Ecologically-Based Rodent Management (EBRM) – Concepts and Practices

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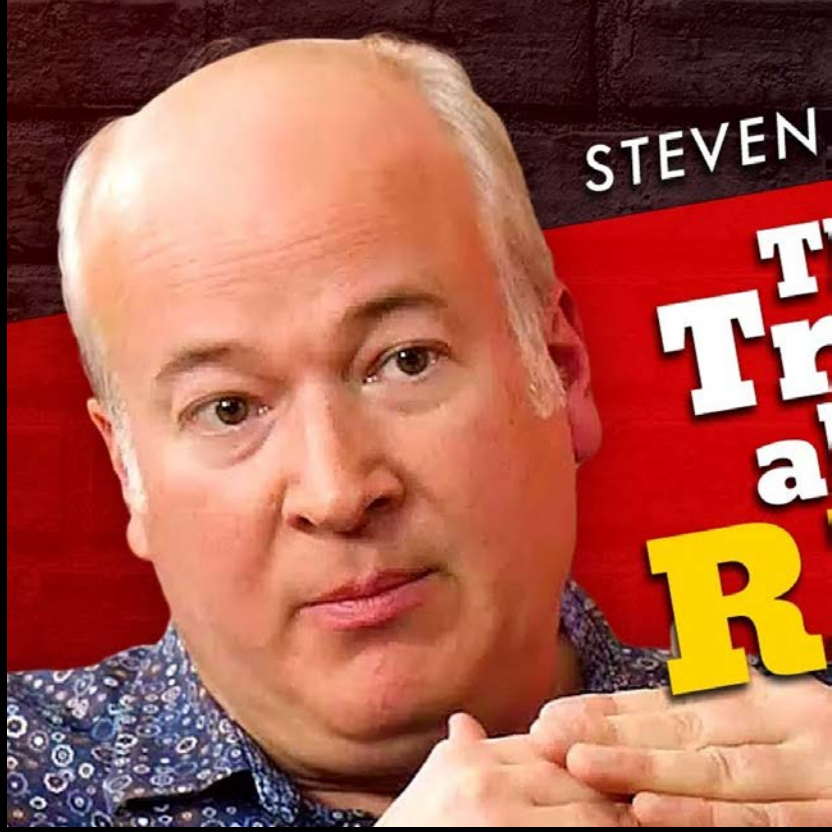


Concept of EBRM

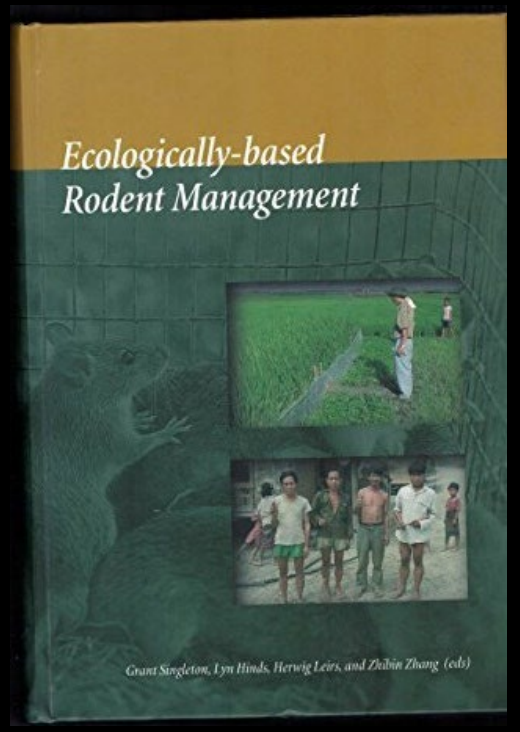
- EBRM proponents: a term coined ~ 20 years ago by Grant Singleton and Herwig Leirs, and Steven Belmain, Rhodes Makundi

Concept of EBRM…

The concept of EBRM was developed based on

- Solid knowledge of rodent pests
- Ecological basis for management of rodent pests
- Environmentally-sensitive approaches
- Socioeconomic and traditional approaches
- Reduce heavy reliance on chemical rodenticides

