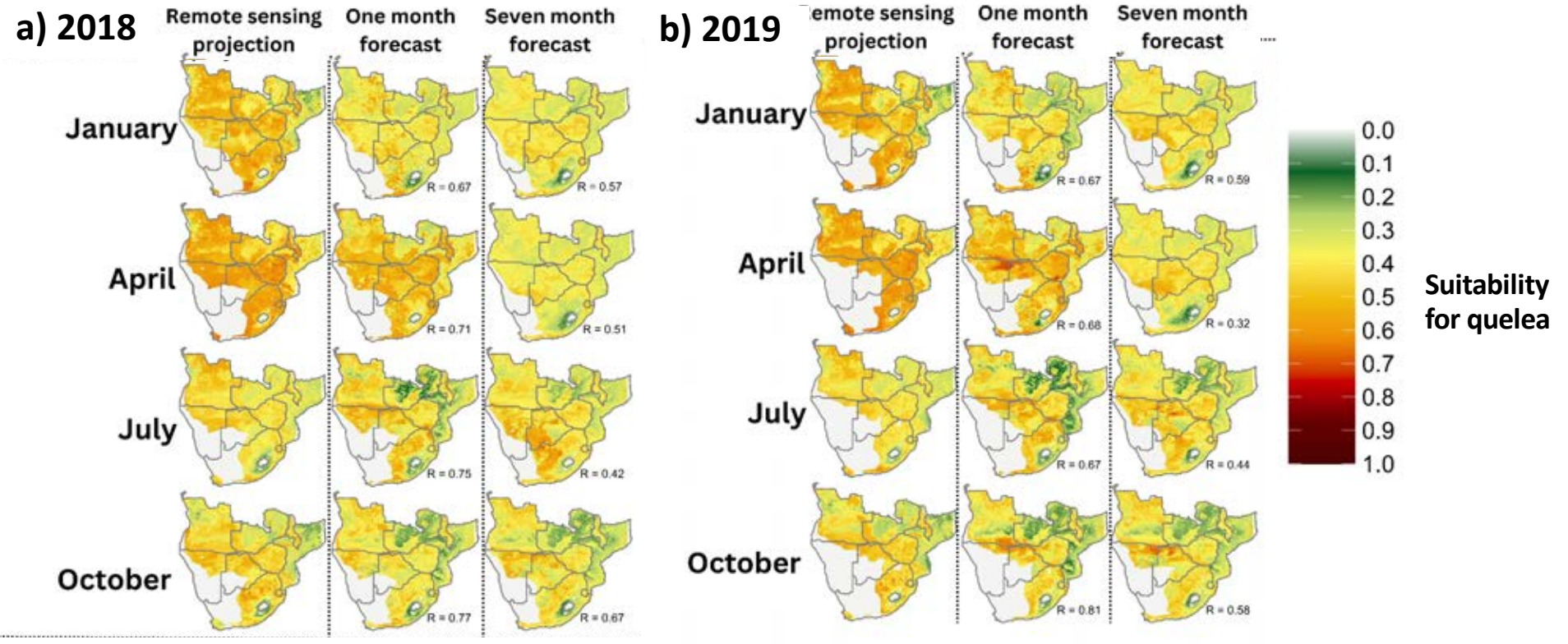
- **Reduce pesticide use**
- **Improve efficiency**
- **Protect food security**

