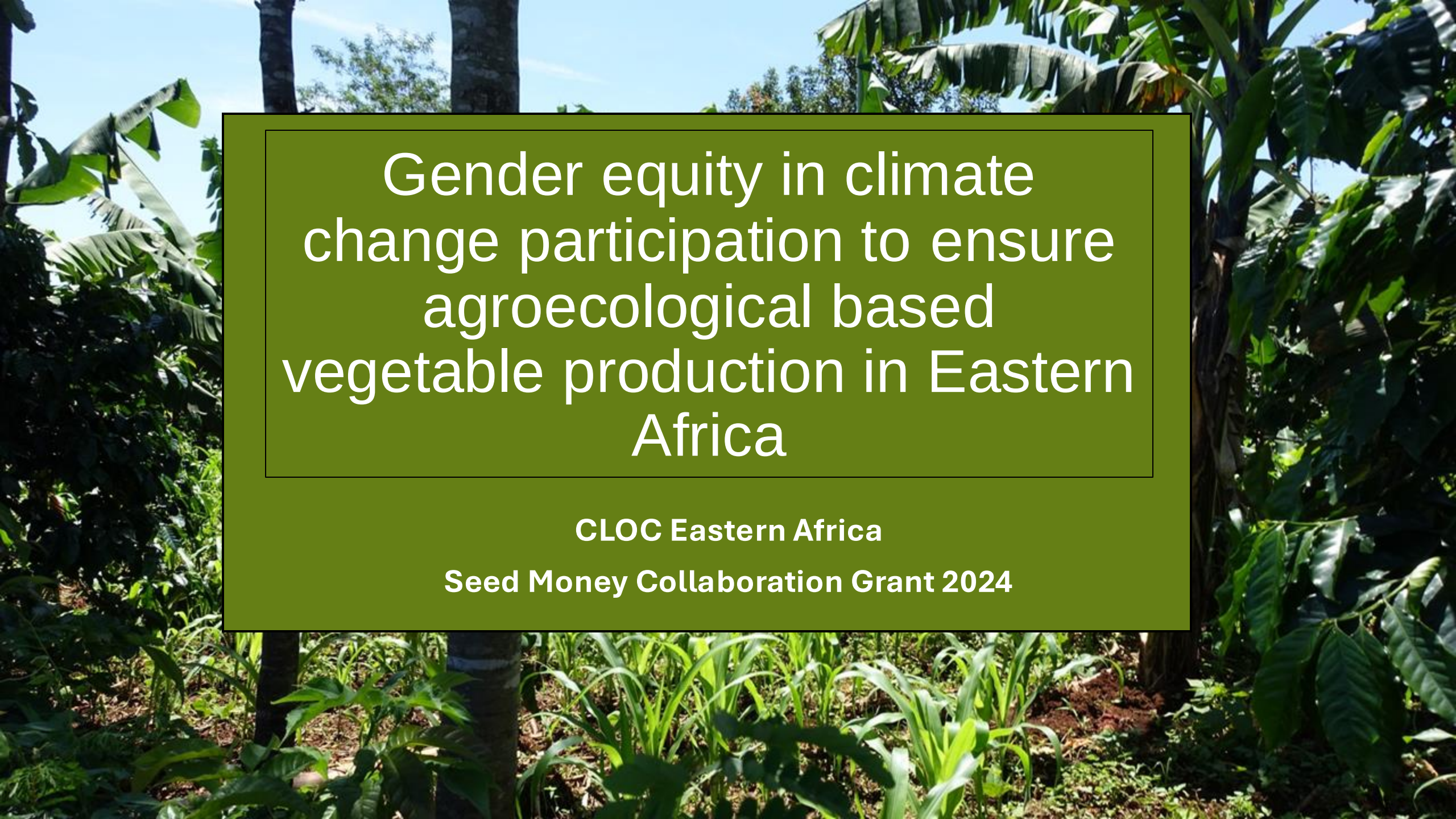


Gender equity in climate change participation to ensure agroecological based vegetable production in Eastern Africa

CLOC Eastern Africa

Seed Money Collaboration Grant 2024

DAY 2: PEST AND DISEASE CONTROL

INTRODUCTION FROM KISII UNIVERSITY EXPERT

- Local context
- Challenges in pest and disease management in vegetable production
- Rest of the presentation is a proposition of natural control in international context
- Please have a look at it and feel free to comment / adapt

CONTROL MECHANISMS

1. High biodiversity
2. Plant nutrition, hygiene and quality seeds
3. Crop associations
4. Use of mosquito nets
5. Repellent treatments
6. Push and pull

CONTROL MECHANISMS

1. **High biodiversity**
2. Plant nutrition, hygiene and quality seeds
3. Crop associations
4. Use of mosquito nets
5. Repellent treatments
6. Push and pull