EBRM introduced to farmers in Asia, Australia, and eastern Africa



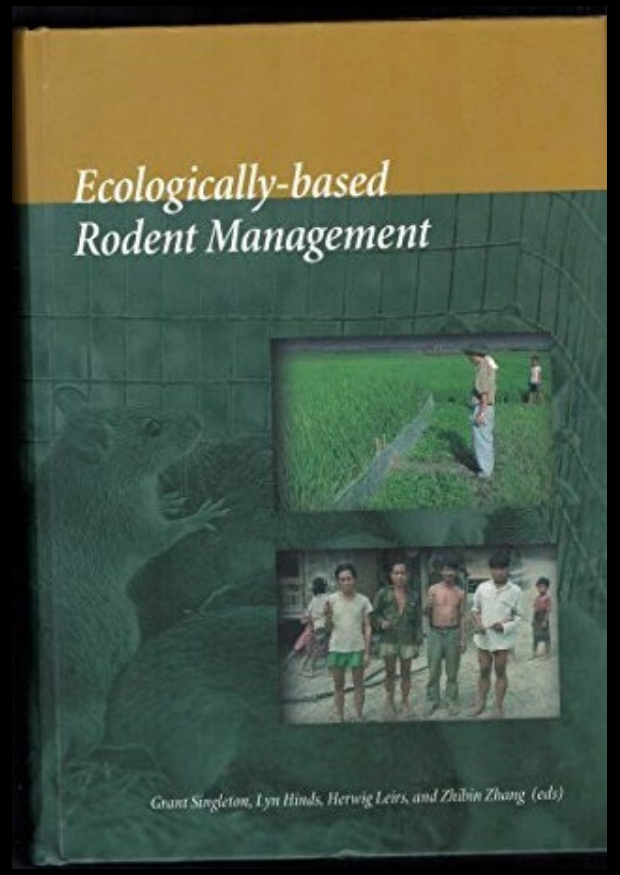
Free download form CSIRO website

Concept of EBRM…

Mobilizes a pool of rodent management methods integrated into community-based actions:

1. Biological (e.g., favouring of predators)
2. Ecological (e.g., habitat modification)
3. Mechanical/physical (e.g., trapping campaigns)
4. Agronomic (e.g., crop rotation, agrobiodiversity)
5. Cultural (e.g., hunting)
6. Chemical

- Implemented as a set of complementary tools



Main EBRM actions

I. Solid **knowledge** of rodent pests

II. Community awareness

III. Rodent exclusion methods and actions

IV. Population reduction methods and actions

- ~ 40% of all mammalian species are rodents - an idea just how numerous they are
- Worldwide, 147 main rodent pest species, i.e., 6.5% of all known rodent species to date (2277)

- Three species stand out:
  1. Roof/black rat *Rattus rattus*
  2. Norway rat *Rattus norvegicus*
  3. House mouse *Mus musculus*

  - The black rat is the main rodent pest species in the world
  - All the three species were cosmopolitan , occur in all six continents

- Other important species were
  1. Pacific rat *Rattus exulans*
  2. *G*rey squirrel *Sciurus carolinensis*
  3. Multi-mammate rat *Mastomys natalensis*
  4. *R*ice-field rat *Rattus argentiventer*
  5. Lesser bandicoot rat *Bandicota bengalensis*

Amount of food consumed daily and yearly by rodents infesting stored foods

Rodent species	Amount of food consumed daily (g)	Amount of food eaten yearly (kg)
Norway rat, *Rattus norvegicus*	15-25	6-9
Roof rat, *R. rattus*	8-12	3-4
Bandicoot rat, *Bandicota bengalensis*	15-25	6-9
Polynesian rat, *R. exulans*	5-8	2-3
Multimammate rat, *Mastomys Natalensis*	5-8	2-3
House mouse, *Mus musculus*	2-3	0.7-1

Brooks and Fiedler, 1999

- John, A. *Food Sec*. (2014) 6:249–260 DOI 10.1007/s12571-014-0338-4

Mechanical/ physical management

Involve:

- **Conduct regular rodent surveys - look for signs of rodents**
  - Sightings of live and dead rodents
  - Droppings and smudge marks
  - Tracks and trails
  - Gnaw marks, burrows, sounds and
  - Odours

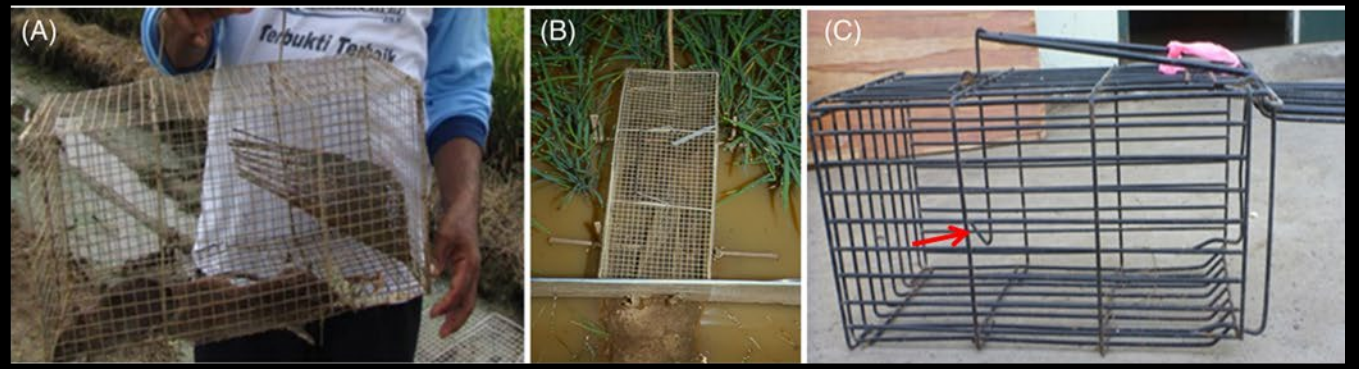
- **Eliminate, deny access to food, water and shelter (promote multiple actions)**
  - Trapping, killing and burying
  - Fumigating burrows and storage areas
  - Flooding burrows
  - Removing, burning shelters and hideouts
  - Destroying, disrupting runways
  - Farm and neighbourhood sanitation
  - Proper garbage disposal
  - ETC.

