



Genome Editing for Food Security
and Environmental Sustainability

Case Study

Instructors:

Dr. Baljit Singh, Dr. R. S. Sethi

Members:

Ekta, Jasmine, Sheza, Zoe

Outline of Presentation

Overview of Case Study

Ekta

Long-term Solutions using CRISPR Approach

Jasmine

Short-term Solutions and Roadblocks (Government Policies and Public Opinion)

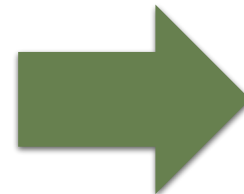
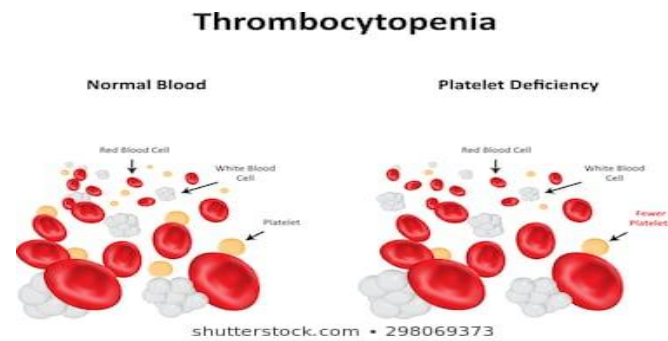
Zoe

Communication to the Public

Sheza

Data Set 1

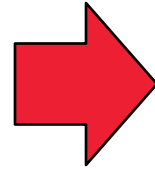
- Cases with high fever (39°C , or more), thrombocytopenia, leukopenia, diarrhoea, and abdominal pain – 30% patients died following multiple organ failure
- Similar symptoms as anaplasmosis, but broad spectrum antibiotics didn't work



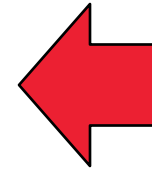
Small arachnids



Hard scutum on
their back



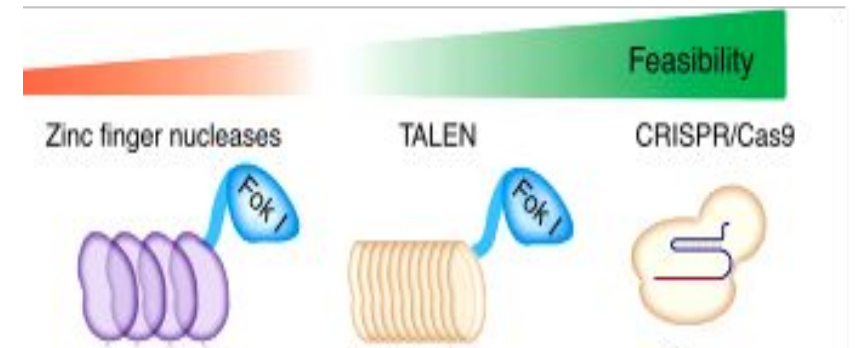
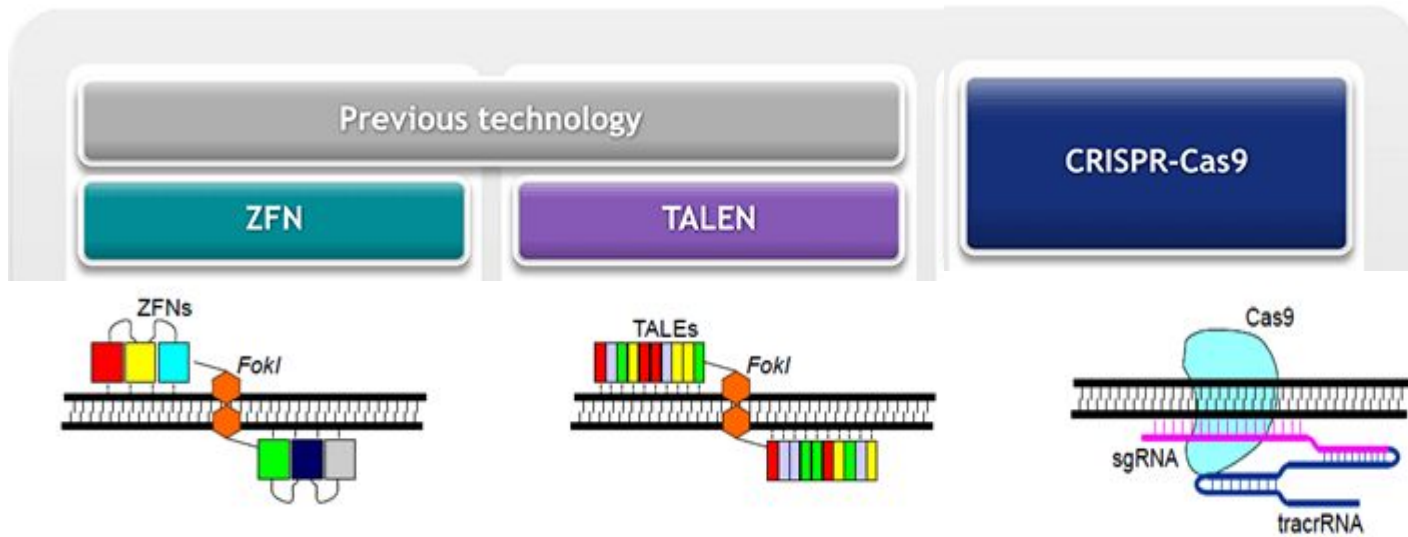
Complex life
cycle



