Climate-Smart Agriculture: Overview

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CARDESA

Centre for Coordination of Agricultural Research & Development for Southern Africa
Centre De Coordination De La Recherche Et Du Développement Agricole De L'afrique Australe
Centro para a Coordenação da Investigação e Desenvolvimento Agrário na África Austral

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The Challenge:

"by 2050, we need to…

- *Double world food production on ~ the same amount of land*
- *Make farms, fields and landscapes more resistant to extreme weather, while…*
- *… massively reducing GHG emissions."*

The Answer: Climate-Smart Agriculture (CSA)

CSA is an approach to help guide the management and transformation of agriculture for food security under the realities of climate change

It is composed of three main pillars:

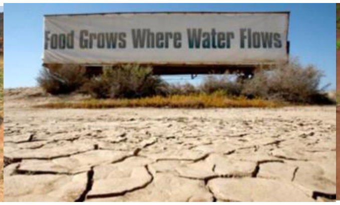
1. Sustainably increase agricultural productivity and incomes;
2. Adapt and build resilience to climate change;
3. Reduce and/or remove greenhouse gases emissions, where possible.

FAO, 2013: Climate-Smart Agriculture Sourcebook

CSA Concepts and Technologies

Climate-smart agriculture (CSA)

- Approach for transforming and reorienting agricultural systems to support food security under the new realities of climate change.
- Climate change threats can be reduced by increasing adaptive capacity of farmers, increasing resilience and resource use efficiency.
- CSA is not just about new technologies, it is combining indigenous knowledge, common agricultural practices and appropriate new technological developments for agriculture to increase sustainably production efficiency – to ensure food security for future generations.
- Knowledge and information is available but a giant task still remains: closing the gap between research and application on farm level and for policy and decision making – knowledge translation for different users.


Old vine in new bottles? What is new?

- Synergies and trade-offs in local context between adaptation, mitigation and productivity benefits
- Inclusion of mitigation (sequestration of CO_2 in soils, reduced emissions of greenhouse gases);
- Inclusion of services and tools – climate insurance, climate services, etc.
- International climate finance increasingly available, agricultural sector can tap into it, big amounts but not easy to access (e.g. GCF, REDD++);
- Emphasis on climate change projections and forecasts as basis for formulation of National Adaptation Plans (NAP) and measures;
- Increasing importance of insurances to cover loss and damage.

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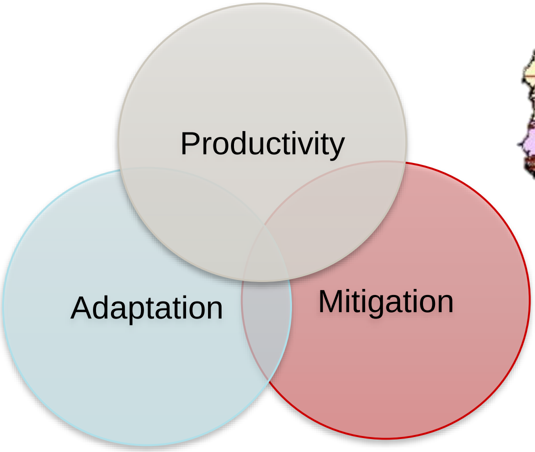
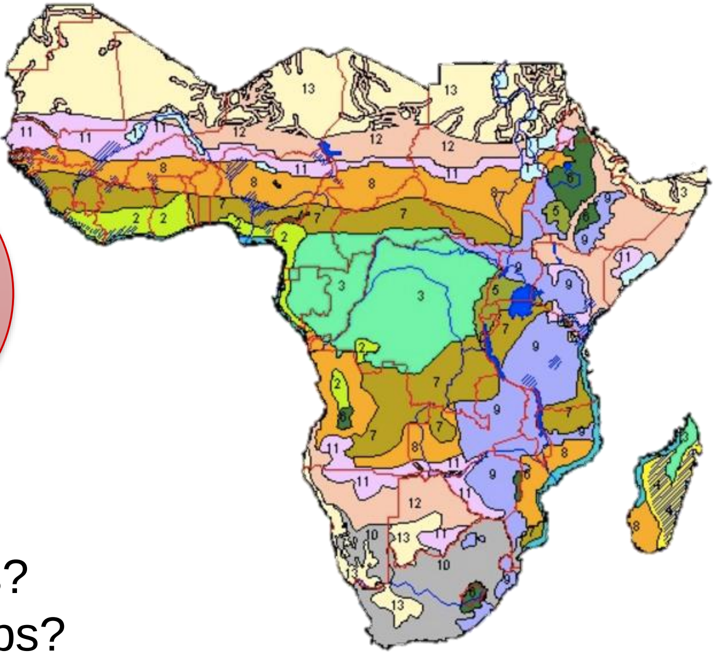
The Challenge for CSA Programs

Many Practices	Many Goals	Many Contexts





Of What?
- Most common crops?
- Most vulnerable crops?