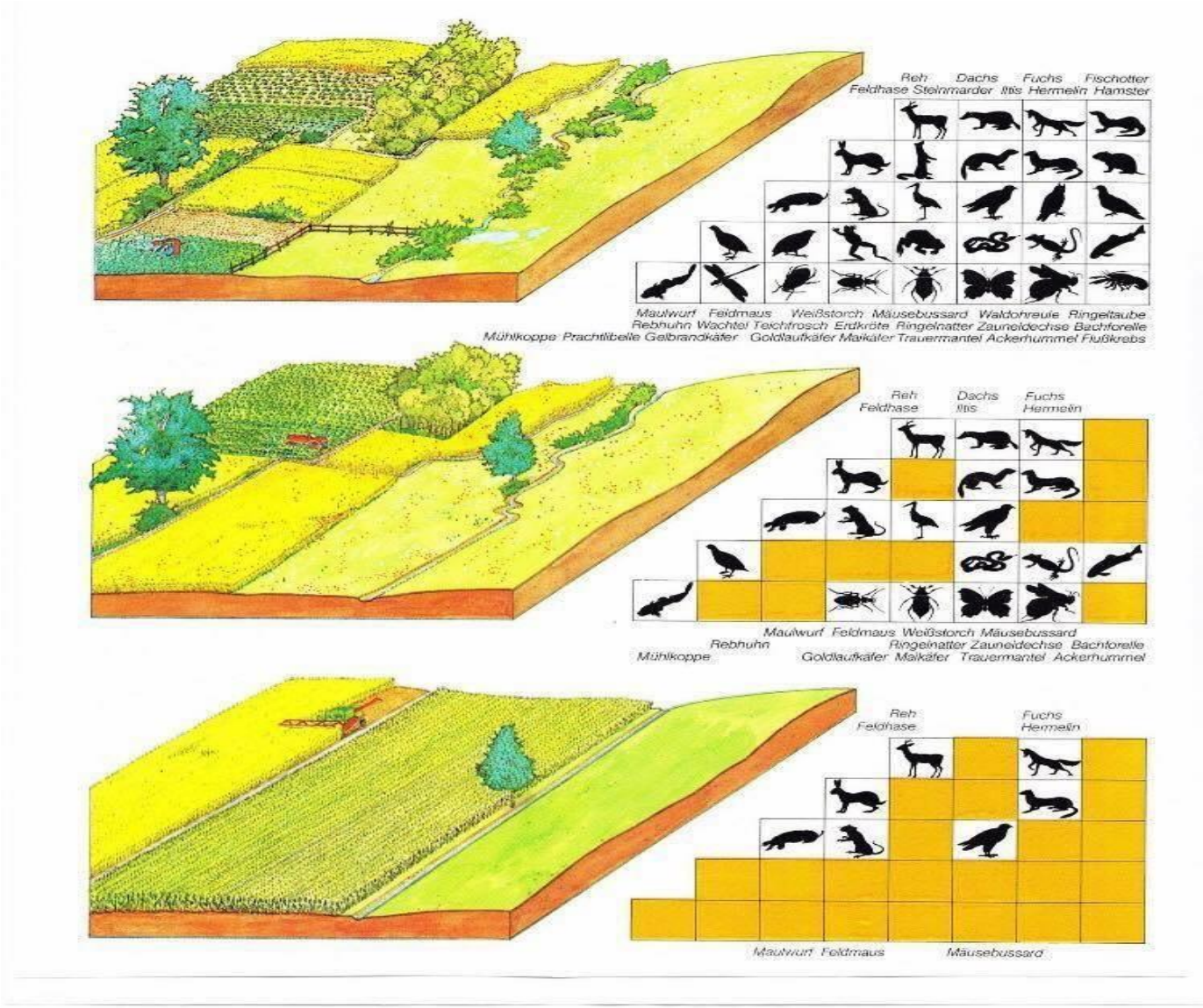
BIODIVERSITY – RESOURCE DISCONTINUITY

- Limits pest expansion
- No suitable host
- Limits risk of crop failure/catastrophic harvest

BIODIVERSITY - CONTROL BY BENEFICIALS

- Diversity of plants
- Diversity of insects
  - Attraction of predators
  - Attraction of pollinators
  - Attraction of parasitoids

These species are called beneficials.