Forecasting system progress

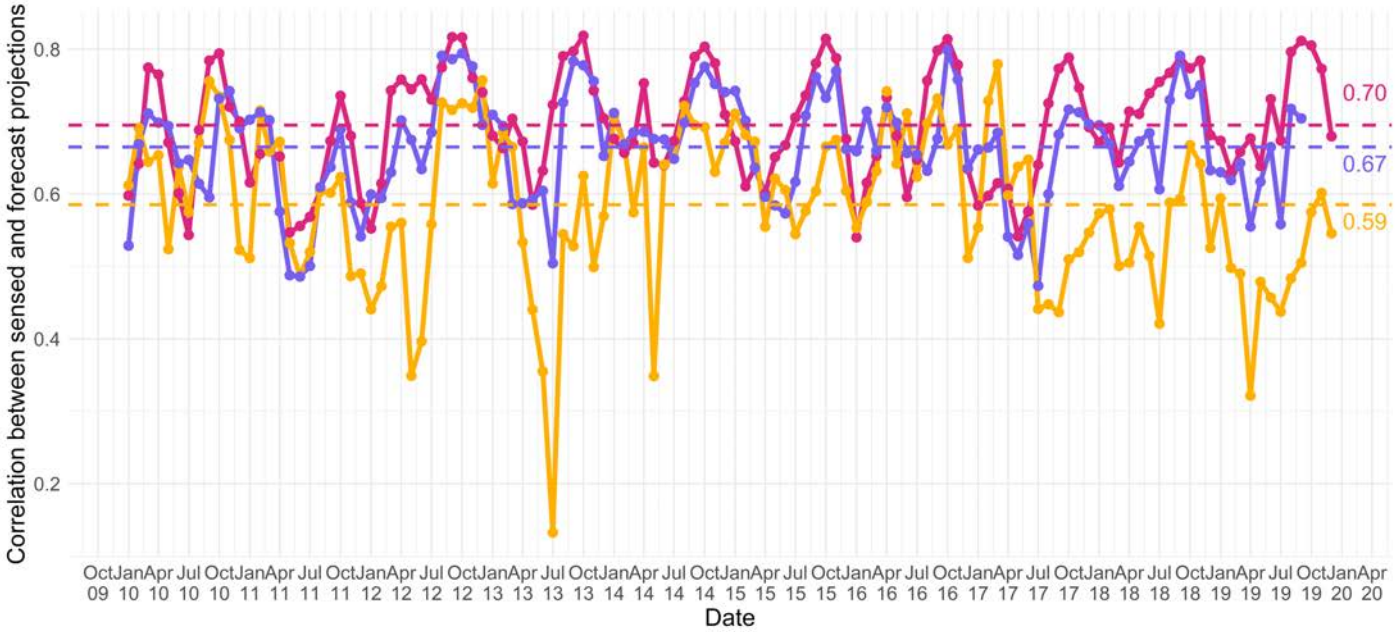
Methodological approach



Forecasting system progress



Forecasting system progress

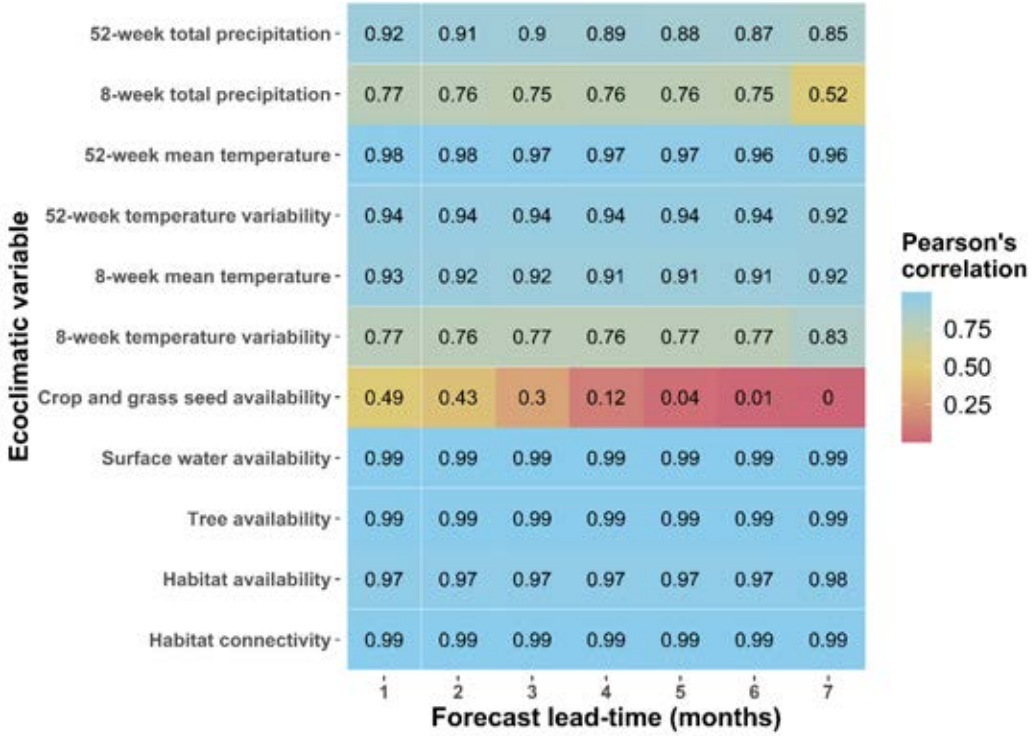


Seven month forecasts poorly match the gold standard projections

Mean correlation with gold standard:

- **One month – 0.70**
- Three month - 0.67
- **Seven month – 0.59**

Forecasting system progress

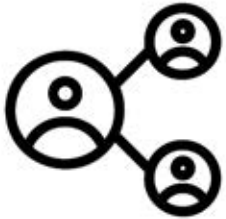


Forecast reliability falls as lead-time increases from one to seven months

Challenges

a) Ecological
- Forecasting remote-sensing variables

b) Climate forecast
- Resolution
- Accessibility



c) Practical
- Updating models
- Reaching stakeholders

Future opportunities

- Early-warning systems could **considerably improve migratory pest management and protect food security**
- Improvements in **data quality and quantity** are driving development of early warning systems
- Need to ensure forecasts are accessible and useful to stakeholders

Thanks for listening!

Acknowledgements

Supervisory team

Martin Dallimer
Andy Challinor
Stewart Jennings
Robert Cheke
Steve Willis

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Durham University

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Funded by…

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Approaches to small-holder farmer agricultural insurance

Samuel Macharia, Business Development Officer, ACRE Africa

UKRI Innovate UK KTN

About ACRE Africa

Agriculture and Climate Risk Enterprise Ltd (ACRE Africa), is a for-profit social enterprise, InsureTech and risk management solutions designer with operations in Africa since 2009. ACRE Africa specializes in linking smallholder farmers to agriculture and climate risk management solutions among them climate change adaptation strategies and tailored agriculture insurance to enhance their resilience towards agricultural and climate change related shocks.

Currently, our main shareholder is Zep-Re (PTA Reinsurance) an organization founded to promote insurance trade in COMESA regions. Cumulatively, ACRE has managed to reach over 5 Million farmers since 2009 in Kenya, Rwanda, Tanzania, Ethiopia, Malawi, Zambia, Nigeria, Ghana, Senegal as well as ASAL Regions.

AFRICA

Crop Insurance as a DE risking tool for small holder farmers

2%
Africa's share of world agriculture exports

90%
Agriculture activities dependent on rainfall

700 Million
Population dependent on agriculture industry in Africa

32%
Contribution of agriculture to GDP

USD 35bn
Food imports by Africa

Industry analysis

Agriculture industry supports 2/3 of the population of sub-Saharan Africa while food purchase accounts for 2/3 of all household budgets of low-income earners. Low productivity levels of agriculture in Africa have resulted in the industry not meeting the growing demand for food from urban centers.

2021 Agriculture Statistics

GROSS WRITTEN PREMIUMS			CLAIMS		
CROP	LIVESTOCK	TOTAL	CROP	LIVESTOCK	TOTAL
353,791,110	423,043,785	776,834,895	133,762,201	138,743,842	272,506,043

AFRICA

Crop Insurance as a DE risking tool for small holder farmers

1. The penetration of risk management solutions in agriculture in Africa remains low, despite the sector's high vulnerability to the impacts of climate change and market inefficiencies. Under the Bima Pima project (2022 season) ACRE Africa ensured that most farmers, 89% of whom had never accessed insurance services before, can afford insurance. A premium of KES 50, for instance, has a potential payout of 10% which is equivalent to KES 500 and would be enough to buy a bag of seedlings.
2. During the drought of 2008 to 2011, the Kenyan economy lost an estimated KSh. 968.6 billion equivalent to USD. 7.3B, it is the reason the government started the KAIP project that was aimed at cushioning small holder farmers against drought and channeling the funds meant for disaster management to development.

AFRICA

Challenges in developing a birds damage Insurance Program

1. Lack of sufficient data ;- As a country , we have not been able to collect enough data to show the impact of quelea birds on either sorghum or rice. Data is very critical in product design, and without sufficient data, it’s not possible to develop birds' insurance products.
2. The effects of quelea birds can be catastrophic, and most insurers have shied away from offering this insurance product. The effect has been a general lack of interest in research and data collection.
3. The Kenyan law is very strict on how one needs to control birds and the insurers shy away from offering the cover because there is a very thin line between negligence and an accident.