Mechanical/physical … Removing individuals - trapping

Innovations in the kitchen

https://www.youtube.com/watch?v=Xel7qALbrRI

Local multiple capture traps



Community campaigns

Trapping:

- Bait selection
- Number and type of traps
- Location
- Timing of trapping

Mechanical/physical …

Houses and storage

- Immediately repair openings where rodents passthrough

Mechanical/ physical …

- Instal **disruptors** on runways, escape routes, and burrow systems to interrupt movements
- To ceilings or granary, a **rodent baffle** could be fitted to stop them climbing up
- **Collars** made from corrugated iron sheet or aluminium interrupt climbing

Mechanical/physical …

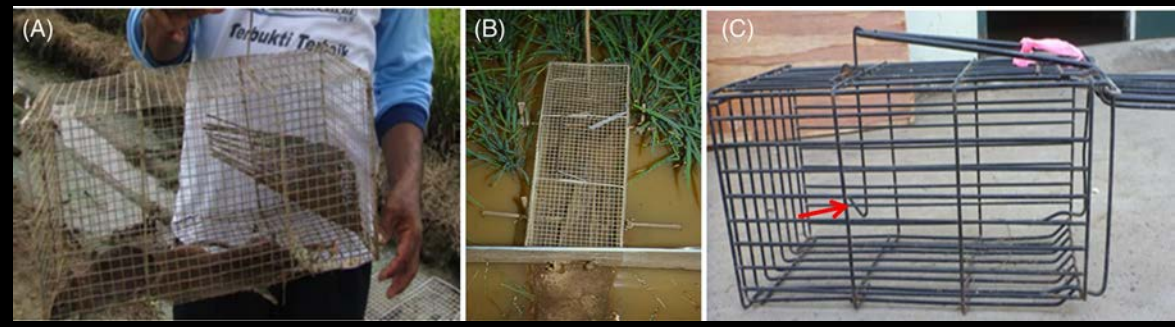
- Construct residential and storage houses using rodent-proof materials – training local carpenters (as part of awareness)

Mechanical/physical …

TBS (Trap Barrier System)

- TBS consists of
  - Trap-plants to attract rodents
  - Plastic fences with holes, and
  - Multiple capture traps

- Trap-plants planted **few weeks ahead**
- Able to protect 8–10 ha surrounding the trap crop (Singleton et al., 2003)



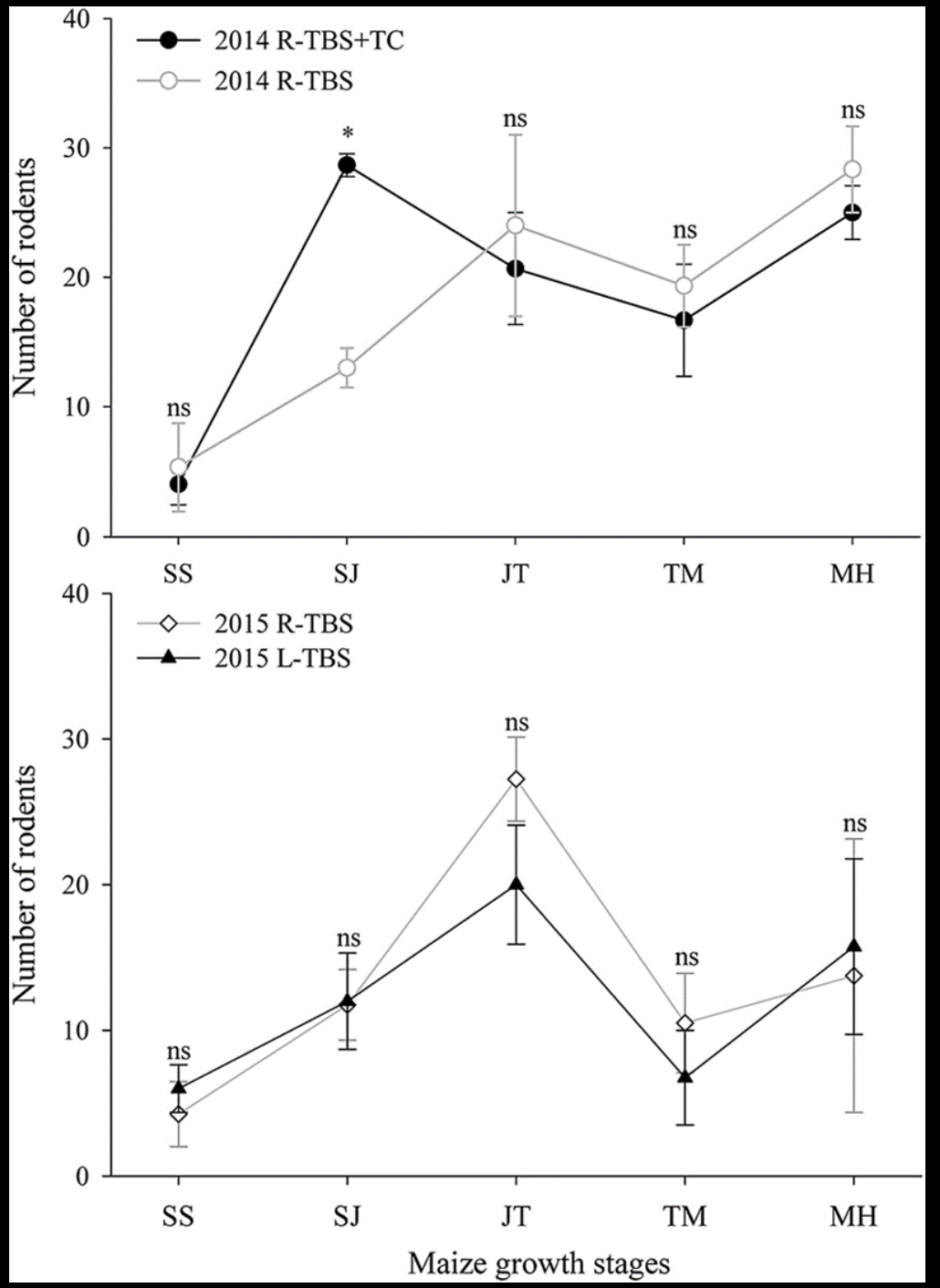
Trap Barrier System (TBS)