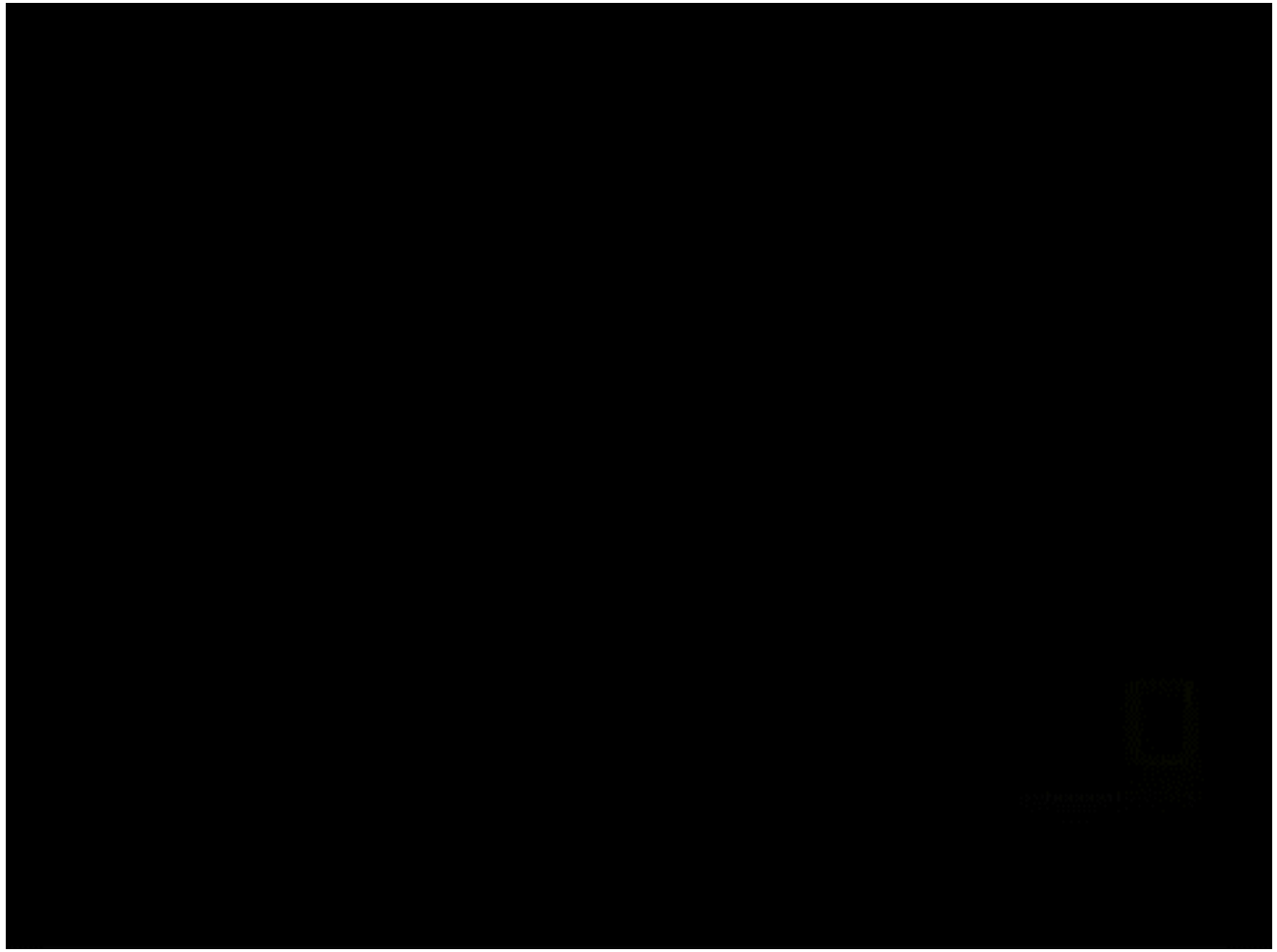
BENEFICIALS

1. **Predators**

2. Parasitoids
3. Pollinators

BENEFICIALS

1. Predators



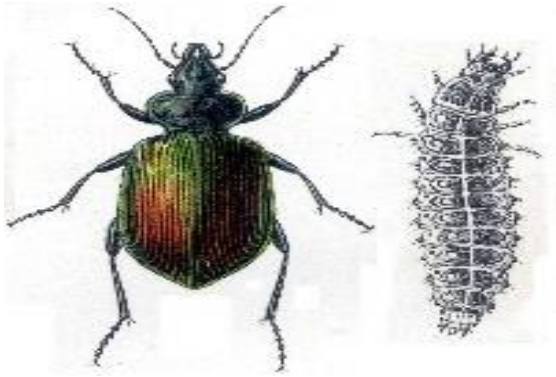
2. **Parasitoids**
3. Pollinators

BENEFICIALS

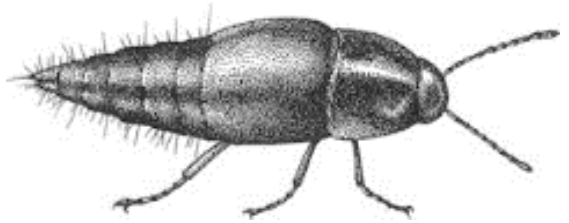
1. Predators
2. Parasitoids
3. **Pollinators**

BIODIVERSITY - EXAMPLES OF BENEFICIALS

- Carabidae: large beetles (15-20 mm) mostly polypredators.

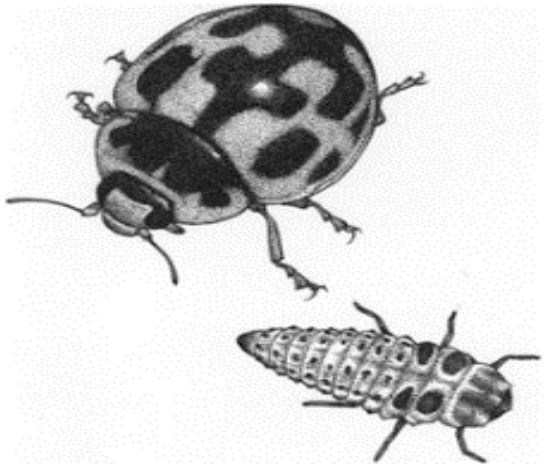


- Staphylinidae: small size (few mm), hunting small insects and nematodes



BIODIVERSITY - BENEFICIAL SPECIES

- Coccinellidae: Flying beetles from 0.1 to 1.5 cm in size, 90% of which are predators of aphids, white flies, mealy bugs and leafhoppers



- Wasp (Apocrita): parasitoid of many pests, the adult is often a pollinator.

- Spiders (Araneae): only beneficial.

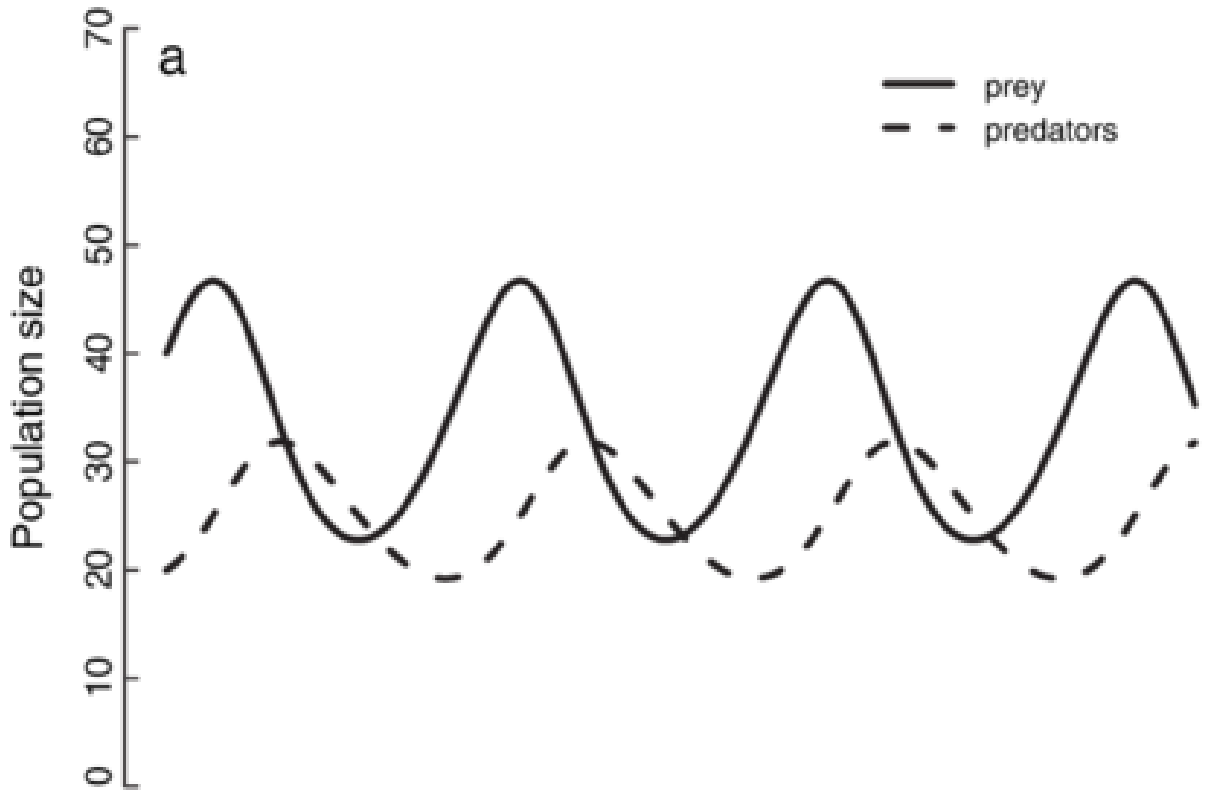
BIODIVERSITY - BENEFICIAL SPECIES

- Lizards: predators of many insects (flies, grasshoppers, etc.)