AFRICA

Opportunities In Rice Farming

Year	Year difference after 2008	Population at 2.7% Annual growth rate	Estimated Annual National need = Pop.x 8 (kg/person/yr)	Actual Production (kg)	Deficit/Imports (kg)	Expected Annual	Expected Deficit after increasing Annual Production (kg) by 9.31%)
					#NAME?	Production (kg) to bridge the gap (9.31% increase)	
2008	0	36,000,000	300,000,000	73,141,000	226,859,000	73,141,000	226,859,000
2009	1	36,972,000	295,776,000	73,141,000	222,635,000	79,950,427	215,825,573
2010	2	37,970,244	303,761,952	73,141,000	230,620,952	87,393,812	216,368,140
2011	3	38,995,441	311,963,525	73,141,000	238,822,525	95,530,176	216,433,349
2012	4	40,048,317	320,386,540	73,141,000	247,245,540	104,424,035	215,962,505
2013	5	41,129,622	329,036,976	73,141,000	255,895,976	114,145,913	214,891,064
2014	6	42,240,122	337,920,975	73,141,000	264,779,975	124,772,897	213,148,078
2015	7	43,380,605	347,044,841	73,141,000	273,903,841	136,389,254	210,655,587
2016	8	44,551,881	356,415,052	73,141,000	283,274,052	149,087,094	207,327,958
2017	9	45,754,782	366,038,258	73,141,000	292,897,258	162,967,102	203,071,156
2018	10	46,990,161	375,921,291	73,141,000	302,780,291	178,139,339	197,781,952
2019	11	48,258,896	386,071,166	73,141,000	312,930,166	194,724,112	191,347,054
2020	12	49,561,886	396,495,088	73,141,000	323,354,088	212,852,926	183,642,161
2021	13	50,900,057	407,200,455	73,141,001	334,059,454	232,669,534	174,530,921
2022	14	52,274,358	418,194,867	73,141,002	345,053,865	254,331,067	163,863,800
2023	15	53,685,766	429,486,129	73,141,003	356,345,126	278,009,290	151,476,839
2024	16	55,135,282	441,082,254	73,141,004	367,941,250	303,891,955	137,190,299
2025	17	56,623,934	452,991,475	73,141,005	379,850,470	332,184,296	120,807,179
2026	18	58,152,781	465,222,245	73,141,006	392,081,239	363,110,654	102,111,591
2027	19	59,722,906	477,783,245	73,141,007	404,642,238	396,916,255	80,866,990
2028	20	61,335,424	490,683,393	73,141,008	417,542,385	433,869,159	56,814,234
2029	21	62,991,481	503,931,845	73,141,009	430,790,836	474,262,378	29,669,467
2030	22	64,692,251	517,538,004	73,141,010	444,396,994	518,416,205	-878,200

AFRICA

Opportunities

1. Rice production Deficits : - Kenya has not been able to meet her rice production deficits. This in turn means that there is a huge potential for expansion and demand for insurance services
2. Data :- The bottleneck has been data, and if the Kenyan insurer would access rice data, it would be easier for them to design insurance products around rice
3. Rice mitigation protocol : - Novel insurance products would be essential in designing Quelea birds control procedures that would be ideal in differentiating negligence and accidents

AFRICA

THANK YOU

AFRICA

Deterrents and Defence

Innovate UK KTN

Sound based deterrents

Professor John Swaddle, Biology, William & Mary

UKRI Innovate UK KTN

Using a “Sonic Net” to deter birds from a target area on a landscape

John P. Swaddle

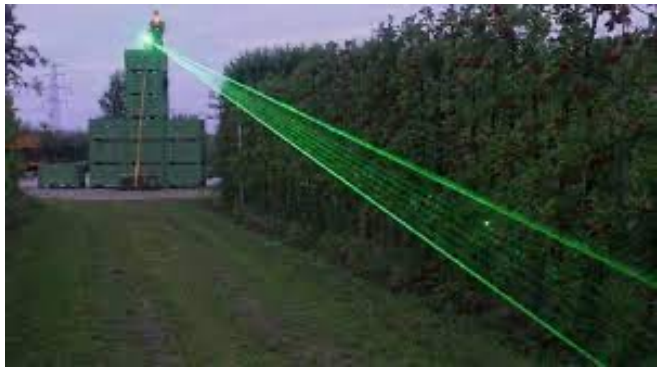
he/him/his

Institute for Integrative Conservation
William & Mary
Williamsburg, Virginia, USA

Email: jpswad@wm.edu

Funding partners:

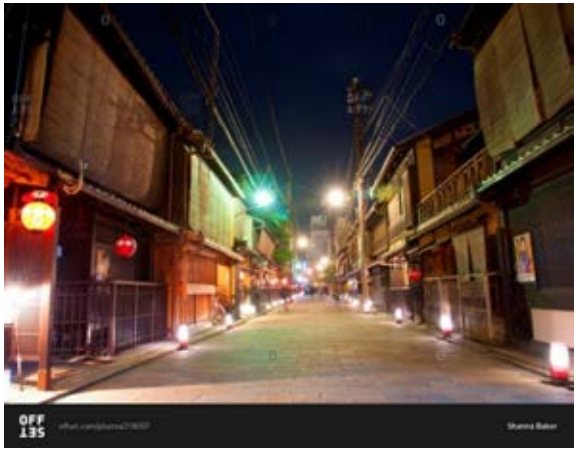
Bird deterrents often fail… as there is no real threat associated with the stimulus



Tap into birds' "ecology of fear"

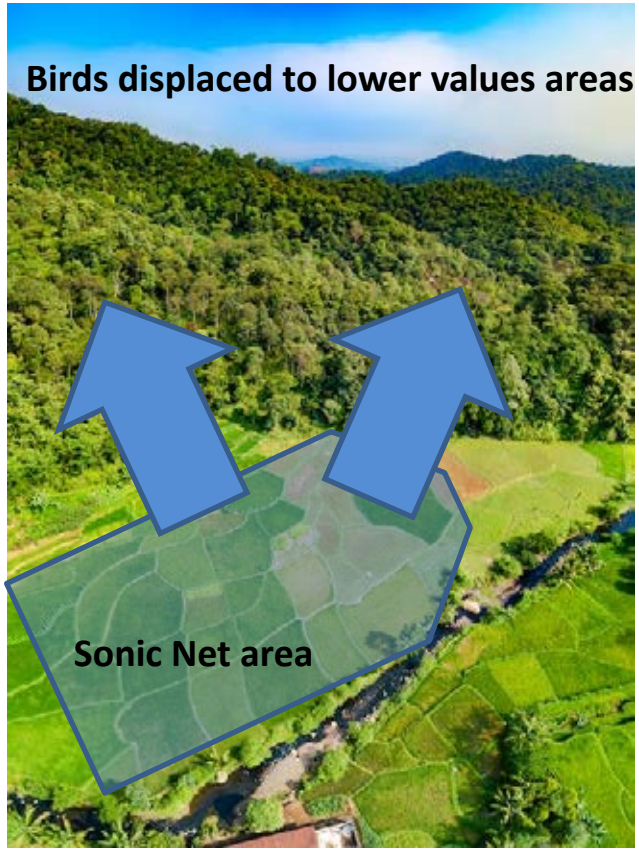
- Birds need constant information about predatory threats
- If sound masks appropriate acoustic ranges, birds' sense of fear skyrockets

An analogy: Which would you choose?



A potential solution: Sonic Net?

- A **spatially-controlled**, **loud sound** that covers the **frequency ranges of avian communication**
- Displaces birds away from the target area, therefore needs to be interpreted as a landscape solution



Does the Sonic Net work?