For Whom?
- Most farmers?
- Most vulnerable farmers?

Not CSA

CSA

Context

Many practices/programs/policies can be CSA **somewhere**

But **none** are likely CSA everywhere

Enabling environment for CSA

Enhancing the **policy-framework** for CSA

Capacity Development for CSA

Financing mechanisms for CSA

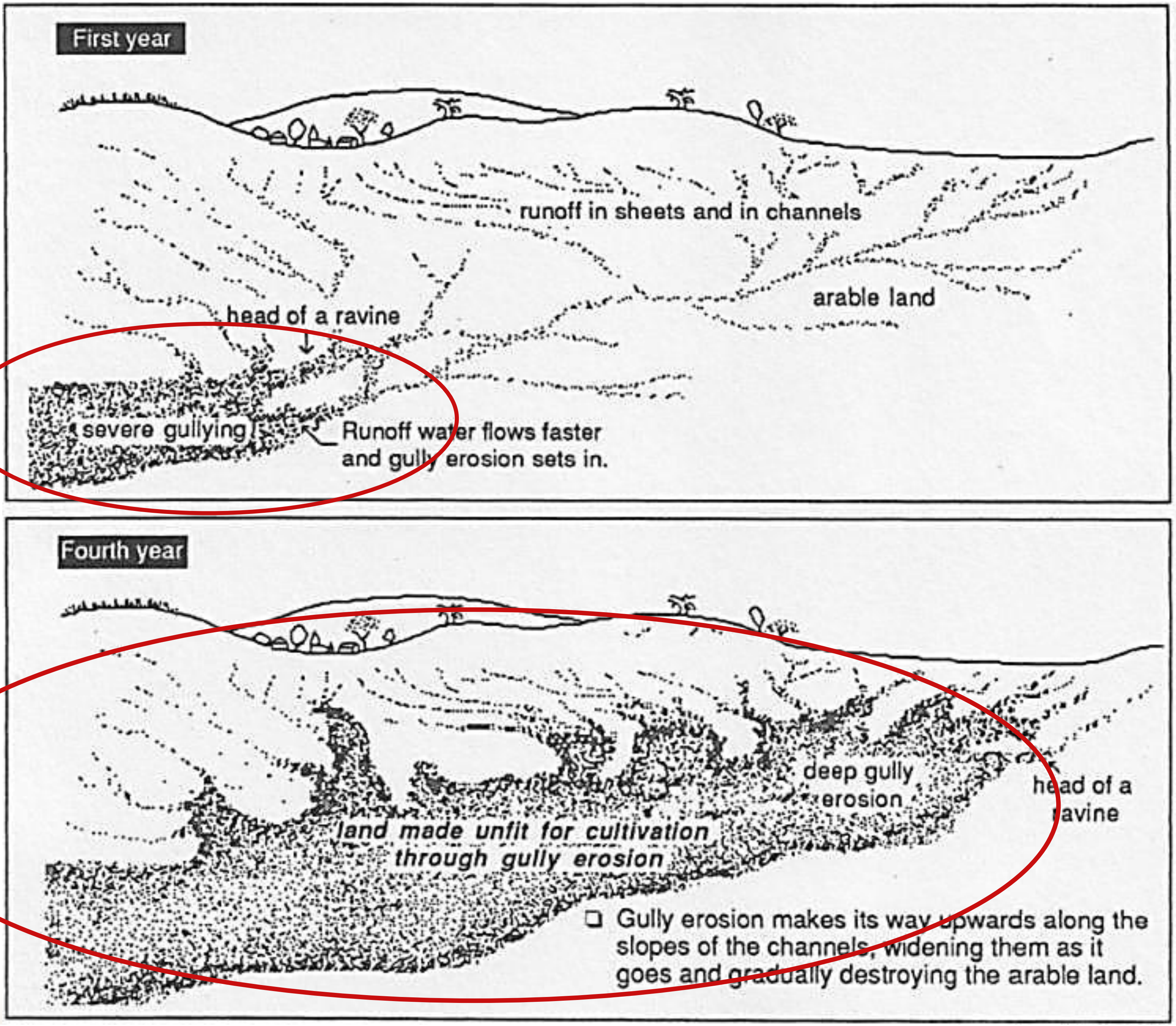
Improvement of **climate-specific data** in agriculture