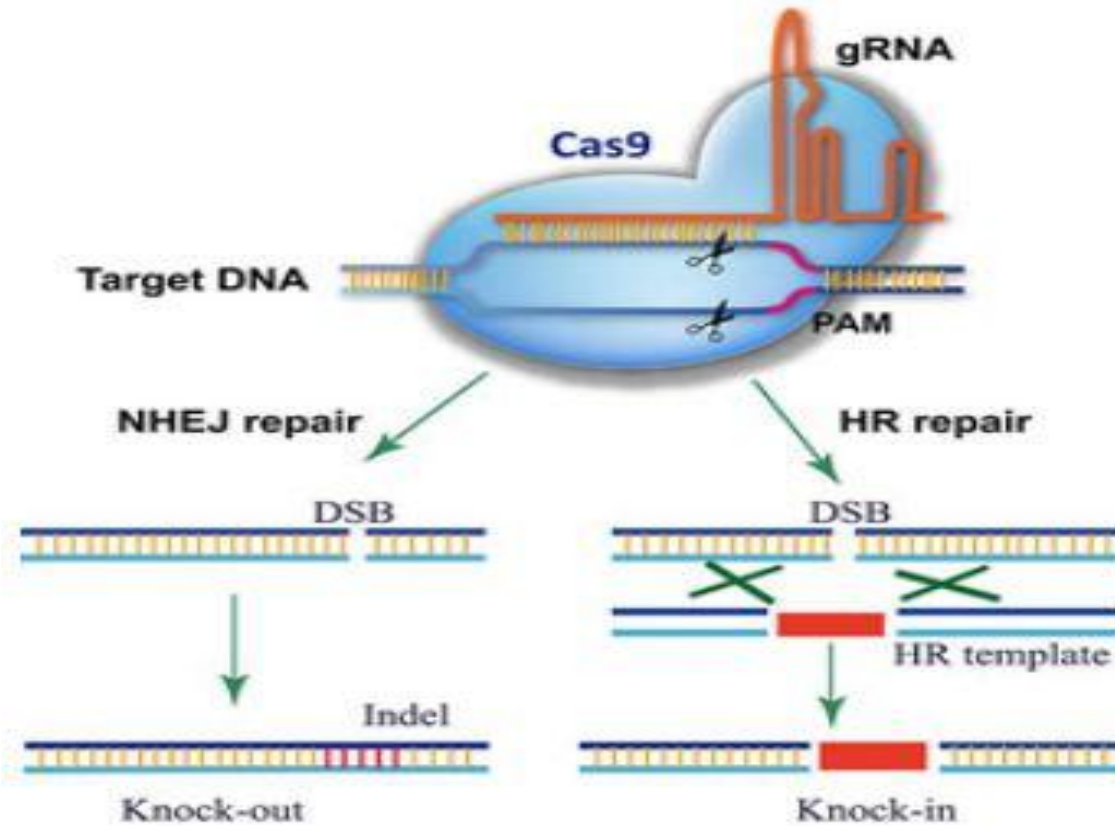
Severe Fever with
Thrombocytopenia



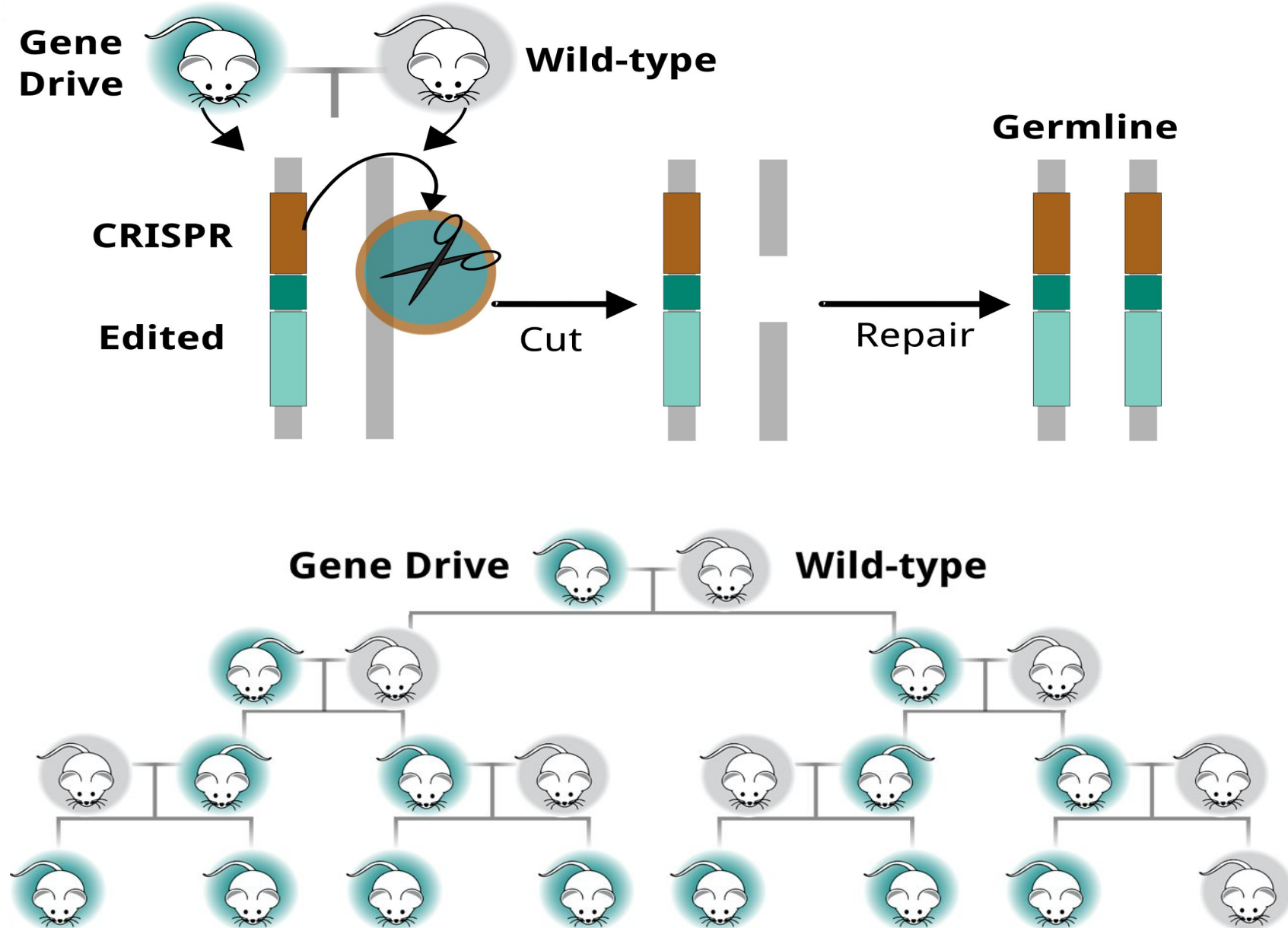
Genome Editing Techniques



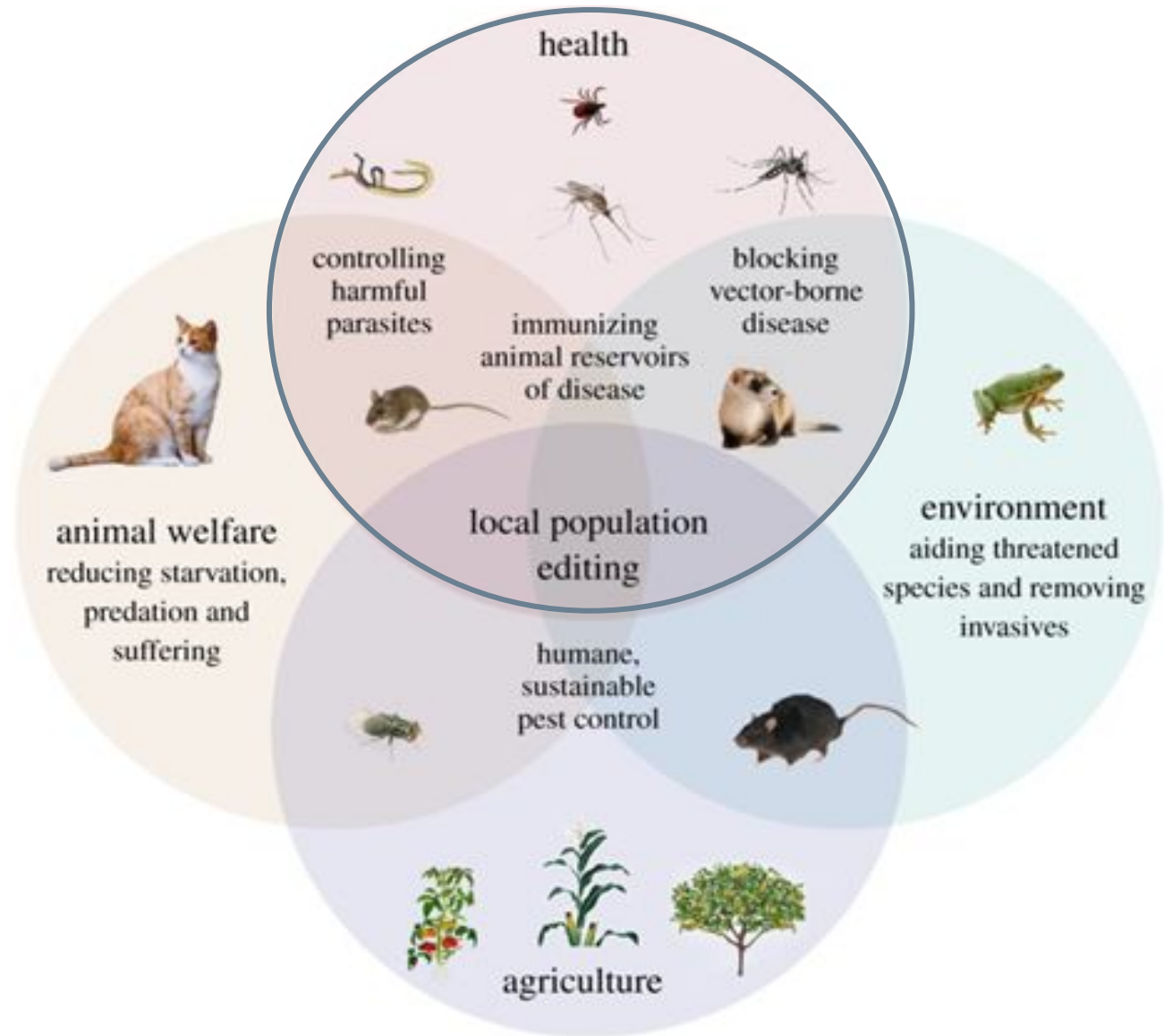
CRISPR



Long-term
Solution:
CRISPR-based
Gene
Drive

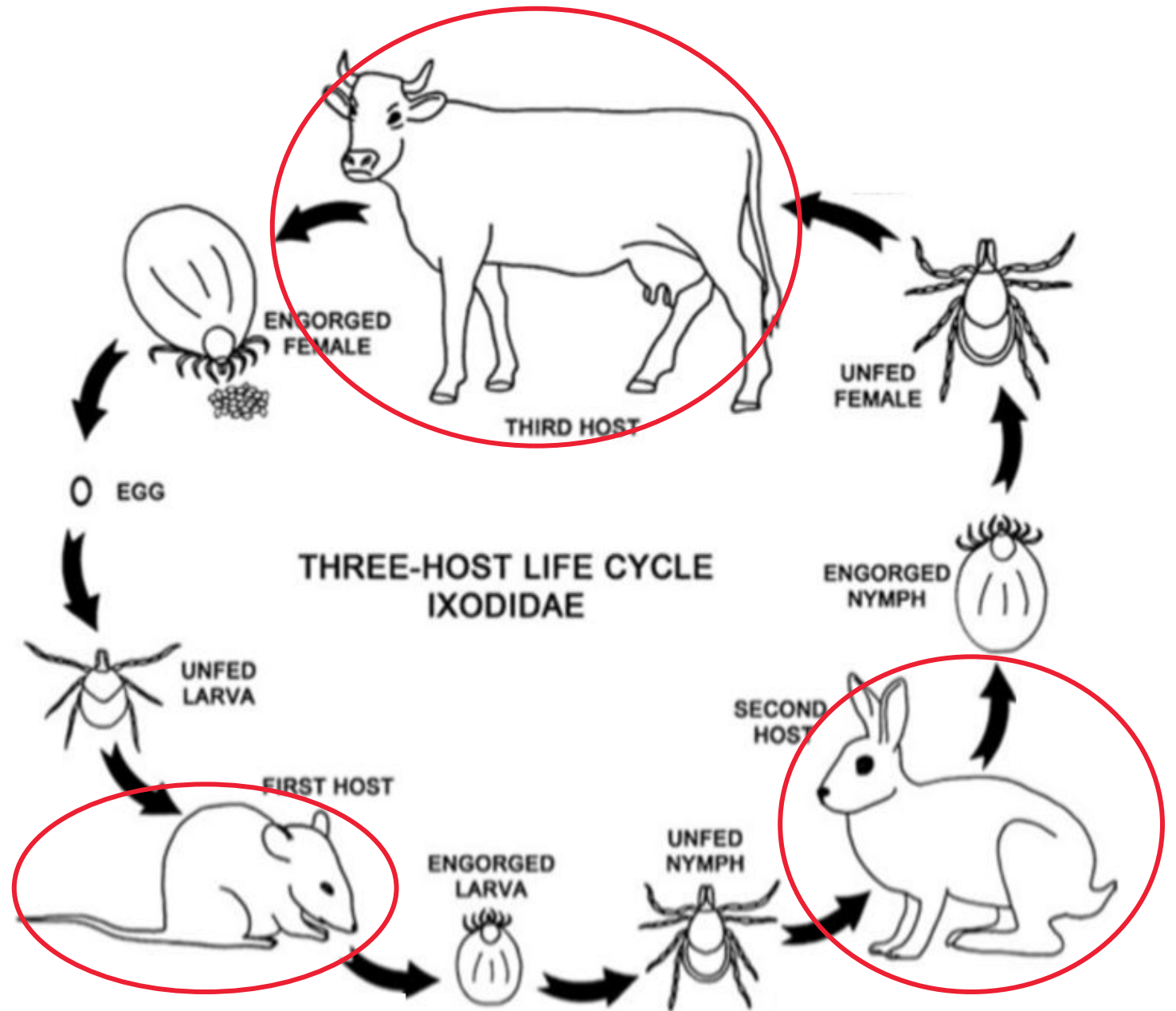