European starling

- Aviary trials = 50% displacement from food over 1 week (no natural predators)
- 2 x field trials = 80-90% displacement over 4 weeks (airfield, post-harvest grain store)

Red-winged blackbird

- Field trials = 23-65% displacement over 4 weeks (sunflower fields, pre-harvest)


UNIVERSITY OF EXETER
AGRITECH CORNWALL
European Union
European Regional Development Fund
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39 °F 3 °C
02-19-2019 07:00:01

For follow up…

John Swaddle

Institute for Integrative Conservation
William & Mary

Williamsburg, Virginia, USA

Email: jpswad@wm.edu

Drone applications in bird challenges

Dr Aditya Paranjape, Faculty of Engineering, Department of Aeronautics, Imperial College + Tata Consulting Engineers

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UAVs as Robotic Herders and Gate Keepers

Aditya A. Paranjape

Senior Scientist, TCS Research
Honorary Lecturer, Imperial College London
Visiting Associate Professor, IIT Bombay

Overview

Source: Wikipedia

- Quelea flocks devastate grain plantations
- Flocks are large - hundreds of thousands of individuals
- Can we use robots to direct flocks away from grain plantations?

Herding Examples

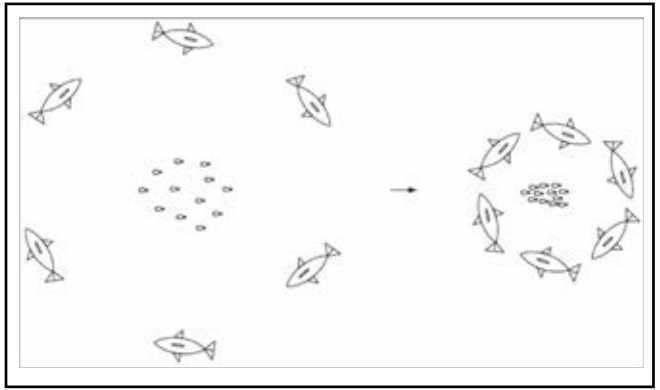
- Inspiration: shepherding dogs, foraging behaviour in dolphins
- Keeping birds away from airports

Source: Wikipedia

Remotely piloted robotic falcon at Edmonton Intl Airport

Source: globalnews.ca

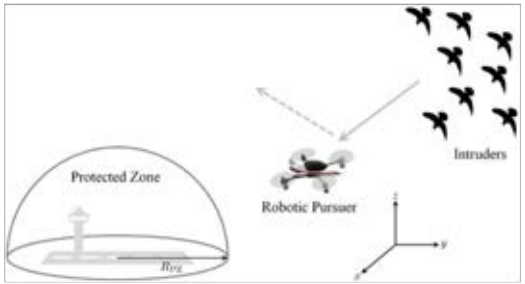
Dolphins using a horizontal carousel for containment



Source: Haque, Rahmani and Egerstedt, 2011

Robotic Herding of Birds - 1

- Our work: use autonomous drones to keep flocks of birds away from airports
  - Alternative to guns, horns, pigs, etc.



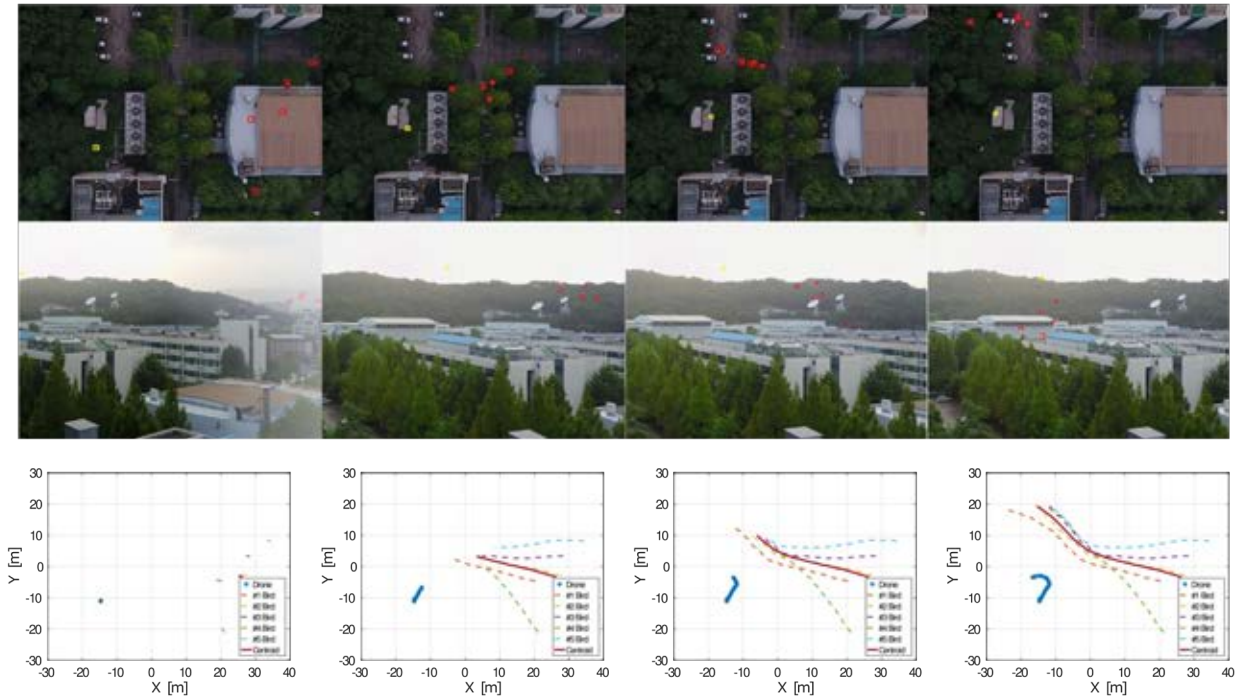
- Assumptions about the nominal behaviour of individual birds:
  1. they maintain a fixed distance from their neighbours
  2. they stick to the flock -> the flock acts as a cohesive unit
  3. they move away “radially” from drones in their vicinity -> this enables herding