- Developed by Lam (1988) to protect an individual farmer's field
- Adapted to include a wider area
- Now part of EBRM tools for rice-based agroecosystems (Singleton et al., 2003)
- Also called Community-TBS (**CTBS**)

- Another variant, Linear-TBS (**LTBS**) to intercept rodent movement into or within agricultural crops
- Currently no published studies examined effectiveness

TBS …

- In China (Wang et al., 2017)
- The overall number of rodents captured by R-TBS + TC and R-TBS with no TC were not significantly different
- L-TBS could be more practical for farmers and appears to provide similar levels of rodent control compared to the traditional R-TBS in this farming system



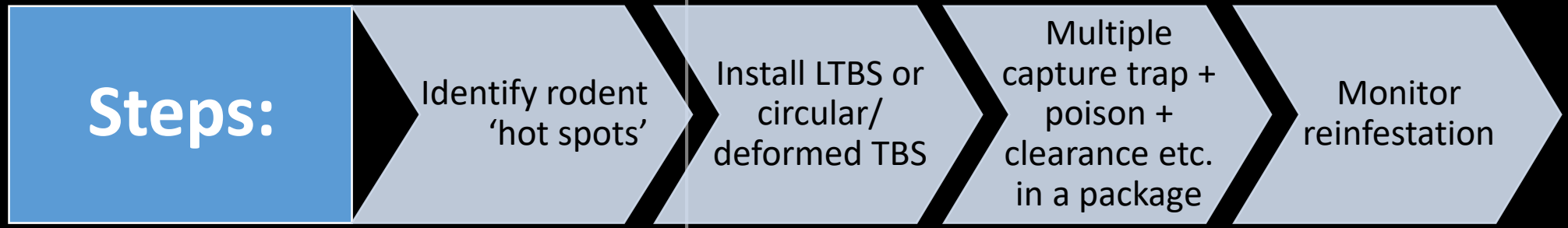
LTBS (Linear Trap Barrier System)

- Stretch of plastic fence, high 60-70cm, a minimum length of 100m
- Installed at every 20m interval in rice fields
- Designed based on daily movement of paddy rats - going back and forth between nesting and feeding sites

➢ **Installed between rice fields and rat habitat** (e.g., village edges, irrigation embankments, and road embankments) = **disrupter,** cut off the migration path

TBS for urban rodent management?

- Which TBS? – e.g., in seaports, stock storage
  - LTBS
  - Circular or deformed TBS
    - Without trap crop



- Installing owl nest boxes and predator perches

Some limitations of TBS

- Incurs cost
- Farmers need to work off season
- More community participation – if many farmers disagree, then less area covered, hence lee effective
- Usually, farm size it too small and needs involvement of many farmers at a time

Cultural methods

- Experience from Malawi

Main rodent management methods in Malawi

- SCR
- Trapping
- **Hunting**
  - **During lean season**
  - **Rats signs of dirt and uncleanness – tabu , shame**

- Domestic cats
- Field clearance

- **Indomethacin tablets**
- **Temik powder**

Cultural/chemical?

- Indomethacin (indometacin active ingredient), anti-inflammatory drug to relieve pain in humans
- Used as rat poison in other countries in Africa

- Temik - aldicarbe pesticide, kill insects by attacking their nervous systems

Donga TK, Bosma L, Gawa N, and Meheretu Y. (2022). *Frontiers in Agronomy*. https://doi.org/10.3389/fagro.2022.936908.