CRISPR Gene Drive

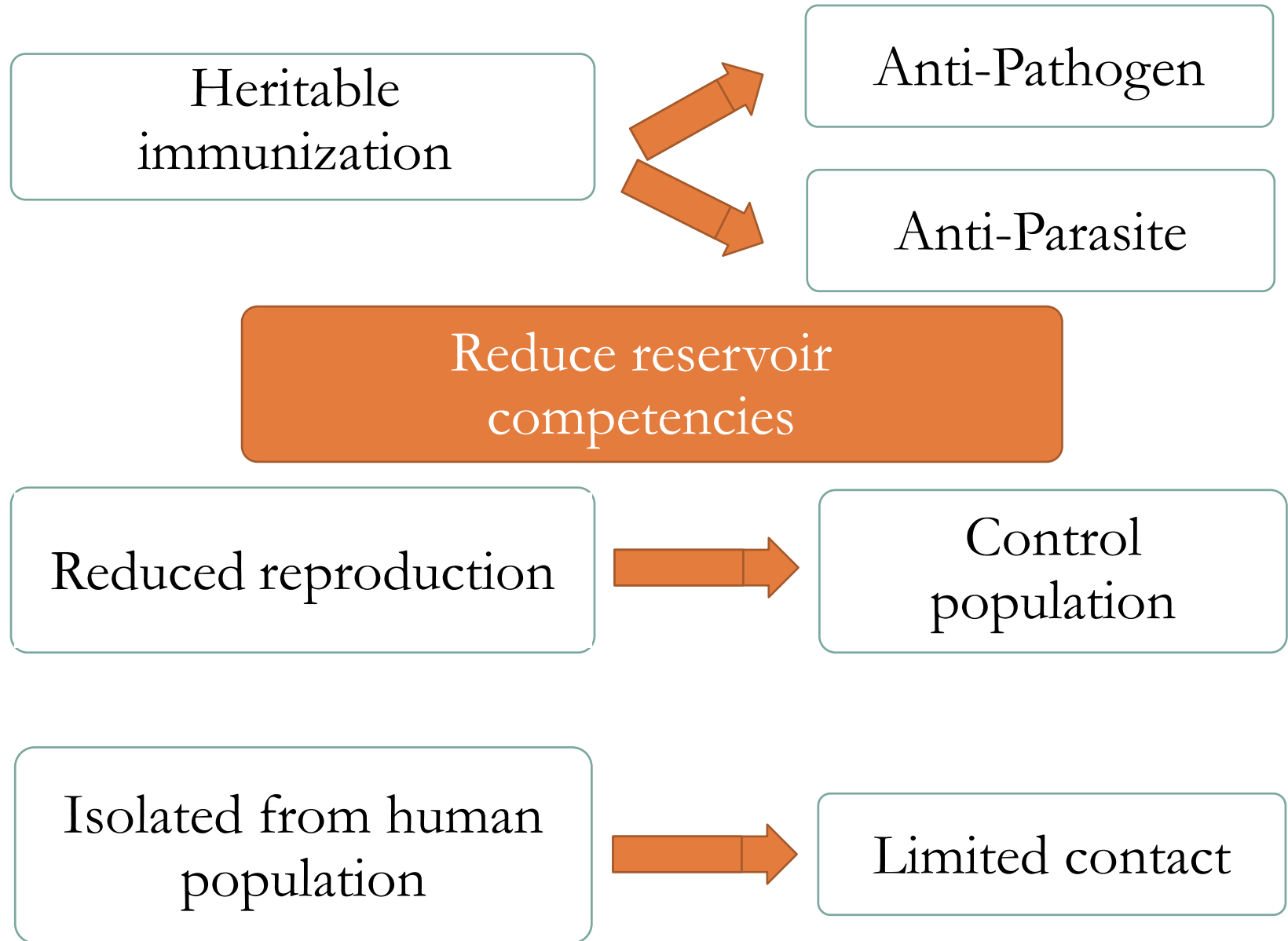




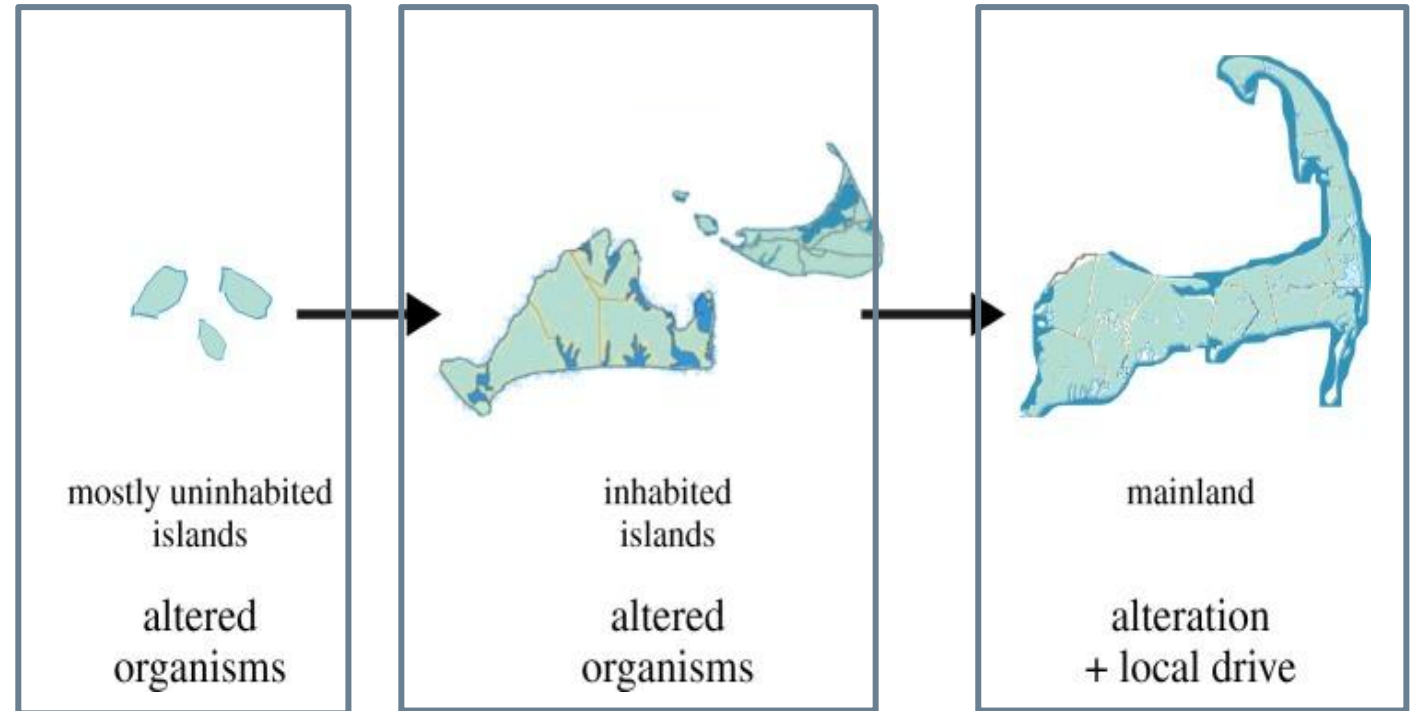
Life Cycle:
Haemaphysalis longicornis



Host Targeted Solution



Introduction into the Environment



Short-term Solutions

- Vegetation control, bug repellent
- *Metarhizium anisopliae* (Lee *et al.* 2019; Samish and Rehacek 1999)
- Application of fungi to soil surface reduced population by 60-90% after 30 days
- Assenga *et al.* (2006) developed a recombinant baculovirus with a tick chitinase gene
- Treated ticks died within 120 hrs

Government Policies to Genome Editing Tech: Canadian Environmental Protection Act (CEPA)

- Regulatory approach is “outcome-based”
- Addresses “animate products of biotechnology” (living organisms)
- Aims to assess, before introduction, if it is a risk to human health, the environment, or its biological diversity
- Need to provide a New Substances Notification Regulations (NSNR (Organisms))
- Canadian data requirements are same/similar to US Environmental Protection Agency
 - Supports effective and sustainable pest management and new pest management technology



Guidelines for the Notification and Testing of New Substances:

Organisms

Pursuant to the New Substances Notification Regulations
(Organisms) of the *Canadian Environmental Protection Act, 1999*

Canadian Policy on Releasing Gene-edited Organisms into the Environment

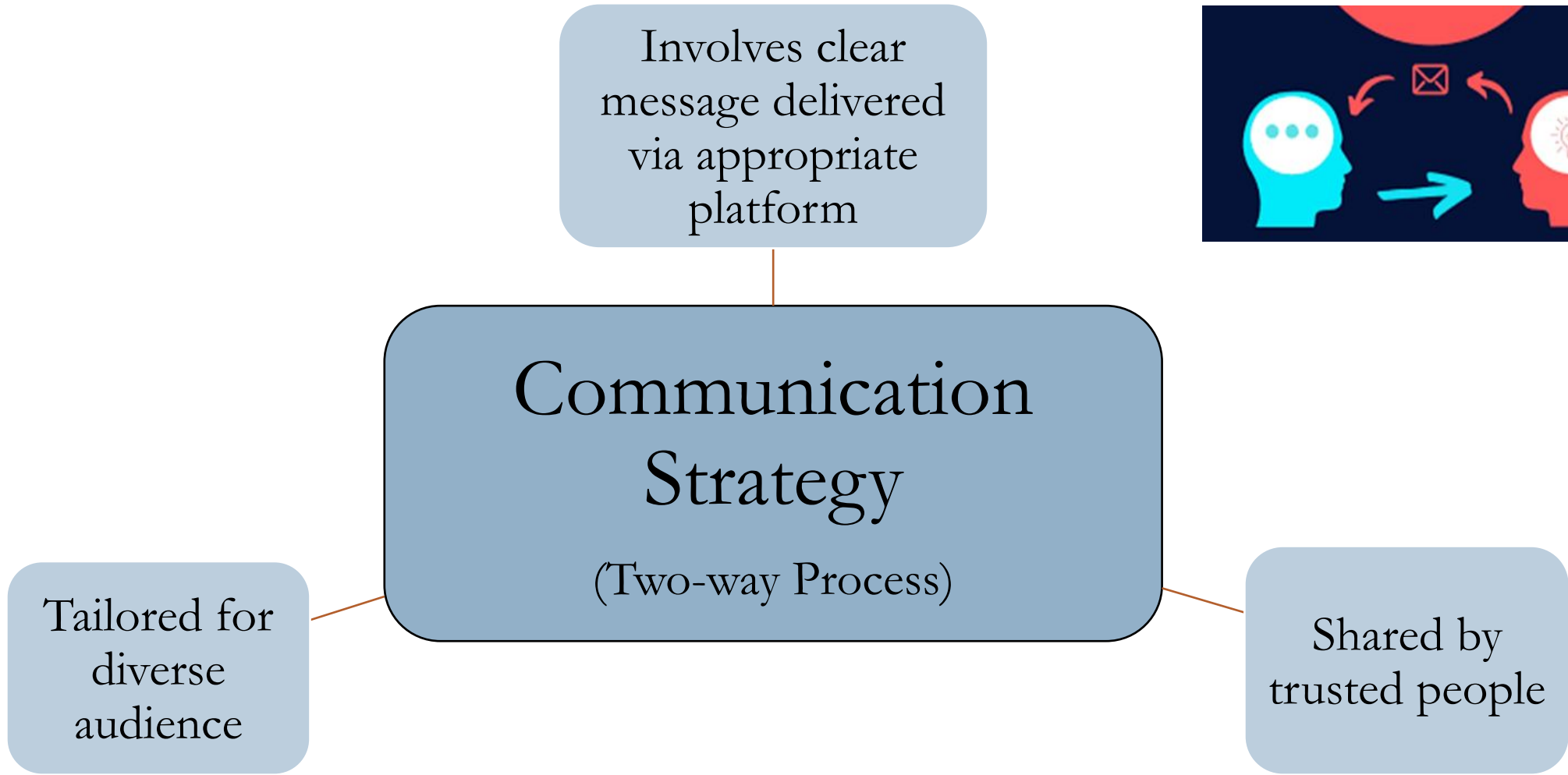
- About the organism (i.e. Literature Review)
- Manufacturing and Importation Process
- Introduction
 - Info on site of introduction
 - Info on experimental field study
 - Contingency plans for accidental release and any reproductive isolation measures
 - Procedure on terminating introduction of organism (killing or means of removal)
- Environmental Fate
 - Estimated quantities and population trends
- Ecological Effects
 - Data from tests to determine pathogenicity, toxicity, or invasiveness
 - Impact on conservation and sustainable use of biological diversity (beneficial, adverse, and any other potential effects likely to occur from introduction)
- Any Human Health Effects
- Additional Information
 - Experimental data