- Use one or more drones to herd *cohesive* flocks

Paranjape, Chung, Kim, and Shim, IEEE Trans. Robotics, 2018

Robotic Herding - 2

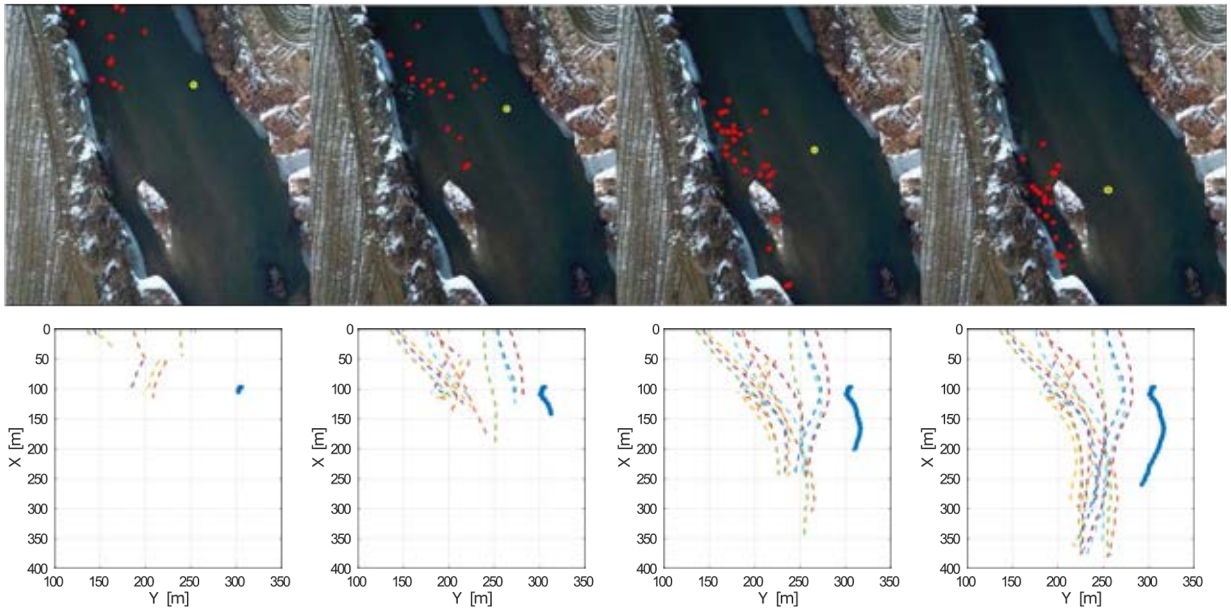
- Example 1: a single group of birds (egrets) deflected using a drone
- Take-away: birds moved away from the drone as expected (i.e., no unexpected manoeuvring)



Paranjape, Chung, Kim, and Shim, IEEE Trans. Robotics, 2018

Robotic Herding - 3

- Example 2: multiple groups of birds deflected using a drone
- Take-away question: how does one identify the number of flocks?



Paranjape, Chung, Kim, and Shim, IEEE Trans. Robotics, 2018

Challenges and Research Directions

- Herding has been investigated for flocks that have no interest in the protected area
  - Present case: quelea's feeding grounds
  - How do flocks react when they are desperate for food?
- Shared intelligence and learned behaviour
  - Divide and conquer
  - Milling behaviour in fish
  - Aggression towards the drones
- How do we identify a flock's behavioural strategy?

Source: Wikipedia

Source: Wikipedia

Source: express.co.uk (2015)

Fertility control to manage overabundant wildlife

Dr Giovanna Massei, Botstiber Institute for Wildlife Fertility Control, University of York

UKRI Innovate UK KTN

Fertility control to manage overabundant wildlife

UNIVERSITY of York

Dr Giovanna Massei

BOTSTIBER INSTITUTE
FOR WILDLIFE FERTILITY CONTROL

Human-wildlife conflicts are increasing

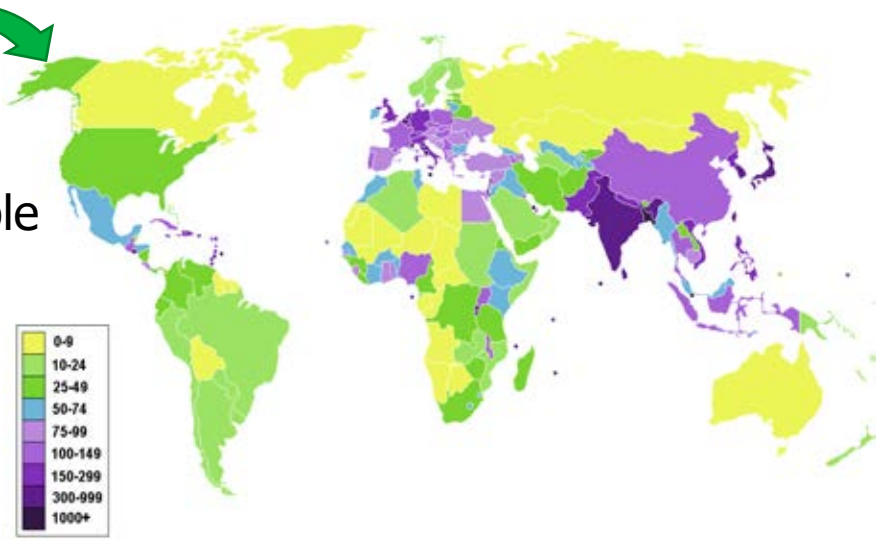
- Damage to crops, forestry, property
- Disease transmission
- Impact on native species
- Traffic accidents
- Livestock predation
- Attacks on humans

Human-wildlife conflicts are increasing

"Too many" people

+

"Too many" animals



Economic & environmental impacts

….publicly supported solutions are needed

Fertility control : when?

When lethal control is:

- illegal
- unacceptable
- unfeasible
- unsustainable
- environmentally hazardous
- ineffective

Additional information

BOTSTIBER INSTITUTE
FOR WILDLIFE FERTILITY CONTROL

About | BIWFC Europe | Conference | Grants | Events | Media | Education | Repository

EVENTS **EDUCATION** **GRANTS**

gmassei@botstiber.org

To join our mailing list, e-mail us at biwfc@botstiber.org

https://wildlifefertilitycontrol.org/

Networking/ Discussion

- Invited to join room
- Please put your camera and microphone on
- Briefly introduce yourself to the group- name, organisation, interest in the event

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Break

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Agronomic and Ecological Approaches

Innovate UK
KTN

The role of crop breeding in preventing loss

Dr Ephrem Habyarimana, Principal Scientist, ICRISAT

UKRI Innovate UK KTN

ICRISAT
INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

Can Genetics Control birds damages in sorghum?

Patancheru, April 25, 2023

Ephrem.Habyarimana@icrisat.org

Quelea + Innovation Event

About ICRISAT

Established in 1972

- By a consortium of organizations convened by Rockefeller & Ford Foundations
- Govt. of India support

Organization

- Non-profit, non-political
- Agricultural research for development
- In semi-arid tropics of Asia & sub-Saharan Africa

ICRISAT's reach

- 2.1 billion people in drylands, of which 764 million are poor
- In 55 countries
- Covers 6.5 million sq.km land

Mandate crops

- 6 climate-resilient crops
- Nutri-cereals: sorghum, pearl millet, finger millet
- Legumes: groundnut, chickpea, pigeon pea

Global HQ- Patancheru, Hyderabad, India

Global presence

- Global Headquarters – Asia (Patancheru, Hyderabad, Telangana, India)
- Other locations: 8 in Africa
- East and Southern Africa – ESA