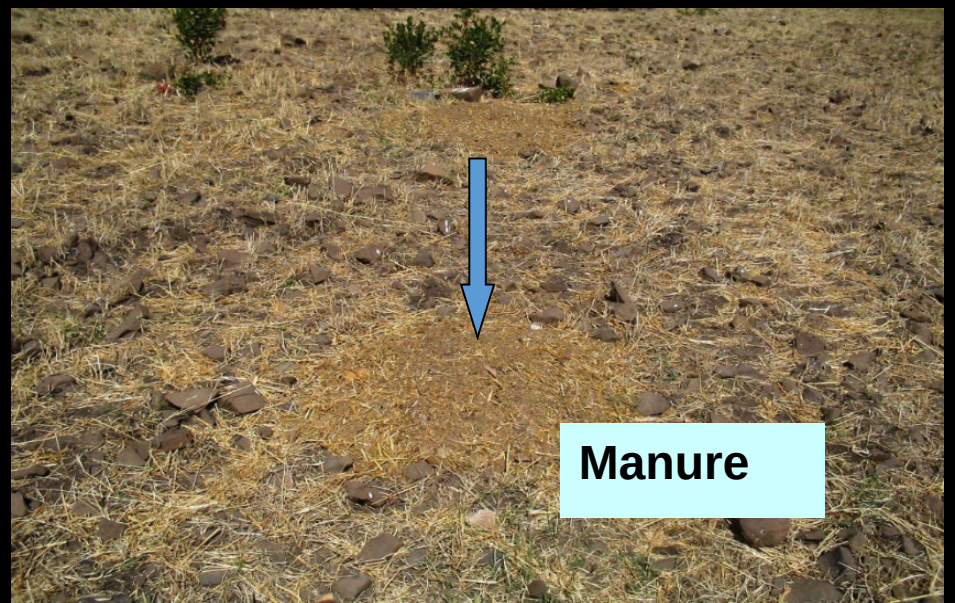
Agronomic management Practices

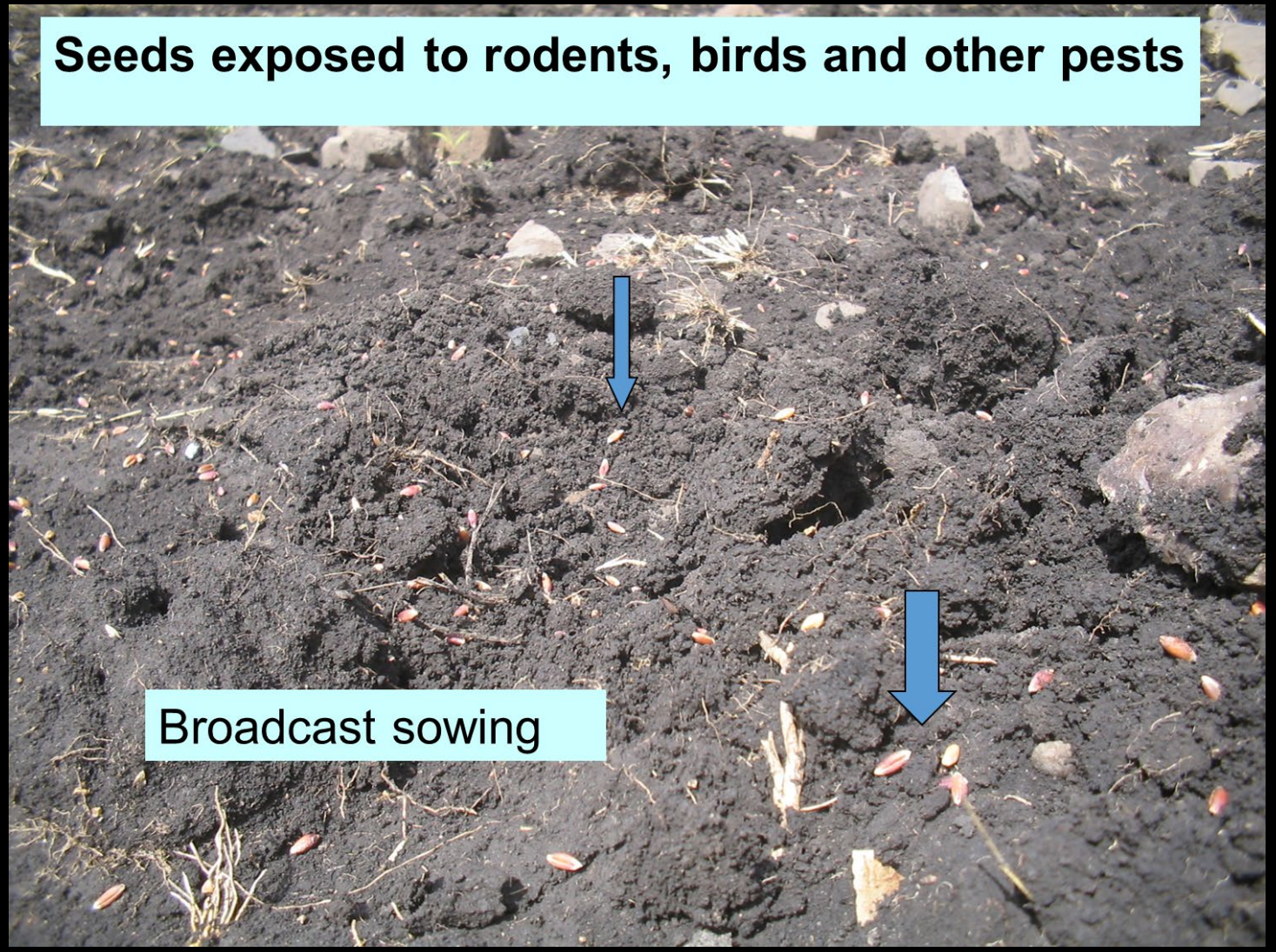
- Mainly environmentally friendly, preventative practices as opposed to reactive measures, e.g., chemical rodenticides

Agronomic management - Ethiopian highlands

Dry- wet season transition

Traditional farming practices:






Exposed seedlings

Replanting – patchy damage

Agronomic management …

- Practice EBRM: such as
  - Crop rotation - cereals (sorghum) or pulses (soybean) or green manure crops at least once in two to three years
  - Land preparation:
    - Dip ploughing - destroys rodent shelter/barrows/tunnels
    - Maintain weed-free fields
    - Burrow smoking (fumigation)
    - Burrow flooding
    - Farm clearance/sanitation
    - **Maintain/add shelters of natural predators**