- Toads: predators of caterpillars, larvae, slugs

HOW TO USE THESE BENEFICIAL SPECIES? BIOLOGICAL CONTROL

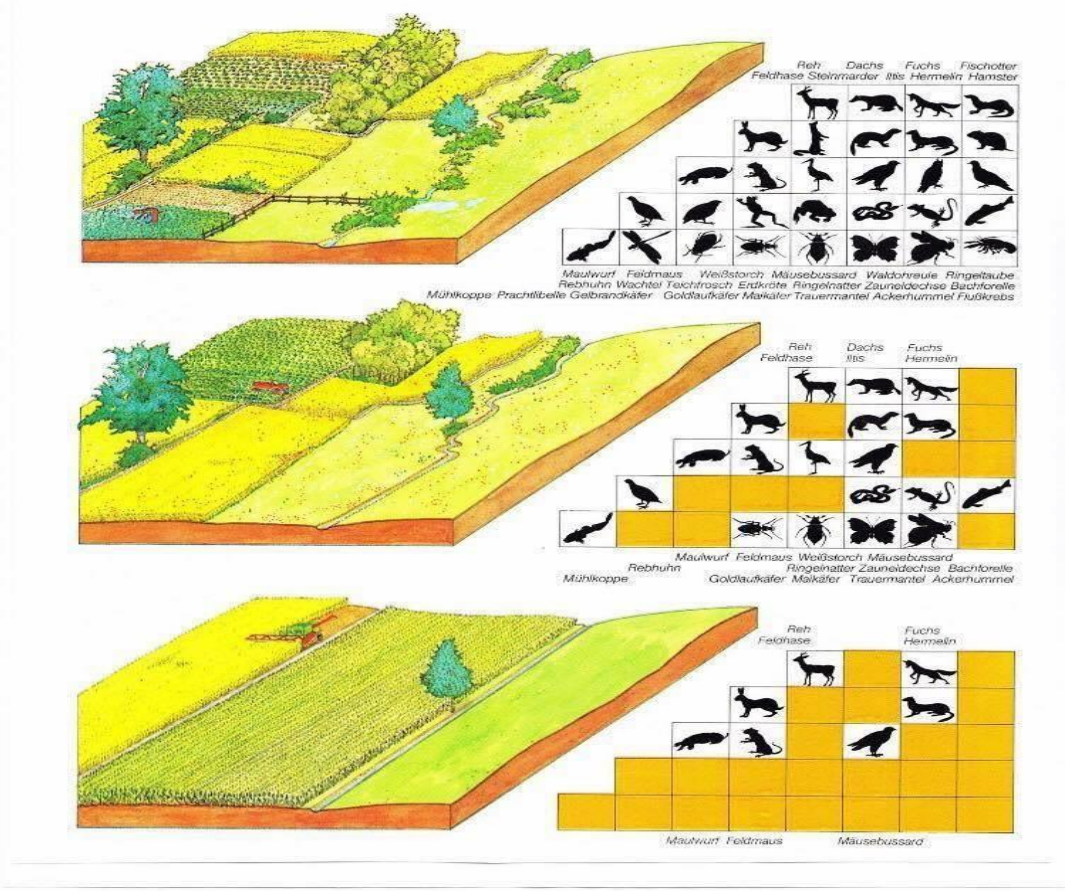
- **Flooded biological control**
- **Conventional biological control**
- **Conservative biological control**



BIODIVERSITY - CONSERVATIVE BIOLOGICAL CONTROL

Promote the presence of natural beneficials by adapting the agroecosystem environment:

- Increase the biodiversity of crops and plants
- Provide refuges for natural beneficials
- Prohibit/limit the use of pesticides



ASSOCIATED CROPS

- Diversity of plants
- Diversity of insects
  - Better soil cover: refuge for beneficial insects

Scientific study (Andow, 1991):

- 53% of predatory species and 75% of parasitoid species are more numerous in a field of associated crops than in a monoculture.
- 52% of pests less numerous in the polyculture.

FLOWERS

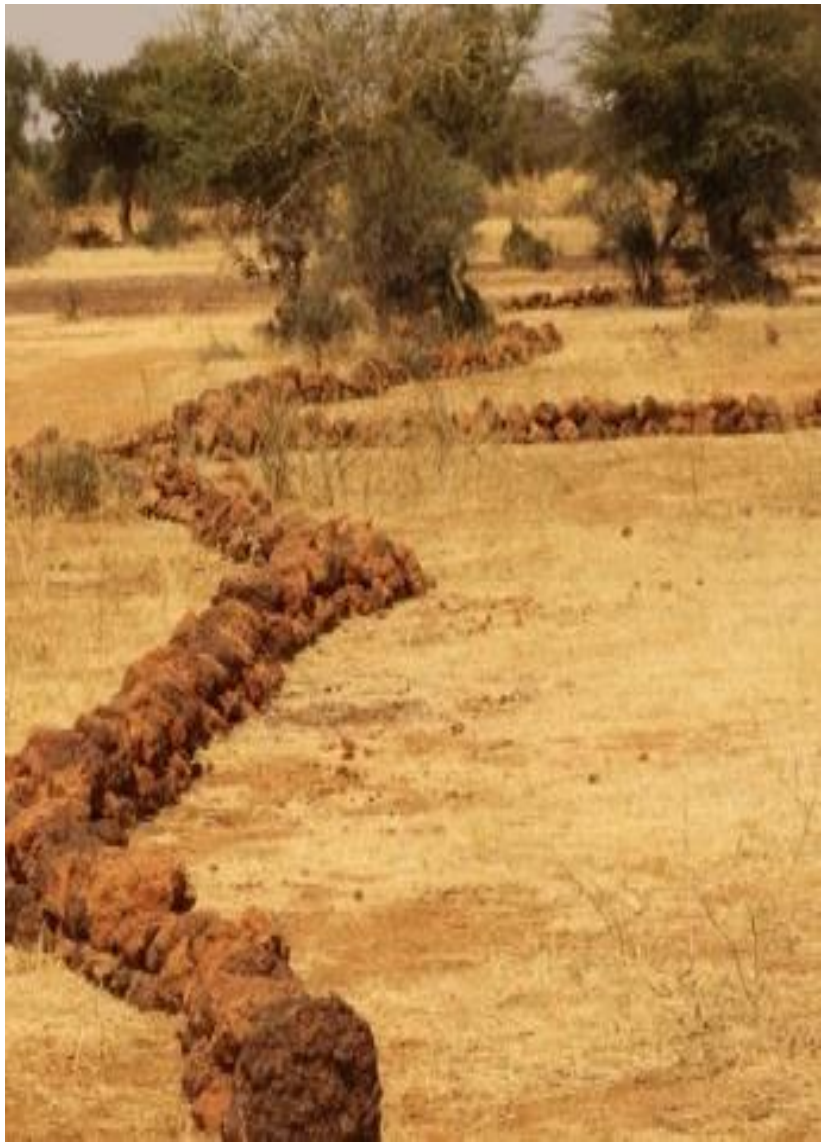
- Many beneficials, especially beetles and parasitoids (wasps), feed on pollen and nectar.
- Also attract pollinators.