Environmental Concerns

- Have to introduce a new organism into the environment (assume permanence)
- Extensive testing in quarantine environment
- Environmental risk assessment
 - i.e. Impact of releasing sterile males
- Current risk assessment strategies used for biocontrol release + release of genetically modified plants into the environment can be used as a framework for genetically modified biocontrol organisms

Public Opinion

- Appears to hinge on the public perception of whether the use of these solutions is warranted to solve the problems being addressed
- Attitudes towards genetic engineering are more positive if technology is applied towards a human health disease vs. management of wildlife (Funk and Hefferon, 2018)
- Public is often not well communicated to/have poor understanding
 - Must introduce very carefully and highlight positive outcomes
 - Prospects for future applications of genetic biocontrols depend on initial benefits achieved vs. perceived risk to the technology



Well-executed communications strategies can facilitate public trust, confidence, and, importantly, compliance with the behaviours needed from individuals, communities, organisations, and nations

(Carter *et al.* 2011; Siegrist and Zingg 2014)

Pandemic Communications: Foundations and Recommendations

Foundations

- Public trust is a critical resource in harnessing public cooperation and sustaining the behaviours needed for pandemic management (Agle 2020; Devine *et al.* 2020)
- A transparent information strategy is necessary to enable people to act and assert that transparency failures can undermine trust in institutions

Recommendations for Communication

Engage in clear communication

Reduce Anxiety
Clear Instructions
Communication across channels



Source: <https://www.wikihow.com/Reduce-Anxiety-Associated-with-Social-Media-Addiction>

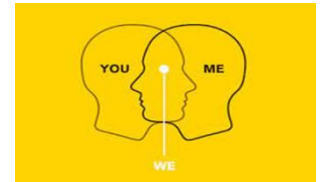
Strive for maximum credibility

Essential for effective communication
Involvement of Authoritative people



Communicate with empathy

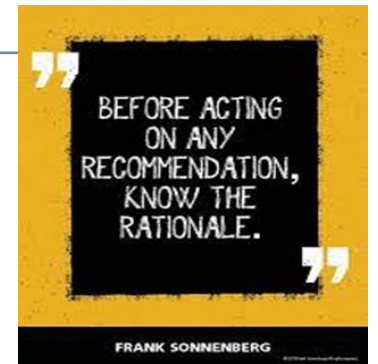
Community needs and concerns
Different ways to alleviate hardships of people



Source: <http://strategy3i.com/18438/>

Recognise that uncertainty is inevitable

DO NOT foster illusions



Recommendations for Communication

Account for levels of health literacy and numeracy

Communicators should use both Qualitative and Quantitative estimates of risk



<https://www.indiamart.com/productdetail/quantitative-risk-assessment-services-11039749691.html>

Empower people to act

Appropriate measures to facilitate behaviour change and action



mergeuk.com/uncategorized/do-you-enable-others-to-act/

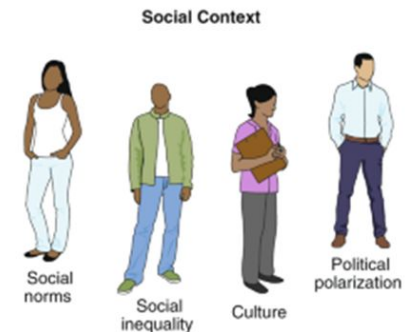
Appeal to social norms

Sense of marginalism

Consider diverse community needs

Communities may not be affected by the pandemic the same way

Language Barrier



Risk Communication and Health Education

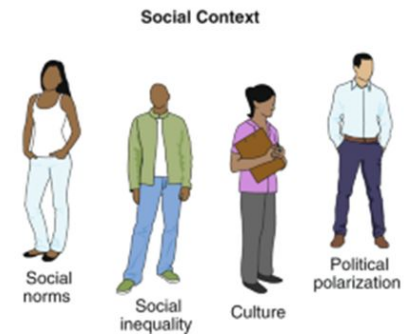
- Mass media: Radio, TV, Internet
- Posters and banners
- Tick repellents and personal protective equipment
- Clinicians trained specifically to improve their diagnostic ability for SFTS

Is the solution working?

- Conduct a survey
- Questionnaire

Summary

- Solutions:
 - Gene-editing (i.e. host, baculovirus)
 - Vegetation control
- Policies:
 - CEPA, NSNR (Organisms)
- Communication:
 - Public education (media, posters, etc.)
 - Survey



Future Perspectives

- The effects on environment
- Technological advances (efficiency, specificity)
- Strategies to educate the public (i.e. regional language)
- Development of policies (promotion of genome editing versus ethics)



Acknowledgements

Instructors

- Dr. R. S. Sethi
- Dr. Baljit Singh
- Dr. Vikram Misra
- Dr. Jaswinder Singh

Program Coordinator

- Japman Kaur Kandola



Genome Editing for Food Security
and Environmental Sustainability

Thank you!

Questions?