- New introduction such as
  - Conservation agriculture and agroforestry have pros and cons for rodent management

Biological rodent management options

- Biorodenticides
- Plants obstructing rodent movements
- Predators - GUD
- Fertility control

Bio-rodenticides: opportunities and challenges

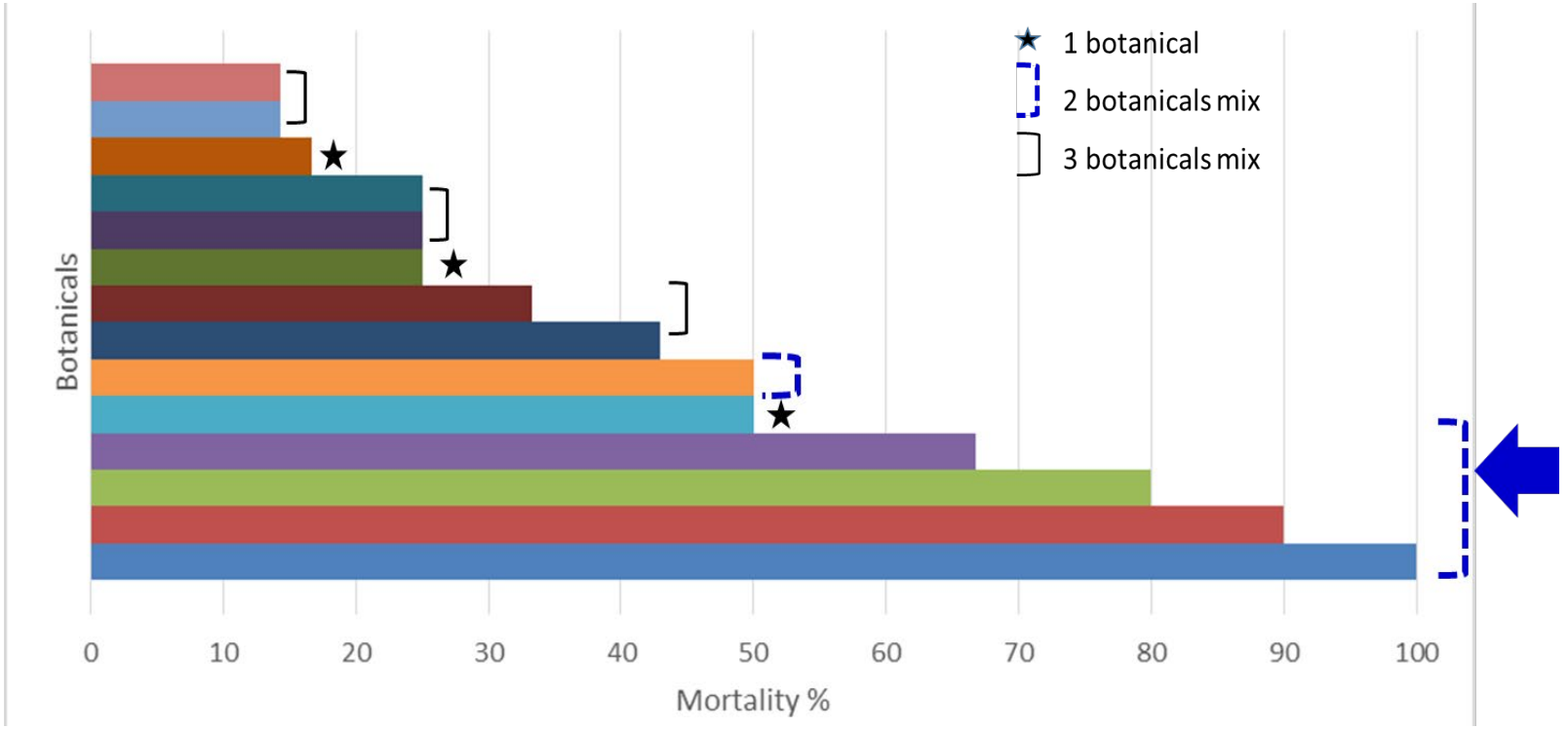
Bio-rodenticides (Botanical rodenticides)

- BR - developed from **plant materials** (e.g., leaves, tuber, roots, seeds, barks, latex, …)
- Organic, quick **degradable, environmentally friendly**
- Can be formulated into **chronic action** to prevent/reduce conditioned bait refusal
- Less **non-target harm**
- Part of the **ecosystem function**

- **Not necessarily poison – bio-glue**

BR testing, lab and field:

Involve testing for palatability
Testing for efficacy



Efficacy testing…

Cumulative mortalities
Median lethal dose (LD50)

BR mix	Conc. (%)	*Arvicanthis niloticus*			*Mastomys awashensis*			*Rattus rattus*			Control	
		Exposed	Dead	%	Exposed	Dead	%	Exposed	Dead	%	Exposed	Dead
X and Y powders, + linseed	40	10	3	30	10	2	20	7	-		10	0
	50	10	8	80	10	7	70	7	5	71,4	10	0
	60	10	8	80	10	6	60	7	5	71,4	10	0
	75	10	10	100	10	8	80	7	-		10	0