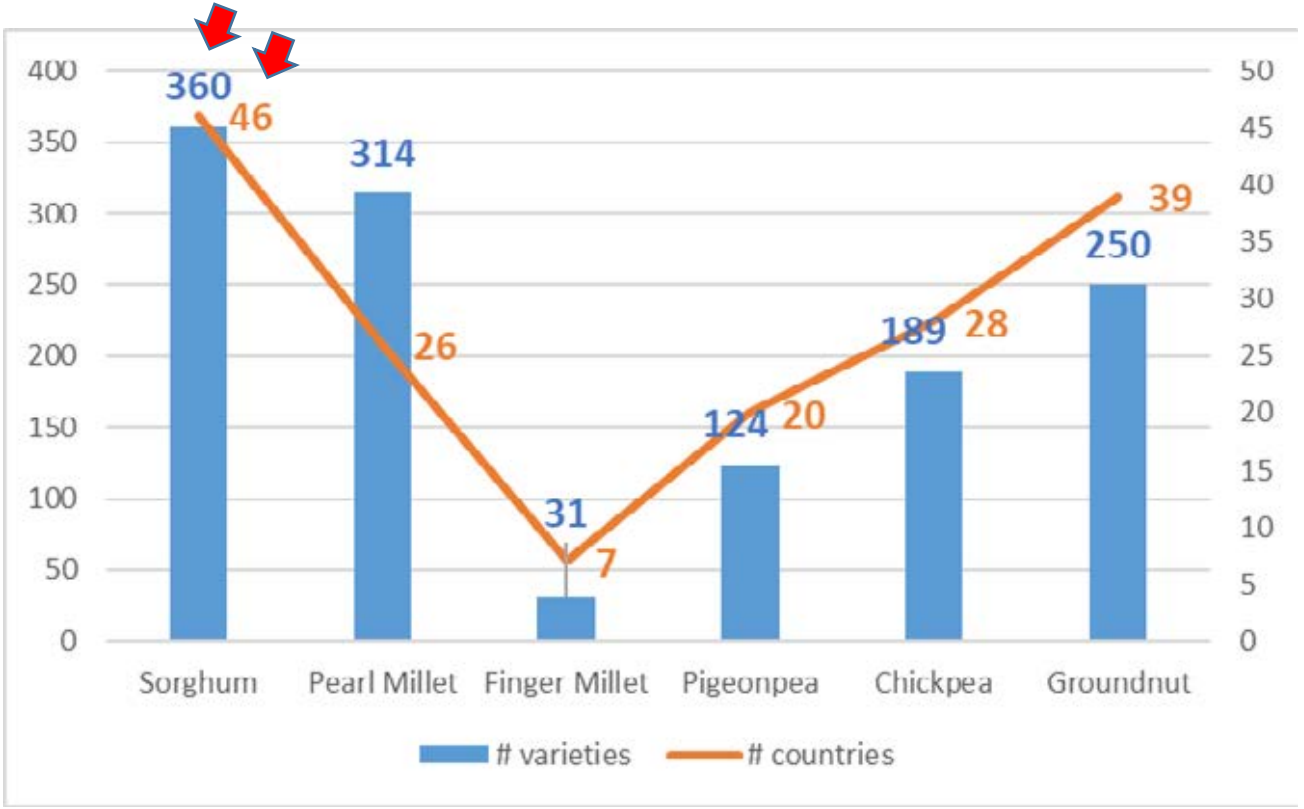
Kenya (Regional office), Ethiopia, Malawi, Mozambique, & Zimbabwe

- West and Central Africa - WCA

Mali (Regional office), Niger, &Nigeria

Creating Impact: ICRISAT varieties released globally (as on April 08 , 2023)

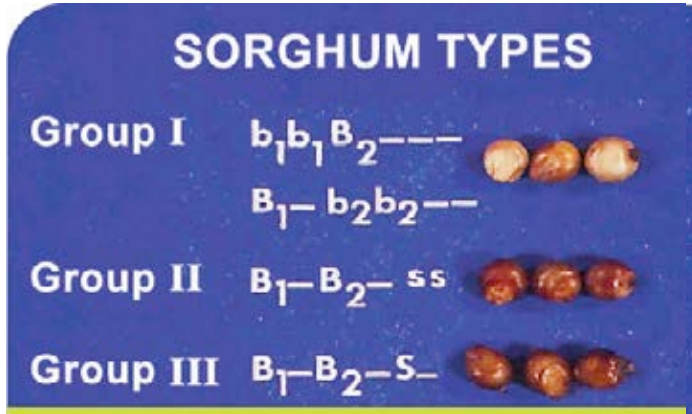
ICRISAT breeds sorghum materials with farmer-preferred traits.

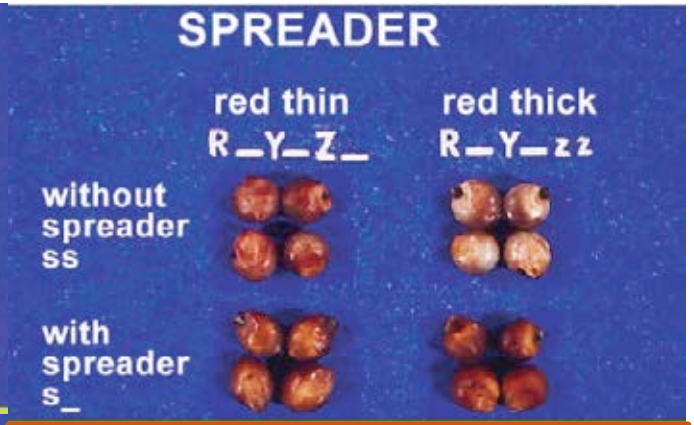


Background: Bird damages vs role of genetics

- Sorghum is among cereal crops most vulnerable to bird damages
- Sorghum grain yield losses caused by birds have been reported to reach 52% and higher; small fields can be wiped out.
- It is believed that natural selection retained a certain tannin content in domesticated sorghum as these compounds conferred sorghum resistance to frequent grain molds and bird damages.
- The condensed tannins are the only type of tannins that have been found in sorghum.
- These compounds in sorghum grains are found in the seed pericarp (external coat) and pigmented testa (the layer between pericarp and endosperm).