LIVING HEDGES

- Refuge for beneficials
- Production of quality forage
- Input of nitrogen into the system (leguminous trees)
- Limited animal movement, can be used as a long term fence.
- **Reduces water runoff**
  - Limits erosion
  - Keeps moisture in the plot
- Fruit production

STONE FENCES

- Refuge for beneficials
- Reduces water runoff
  - Limits erosion
  - Keeps moisture in the field



GOOD SOIL COVER AND MULCHING

- **Refuge for terrestrial beneficials (spiders, beetles, mites)**

LIMITING/NOT USING PESTICIDES

- Pesticide will also kill the beneficials, disrupting the stability of the system.
- Instead, use repellents, which keep pests away from crops without killing them, and thus without killing beneficials.

CONTROL MECHANISMS

1. High biodiversity
2. **Plant nutrition, hygiene and quality seeds**
3. Crop associations
4. Use of mosquito nets
5. Repellent treatments

HYGIENE IN THE FIELD

CONTROL MECHANISMS

1. High biodiversity
2. Plant nutrition, hygiene and quality seeds
3. **Crop associations**
4. Use of mosquito nets
5. Repellent treatments

3. CROP ASSOCIATIONS

- Benefits of pest control
- Discontinuity of resources (see above)
- Greater diversity of insects, more beneficials (see above)
- Plants that attract a particular beneficiary
- Trap plants: pennisetum, brachiaria
- General repellent plants (chilli, ginger, onion, garlic, tagetes, nasturtium).
- Specific repellent plants: onion, desmodium
- In case of destruction of a crop by a pest, the associated crop will be able to compensate this loss.

3. CROP ASSOCIATIONS

Benefits not related to pest control

- Better soil cover
- Better use of space
- Better use of soil resources
- Diversification of production
- Harvesting at different times
- Higher yields than a monoculture
- To summarize: complementarity of associated species

CONTROL MECHANISMS

1. High biodiversity
2. Plant nutrition, hygiene and quality seeds
3. Crop associations
4. **Use of mosquito nets**
5. Repellent treatments

4. USE OF MOSQUITO NETS

- For delicate fruiting vegetables
- For nurseries
- Must not have a shaded area
- Must not have heat build-up
- Effective if combined with the following measures:
  - Installation of insect traps
  - Association with repellent plants
  - Repellent treatment
- A fixed greenhouse is not recommended if you want to do rotations

MOSQUITO NET GREENHOUSES

MOSQUITO NET TUNNELS

NURSERY UNDER MOSQUITO NETTING

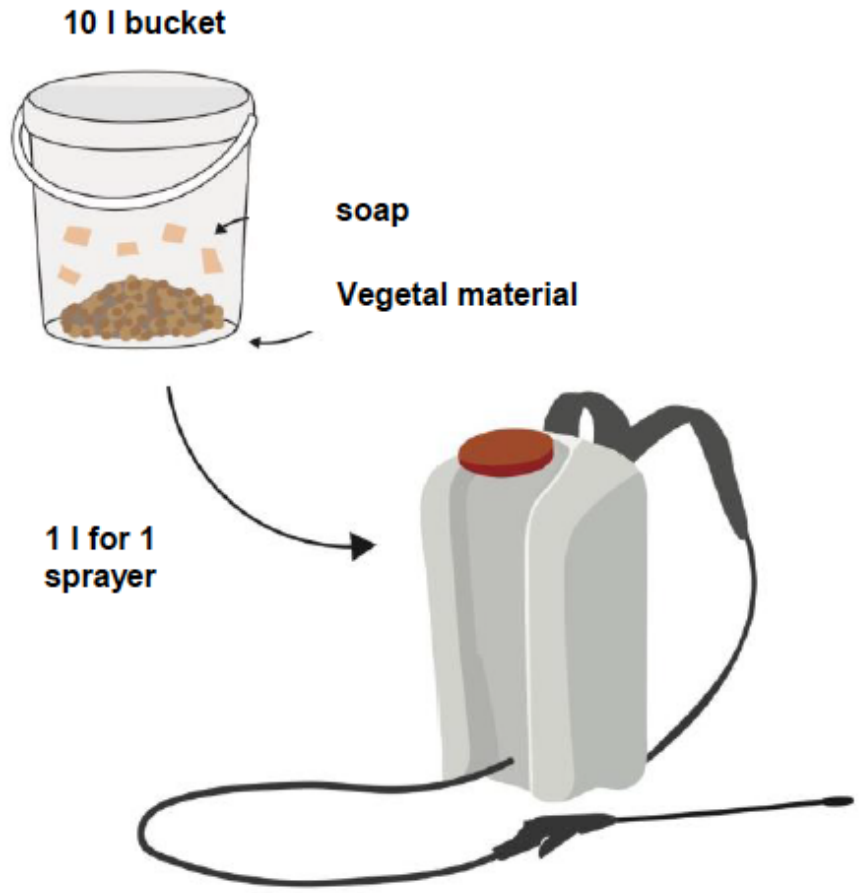
PROPOSITION OF QUESTION TO THE AUDIENCE

- Do you practice any of those technics?
- Can you explain one of your practice and why you are doing it?

6. REPELLENT TREATMENTS

Why is it better than pesticides?

- Produced with resources from the farm or local market = more accessible and economical
- Don't kill beneficials! The repellent effect applies not only to pests, but also to beneficials.