- Mortalities at 50% concentration, 96 hrs:
  - *Arvicanthis niloticus*: 80%
  - *Mastomys awashensis*: 70%
  - *Rattus ra*ttus: 71.4%

- Mortality higher at 144 hrs
- Such delayed action (rather than acute) preferred to reduce bait refusal/bait shyness
- No. of test animals (and control) range: 4-10

Median lethal dose (LD50)

BR mix	Conc. (%)	*Arvicanthis niloticus*			*Mastomys awashensis*			*Rattus rattus*			Control		Regression equation	LD_{50}
		Exposed	Dead	%	Exposed	Dead	%	Exposed	Dead	%	Exposed	Dead		
X and Y powders, + linseed	40	10	3	30	10	2	20	7	-		10	0		
	50	10	8	80	10	7	70	7	5	71,4	10	0	Y = 12.70x-16.82	52.16%
	60	10	8	80	10	6	60	7	5	71,4	10	0		
	75	10	10	100	10	8	80	7	-		10	0		

The BR mix with the lowest LD_{50} score:

- X and Y mix LD_{50} = 120.29 mg/g
- LD_{50}–intake = 11.35g

- Achieve 50% rodent population reduction with 11.35g intake dose (intake-threshold) per a rodent
  - Excluding the linseed

- A rat ingested 11.35g of the BR once or within 96 hrs has a 50% chance of being dead or would be in bad shape

Shelf-life determination – dictates farmers demand

Store

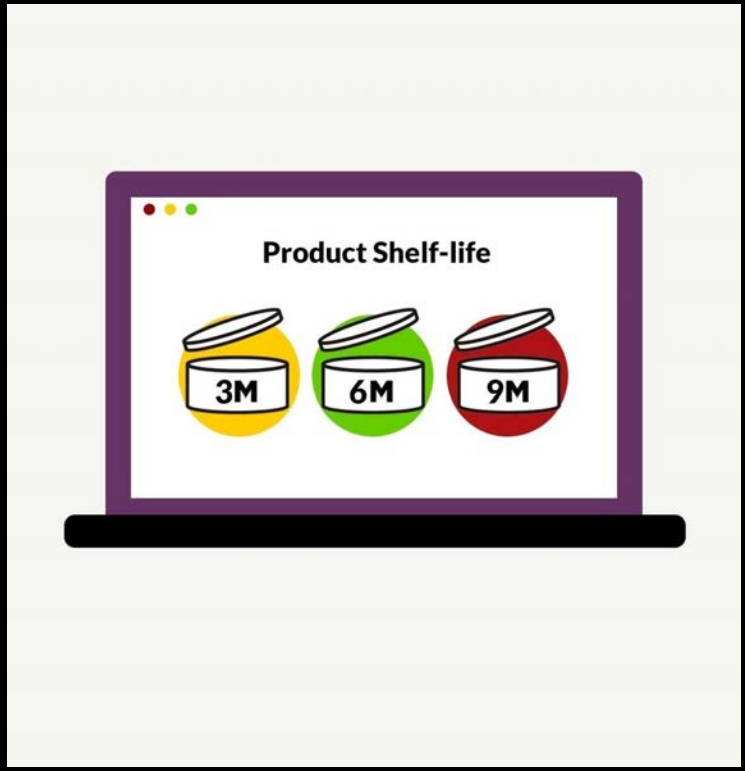
- Store portion of BR at room temp for 3 to 24 months, at 3 months interval

Repeat

- Repeat the same efficacy experiment on 3rd, 6th, 9th, 12th, … months, to determine efficacy alteration

Use

- Use same protocol (i.e., same rodent species, number of rats, concentration, control diet, …).



Meeting standards – e.g., **EU standard**

- A min mortality rate of 90% of test animals
- At least 33% of BR consumed
- No >10% of control group die

- ➢ Lab facilitates
- ➢ Field testing
- ➢ Patenting and marketing

Other botanical uses…

- Thorny plants
- Sharp edge leaves
- Itching plants
- Growth system

- Take space
- Limit movement other animals (e.g., predators)

Raptors as Biological Control Agents

Predator impacts on rodent populations can be direct or indirect:

1. Physically removing individuals
2. Inducing behavioural (e.g., spatial activity) or physiological changes (e.g., breeding)

More appropriate in agricultural fields

Involves mainly creating suitable conditions to attract raptors

Less labour intensive

&

Easily integrated into routine farming practices

Meheretu, Y., & Leirs, H. (2019). Raptor perch sites for biological control of agricultural pest rodents. Springer Nature

Perceived Predation Risk Experiment

- To investigate whether stone bunds make a difference for predation/shelter of rodents
- We used “Giving-Up-Density” (**GUD**) experiment
- We provided seeds mixed in a tray with sand and 24 hrs later, we sieved and measured how much seed was left in the tray

Perceived Predation Risk Experiment

- The underlying idea: rodents will continue looking for the seeds in the sand until they find that the chances for finding more seeds no longer outweigh the risk for predation
- Placed trays nearby (~1 m) and far (~10 m) from the stone bunds
- In **high density of stone bunds**,
  - **16–38%** of the seeds eaten from the trays placed near
  - **16–24%** from the trays placed far
- In **low densities of bunds**,
  - 10–13% of the seeds were eaten near
  - **9%** from the trays placed far
- Rodents indeed feel less threatened close to the stone bunds