Genes governing tannins accumulation in the kernel

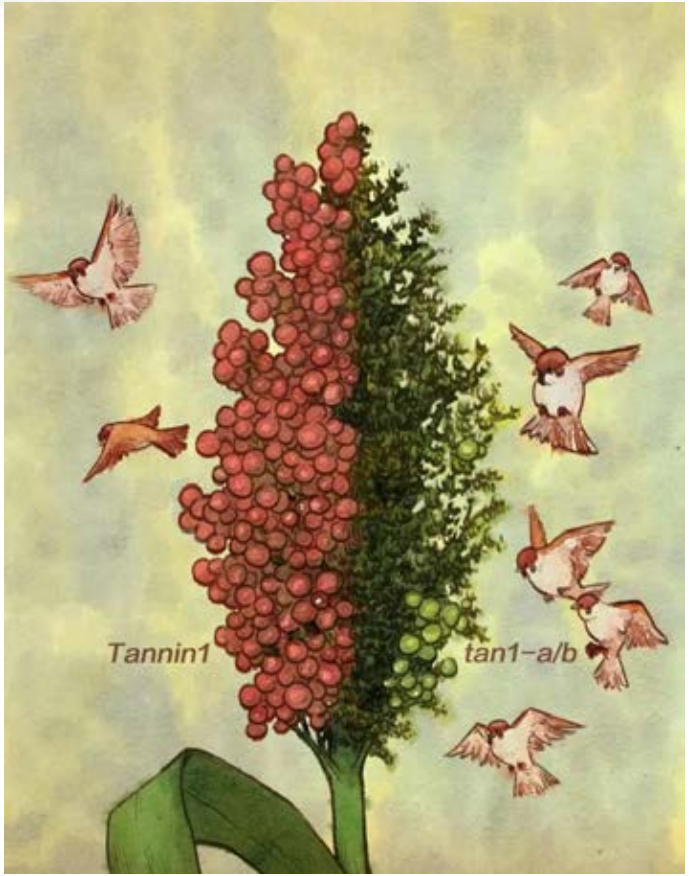




The presence of genes B1_B2 indicates that there are tannins present in the testa layer which can be increased in the pericarp if there is interaction between I_, S_, zz, Tp_ (testa color, brown), tptp (purple) genes.

Towards Integrated Birds Damages Management in Sorghum

- Awns, large glumes, very compact heads, and gooseneck can reduce birds damages especially when there is plenty of food around.
- The amount of tannin is determined by the presence of the intensifier (I_) and spreader genes (S_), interacting with genes B1_B2_, Tp_, tptp and other genes (Z_ and zz) that control mesocarp thickness.
- Increased tannins in the kernel can enhance birds damage control using conventional, marker-aided breeding, and/or New Breeding Techniques (NBTs).
- Tannin sorghums are astringent but **not toxic** to birds and animals, and they are not "**bird proof**."
- Birds prefer foods other than tannin sorghums, but they eat the bird resistant sorghums if they do not have an alternative bird food supply (ABFS) and they thrive on it.
- Integrated birds management (IBM): Landscape level (coordinated planting, habitat integrity, ABFS), & plant genetics, can maximize birds damage control and substantially limit grain yields loss.



Sorghum Hybrid Parents Research Consortium (SHPRC)

HYBRID PARENTS RESEARCH CONSORTIUM (SORGHUM)

ABOUT HPRC (SORGHUM)

ICRISAT's HPRC (Sorghum) partners with Private Sector (PS) seed companies in India, and abroad to deliver improved hybrids and varieties to poor farmers.

HPRC provides the following:

- Evaluating breeding materials for various traits and adaptation at targeted sites in target ecologies
- Serving as a platform to evaluate promising pipeline hybrids across agro-ecological zones
- Providing services to screen private sector lines and hybrid
- Supporting nucleus seed supply
- Facilitating networking.

333 sorghum varieties released in 46 countries.

IMPACT

- Of the 14 new hybrids commercialized by private sector partners, 8 were developed using ICRISAT-bred material (A-/B- or R-lines)
- About 25% of partners used ICRISAT-bred sorghum R-lines directly to make two hybrids; another 25% of private sector partners used the ICRISAT-bred lines (up to 50% R-line) to develop two hybrids
- About 25% of partners directly used ICRISAT-bred A-lines to develop five hybrids; the other 25% used the selections from ICRISAT-bred A/B pairs to make two hybrids while another 12% used <25% ICRISAT bred line to make one hybrid
- 12 of hybrids were generated using ICRISAT-bred hybrid parents by six seed companies
- ICRISAT contributed about 80% of sorghum A- and B- lines, and 60% of R-lines to the working collection of private seed companies (2000-2010).

ICRISAT INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

About ICRISAT: www.icrisat.org

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ICRISAT
1972-2022

Thank YOU

Agronomic approaches to loss prevention

Professor Jonne Rodenburg, Agriculture, Health and Environment Department, Natural Resources Institute

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Agronomic approaches to loss prevention

Strategies to manage quelea birds in Africa

Jonne Rodenburg

Professor of Agronomy

1. Non-chemical quelea control in rice

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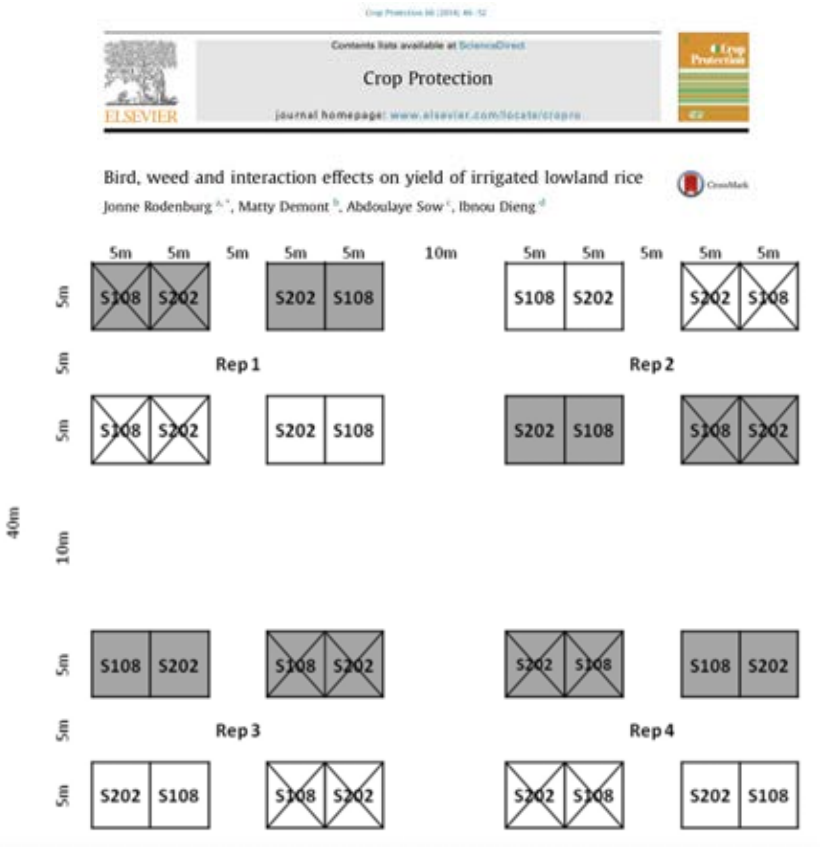

Experimental set-up with two rice cultivars (Sahel 202, Sahel108), weedy (grey), weed-free (white), netted (crossed) and un-netted (open) plots.