6. REPELLENT TREATMENTS

Procedure:

- Maceration, trapping, mixing, etc.
- In case of heavy pressure on the plot, 1 to 3 times / week
- Apply to the entire plot of the affected crop
- Use one treatment 3 times, then change product
- Preparations can be combined for greater efficacy = Cocktail
- In the event of heavy rain after application, re-apply the treatment
- Protected from light, preparations can be stored for several weeks.

6. REPELLENT TREATMENTS

- Garlic maceration: aphids, mites, flies.
- Pepper maceration: sucking and biting insects, caterpillars, crickets and locusts.
- Tomato maceration: insects and fungal diseases.
- Papaya maceration: fungal diseases (oidium and rust)
- Tagetes maceration: white flies, noctuid moths and leafhoppers.
- Neem leaves maceration: general repellent against pests.
- Neem oil: To be used in case of failure of other treatments against a pest. To be used with care and on wet plants (risk of burning).
- Milk: powdery mildew on vegetables.

6. REPELLENT TREATMENTS

Product	Recipe	Dilution	Application	Efficace against
Garlic maceration	2 tablespoons garlic powder or 500g fresh garlic in 10L water. Leave to macerate for at least 12 hours.	Mix 1L of maceration with 10L of water (10%) and 3 capfuls of soap.	Spray approximately 1L for 10 m2 of crop	aphids, mites, flies
Chili maceration	identical	identical	identical	Biting and sucking insects, caterpillars, crickets and locusts
Tomato leaf maceration	identical with 2kg of leaves	identical	identical	insects + fungal diseases
Papaya leaf maceration	identical with 1kg of leaves	identical	identical	fungal diseases (powdery mildew + rust)
Marygold maceration	identical with 2kg of plant leaves and flowers	identical	identical	whiteflies, noctuids, leafhoppers

6. REPELLENT TREATMENTS

Neem oil	identical with 2.5kg of seeds, also possible to buy the oil directly	identical with 2L of maceration, or with 90 to 120 ml for a 15L sprayer	identical, beware of the risk of burns when applying in direct sunlight	insects in general
Maceration of neem leaves	identical with 3kg of leaves and 24h maceration	identical with 30g soap	identical	all insects in general, treatment residues are applied to the base of the crop as a nematicide
Milk	Mix 50% water and 50% milk for infected plants, 80% water and 20% milk as a preventive measure for surrounding plants.	-	identical	powdery mildew on vegetables

PROPOSITION OF EXERCISE

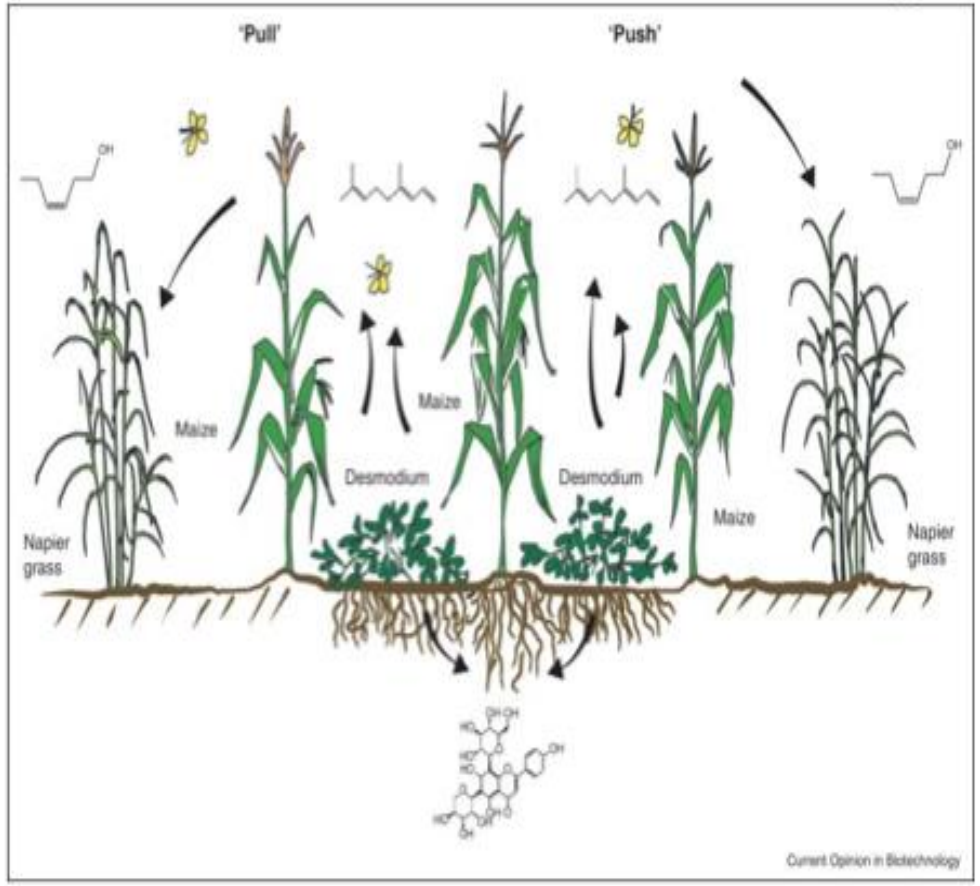
- Do you practice any of those treatments?
- Are there any other treatment that you practice, which you could share to the group?

- Preparation of one of the treatments:
  - Identify what treatment would be interesting for participants

7. PUSH AND PULL

- The push-pull system is a particularly effective strategy that uses on-farm diversity to control parasitic weeds, improve soil fertility and control cereal pests (Khan et al., 2011; 2014).
- Desmodium spp. are intercropped with cereals, whilst grasses such as Napier or Brachiaria are planted in border rows surrounding the plot.
- Stem-borers are attracted to the Napier grass (pull) whilst being repelled from the cereal crop by the intercropped Desmodium (push).
- Root exudates from the Desmodium also control the parasitic striga weed (or witch weed)by affecting germination efficiency.
- Desmodium also improves the soil fertility through nitrogen fixation.
- Both Napier grass and Desmodium provide high value fodder for livestock, therefore benefitting milk production and the nutrient content of manure (Zingore et al., 2007).

Pest and striga control in cereals



Desmodium: repels stem borers and armyworms. (PUSH)

Pennisetum/brachiaria: attracts and traps these pests (PULL)

Desmodium also leguminous: nitrogen fixation.