Role of predators …

- Predators can limit low-level rodent populations
- Target rodent hideouts and shelter more for management
- Example from Swedish owl nest boxes
- See heron the predator ☺

Fertility control

- Recently attempts are underway to develop efficient fertility control for pest rodents (using contraceptive hormones) mainly for managing rodent population **outbreaks**

  - Quinestrol and Levonorgestrel
  - Treated females showed uterine oedema

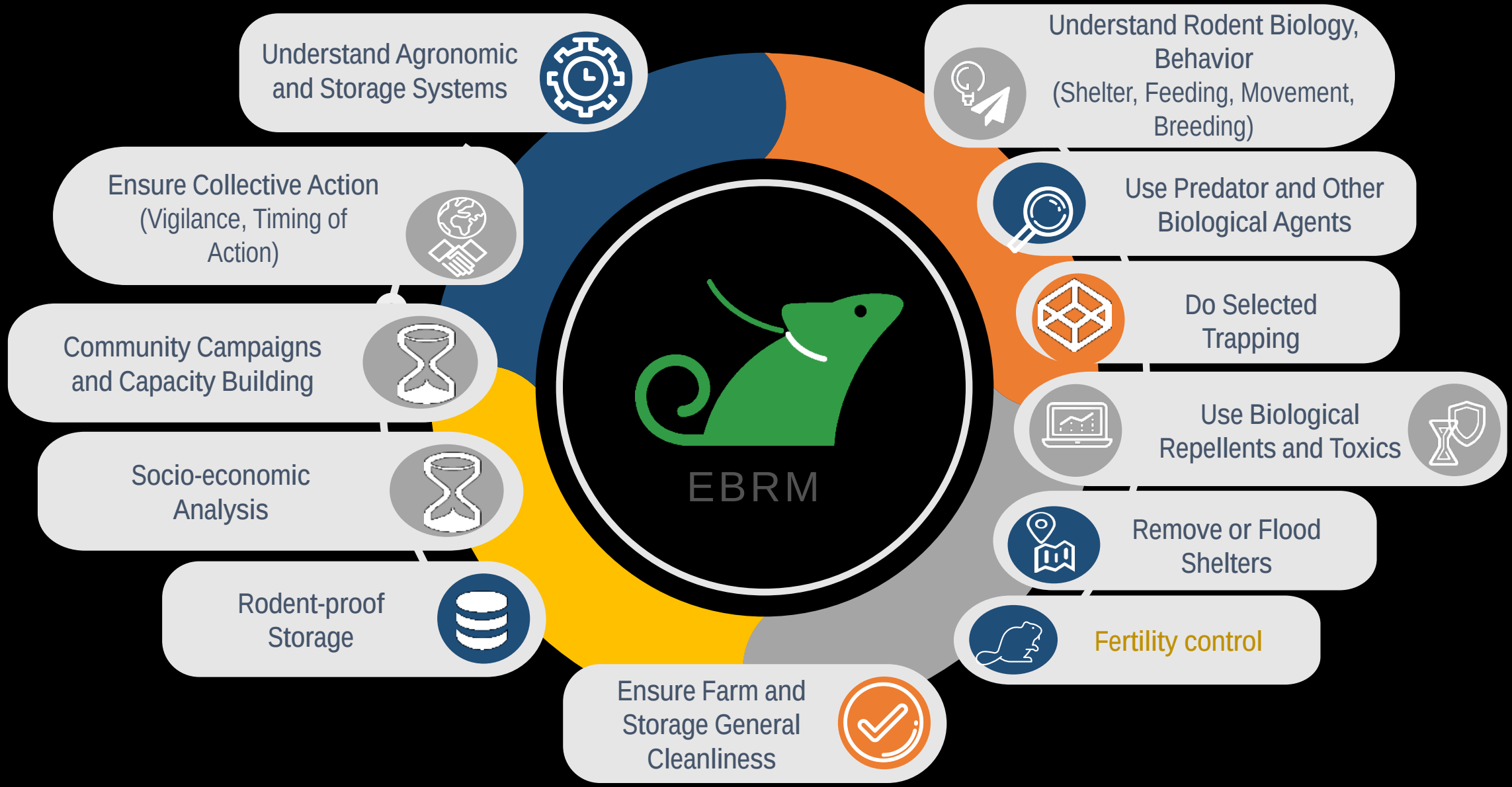
Control uterus

Uterine oedema

Male reproductive physiology:

- Histological observation of reproductive organs
- Testes, epididymis and seminal vesicles weighed
- Sperm motility observation

Summed: Ecologically Based Rodent Management



Some limitations to EBRM in Africa

- Not all countries have robust 'prerequisite data'
  - ➢ Hence, investment on research is needed
- EBRM could conflict with culture
  - Hunting rodents for food
  - Nomads cattle movement and e.g., TBS, trapping …
  - Stable grazing
  - Community mobilization
  - How in urban areas
- Both government authorities, extension staff and some members of the community reluctance to participate in activities and engagements that do not incur cost
  - ➢ **Awareness campaigns**
  - ➢ **Integration with WASH, FAO, Municipalities, Local health services – early on**

Thank you for your attention.