1. Non-chemical quelea control in rice

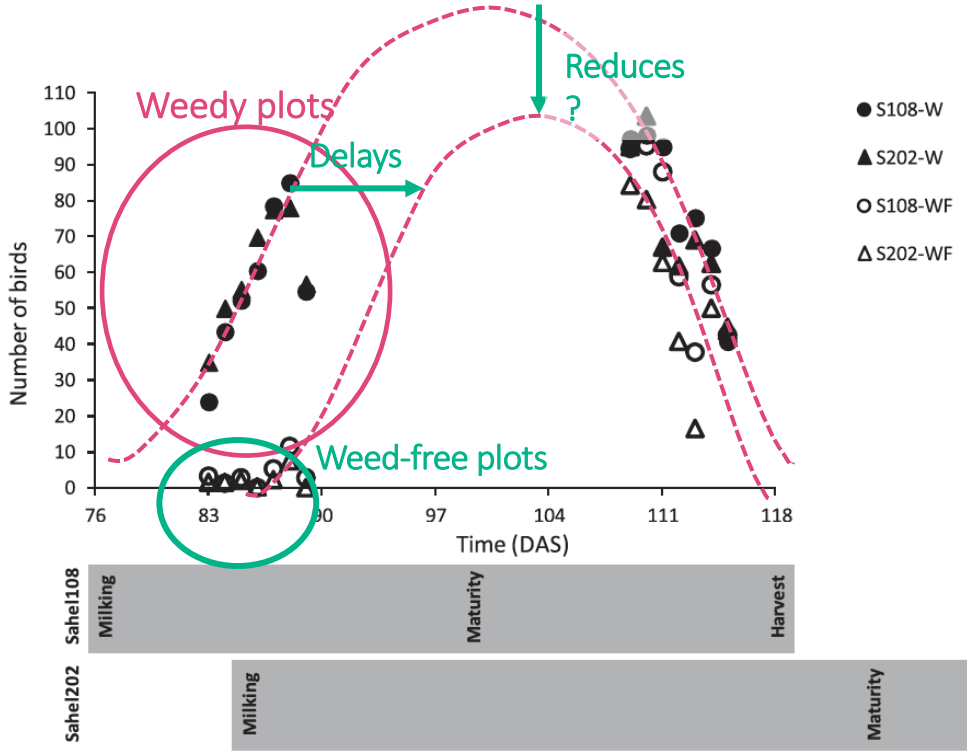

Table: Relative yield losses (%) per yield reducing factor

Yield reducing factor		Rice cultivar			Overall
		Sahel 108		Sahel 202	
Year 1	Birds	13.4	<	51.8	31.5
	Weeds	68.3		74.8	71.3
	Birds × weeds	86.5		79.7	83.3
Year 2	Birds	70.8	>	26.6	48.7
	Weeds	75.0		50.0	62.6
	Birds × weeds	98.6		94.4	96.6
Year 3	Birds	44.5	<	93.6	68.5
	Weeds	71.2		58.8	65.1
	Birds × weeds	91.2		98.1	94.5

Differences between short (Sahel 108) and long (Sahel 202) duration cultivars, but inconsistent

1. Non-chemical quelea control in rice

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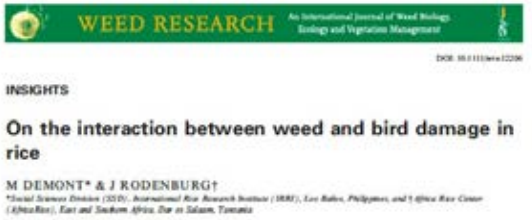


Year	RYL weeds, bird-free (%)	RYL birds weed-free (%)	RYL weeds + birds (%)	RYL (1) contribution by birds in weedy field (%)
Yr 1	71	31	83	12 (83-71)
Yr 2	63	49	97	34 (97-63)
Yr 3	65	69	95	30 (95-65)

- Birds seem to cause less damage to a weedy compared to a weed-free field following RYL (1)
- However, birds only eat what is left after damaging effects of weeds, hence:

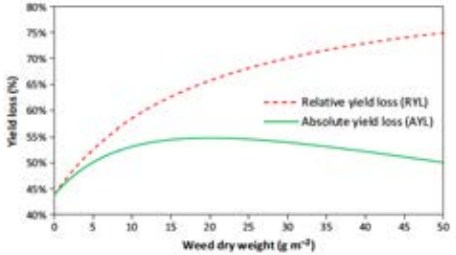
✓ Yr 1: YP: 7.4 → + weeds→ 2.1→ + birds →1.2
  ✓ Bird-inflicted RYL (2) = (2.1-1.2)/2.1 → 43 %

✓ Yr 2: YP: 11.1 → + weeds→ 4.1→ + birds →0.4
  ✓ Bird-inflicted RYL (2) = (4.1-0.4)/4.1 → 90 %

✓ Yr 3: YP: 5.4 → + weeds→ 1.9 → + birds →0.3
  ✓ Bird-inflicted RYL (2) = (1.9-0.3)/1.9 → 84 %

- Weed control can reduce bird visits and bird damage in rice
- Cultivar choice (short or long?) may have importance (as well as sowing date)

Model: bird-inflicted yield loss increases from 44% in weed-free conditions to max. of 55% at a critical weed infestation level of 20 g/m^2



2. Non-chemical quelea control in sorghum

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- Weed management less likely to contribute?
- Role of sorghum varieties?
  - Grain colour, size, taste*?
  - Variation in grain glumes?
  - Panicle types, i.e. Guinea, Caudatum, Kaffir, Durra
    - Variation in beards and awns?
    - Pendant or bended vs upright (open vs dense)
  - Maturity time: long vs short duration?
    - Short duration cv's may avoid or reduce length of bird exposure

Durra variety N13 reported as less attractive to Quelea

** high tannin levels at milking/early dough stages*

2. Non-chemical quelea control in sorghum

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Additional agronomic & agro-ecological measures

- Quelea prefer wild seeds over cultivated?
  - Diversified or improved field margins with tall and productive 'lure' grass species?
- Rotations with maize or non-cereal crops?
  - May require community-coordinated approach
- Intercropping with 'repellent' cover crops?
- Timing of crop establishment to avoid milking/dough/maturity stages coincide with migrating bird arrivals
  - May require community-coordinated approach
  - Most often requires irrigation facilities
  - Could be combined with short-duration cv's
- *Netting – effective but expensive and not widely available in remote rural areas*

- No measure will provide the ultimate solution
- Range of options is a function of crop and growing environment
- Integrated quelea control strategy proposed: "*many little hammers*"

2. Non-chemical quelea control in sorghum

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Research in agronomic & agro-ecological measures

- Cultivar screening
  - Identifying adapted and accepted cultivars with bird avoidance or resistance properties
- Identification of species for agro-ecological approaches
  - ‘lure’ grasses for field margins
  - ‘repellent’ cover crops (?)
- Community-based crop rotations
- Timing experiments
  - Planting times
  - Synchronization (community-wide)
  - Long vs short-duration cv’s
  - Combinations
- Integrated quelea control strategies
  - Farmer-participatory, community-wide research

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Thank you

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Discussion

- Invited to join a random breakout rooms
- Please put your camera and microphone on
- Briefly introduce your self to the group- name, organisation, interest in the event
- **Key Question**: How can stakeholders work together to implement new innovations to reduce crop loss?

UKRI Innovate UK KTN

Thank you for attending!

Get in touch:

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