Desmodium controls striga

Desmodium and pennisetum/brachiaria quality fodder

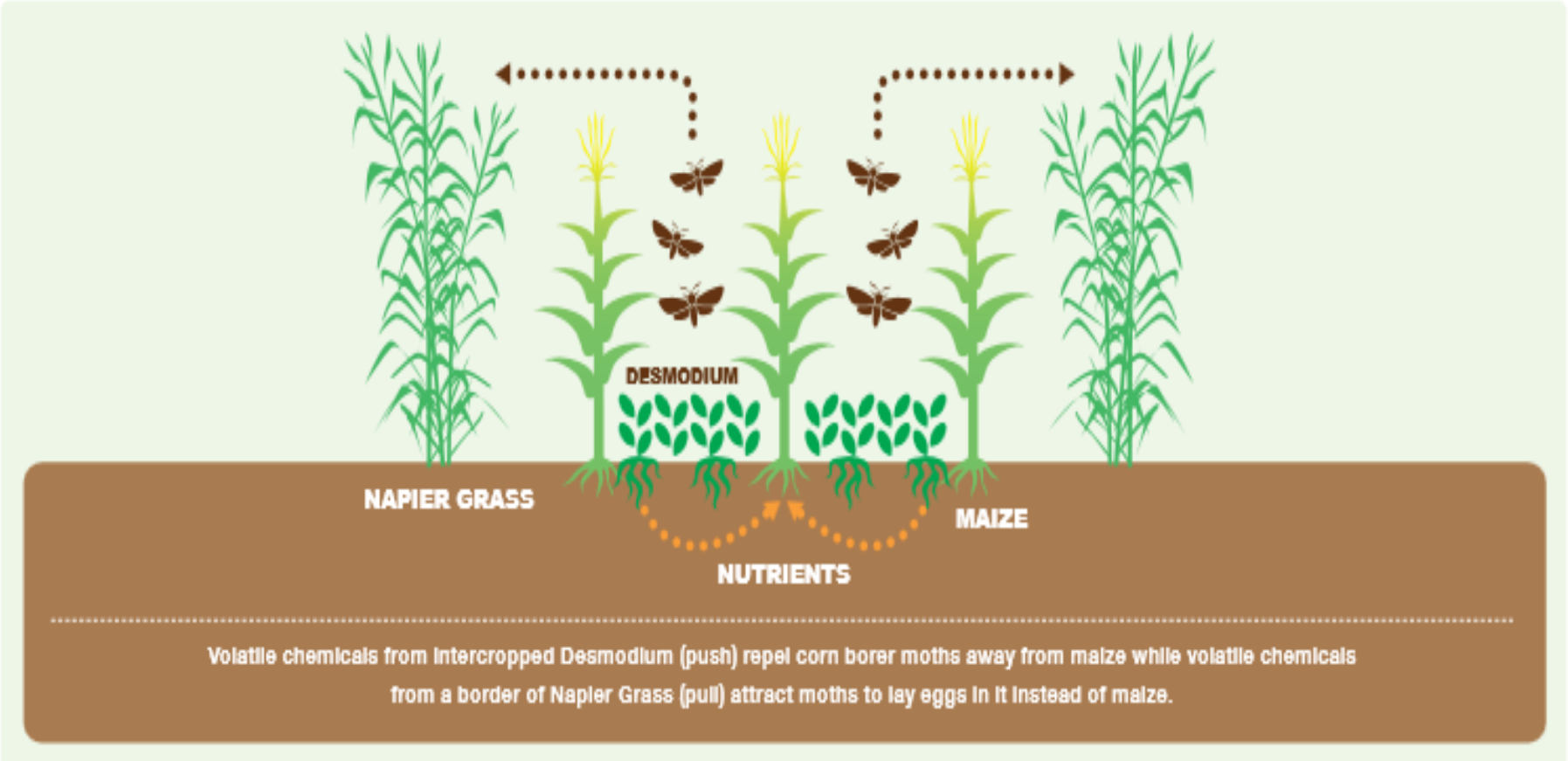


Figure 5. The push-pull pest management system showing intercropping of maize with Desmodium spp. legumes that repel (push-) and Napier grass that attracts (pulls) stem-borer. Desmodium also improves soil quality through nitrogen fixation and impedes striga weed. Source: Fostering Economic Resilience: The financial benefits of ecological farming in Kenya and Malawi. Greenpeace Africa.6

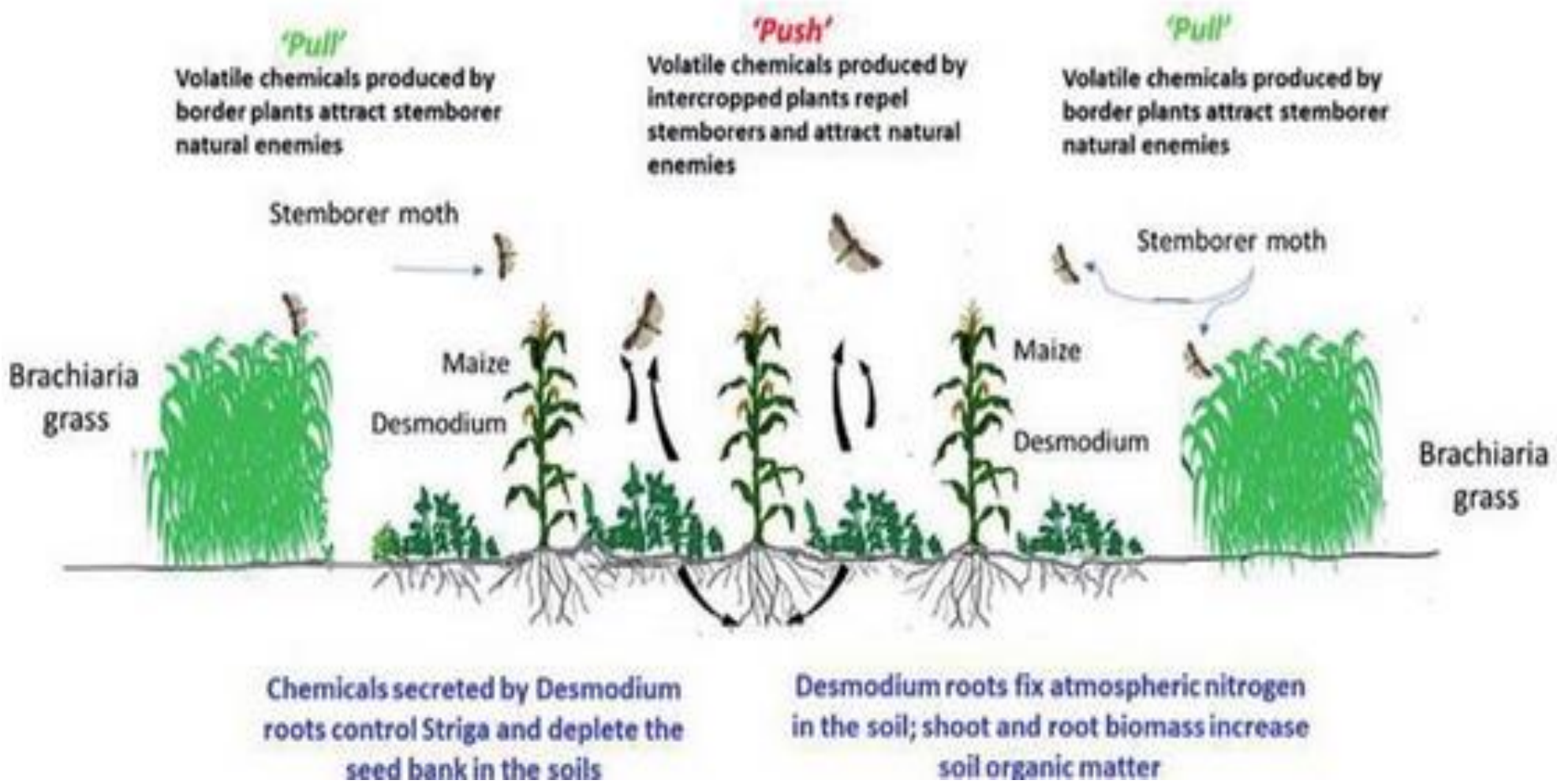


Figure 6. Climate-smart push-pull technology: Maize intercropped with repellent green leaf desmodium and Brachiaria grass as border crops.

- The "push and pull" system in pest management is an integrated approach designed to control pest populations in a sustainable and environmentally friendly manner.
- The system is widely used in sustainable farming, particularly in Africa, to manage pests like the stem borer in maize.
- **Push Component (Repellent Action):**
  - **Desmodium:** A leguminous plant that is intercropped with the main crop (e.g., maize). Desmodium emits chemicals that repel pests like stem borers away from the maize.
  - This "pushes" the pests away from the main crop.
- **Pull Component (Attractant Action):**
  - **Brachiaria (Napier grass or other trap crops):** Planted around the field's perimeter, this grass attracts pests away from the main crop.
  - The pests are "pulled" towards the Brachiaria, where they lay eggs. However, the Brachiaria either kills the larvae or reduces their survival rate, effectively trapping the pests and reducing their impact on the main crop.

Combined Approach

- **Integration:** The push and pull strategies are often used in tandem for a more comprehensive approach.
- For instance, using a combination of repellent plants (push) and trap crops (pull) can effectively manage pest populations while reducing reliance on chemical pesticides.
- **Benefits:** This integrated approach helps in reducing pest populations more sustainably, protecting biodiversity, and minimizing environmental impact.
- It also often leads to more effective pest control compared to using a single strategy.
- By using both push and pull methods, farmers and land managers can create a more balanced ecosystem that supports effective pest management

CONT'…

- Stalk borer and fall armyworm in cereals (mostly maize) are controlled using the push-pull technology.
- Desmodium associated with cereals repel the pest, while a row of Napier grass around the field attract them and kill them.
- In dry areas (<900-1000 mm), it is advised to use the grass brachiaria instead of Napier.
- In the absence of pests, disodium can be replaced by a grain legume, while in case of infection, desmodium should be planted instead of grain legumes.
- Brachiaria, Napier and desmodium are high quality forage

CONT'…

- A double row is sown between the plots, a single row at the foot of the hedges on the sides of the plots.
- The distance on the line Is 40 cm.
- Sow either several seeds or one cutting per seedhole.
- The first lines of cereal should start at least 1 m from the grass.

HOW DO W PLANT A CLIMATE-SMART PUSH–PULL FIELD?

1. Plant drought-tolerant Brachiaria grass in a border around the maize or sorghum (cereal) plot

2. In the first year, plant Brachiaria before the rains so that it has a start on the maize or sorghum.

✓ The stem borer moths will be attracted by the Brachiaria

3. Get drought-tolerant green leaf Desmodium seeds. For 1 acre of land=, 4046.86 m2, 1 kg of Desmodium seeds is needed

4. Prepare the soil carefully so that it is as fine as possible

5. Using a strong pointed stick, make a trough in the middle of the rows where maize or sorghum will be planted

CONT'…

- 6. Mix the Desmodium seeds with the fine soil (about one handful of seed and two handfuls of soil)
- 7. Sow it into the furrows you made and cover with soil
- 8. Plant Desmodium seeds with the rains for maximum germination
- 9. Plant your cereal in the field surrounded by Brachiaria
- 10. After 3 and 6 weeks, trim the Desmodium so that it does not overgrow in between the maize or sorghum crops
- 11. Keep the field weed free.

ADVANTAGES OF ADOPTING THE CLIMATE-SMART PUSH–PULL TECHNOLOGY

- Increased maize and sorghum yields
- Continuous supply of cattle feed from the Brachiaria and Desmodium
- Nitrogen fixed in your farm by the Desmodium, hence saving on fertiliser costs
- Soil protected from erosion as Desmodium acts as a cover crop
- Soil retaining water as Desmodium acts as a mulch
- Increase in profits from sale of Desmodium seeds at high prices
- Increase in cash from selling more milk
- Saving on farm labour, as you do not have to pull out striga

Harvested Vegetables Jimma, Ethiopia

QUESTIONS?

…

References:

Khan Z, Midega C, Pittchar J, Picket J, Bruce T (2011) Push-pull technology: a conservation agriculture approach for integrated management of insect pests, weeds and soil health in Africa. Journal of Sustainable Agriculture 9: 162-170.

Khan Z, Midega C, Pittchar J, Murage A, Birkett M, Bruce T, Pickett J (2014) Achieving food security for one million sub-Saharan African poor through push-pull innovation by 2020.Philosophical Transactions of the Royal Society B 369: 20120284.