Fostering CSA at **local level**

From left to right: © GIZ / Markus Kirchgessner, Joerg Böthling, Shilpi Saxena, Ursula Meissner, Michael Kottmeier

Soil and water conservation

Climate Smart Agriculture
Concepts and Technologies for Sustainable Use of Water and Soil



Source: Dupriez & de Leener

Erosion on grasslands

Soil and water conservation (SWC) – main points

Technical principles of conservation

- Reduce erosive power of rain drops by keeping the soil covered
- Fight erosion at its source and retain water where it falls (facilitate infiltration)
- Reduce speed of water flowing down slopes with constructions (e.g. gabions, erosion blankets/geotextile etc.)
- Store and reuse of water for irrigation

Organisational aspects

- SWC requires a collective action
- Catchment approach and village land-use planning

Technologies of erosion control

Biological methods:

- Contour planting of crops, mixed cropping and mulching
- Vegetation strips along contour

© WAC

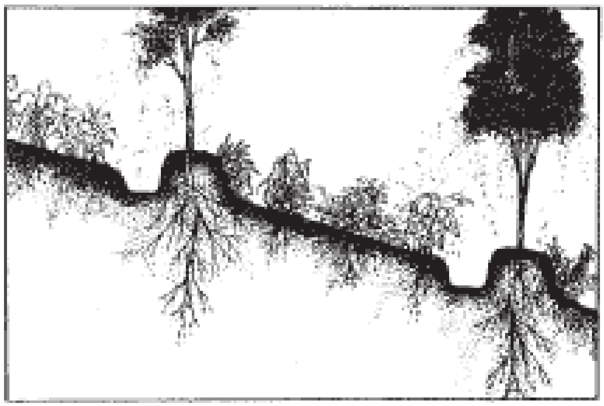
Mechanical methods:

- Terracing
- Infiltration ditches along contour lines
- Earth bunds: retain surface water
- Stone bunds: allow water to permeate but reduce flow velocity considerably

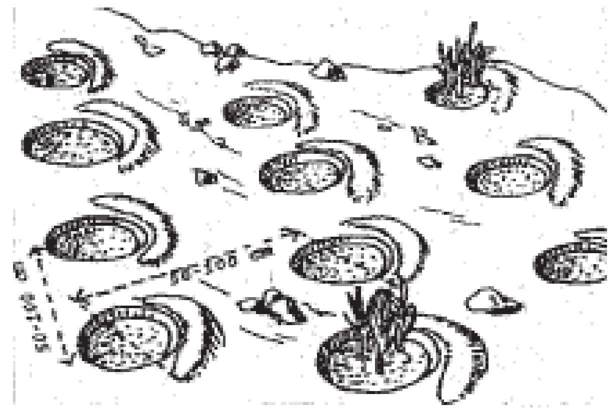
© GIZ

Increasing the infiltration

Contour trenches



Semi-circular bunds



Circular bunds

Plant pits with mulch

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How to increase the water use efficiency ???

- Apply water directly where it is consumed (drip irrigation, bottle solution for small fields)
- Prefer irrigation in the early morning or evening, even at night - but never during full sunshine
- Support water storage capacity in the field (ditches, mulch, higher organic content etc.)
- Shade netting
- Use drought tolerant and water efficient varieties

Water harvesting in practice

Source: http://www.searnet.net/fileadmin/Experiences_in_promoting_In-Situ_RW_technologies.pdf

© www.senwes.co.za

Example (Video): Water harvesting in Bolivia as a way to adapt to climate change

4 main types of irrigation systems

- Irrigation by flooding
- Sprinkler irrigation
- Irrigation with buckets or cans
- Drip irrigation

Depending on

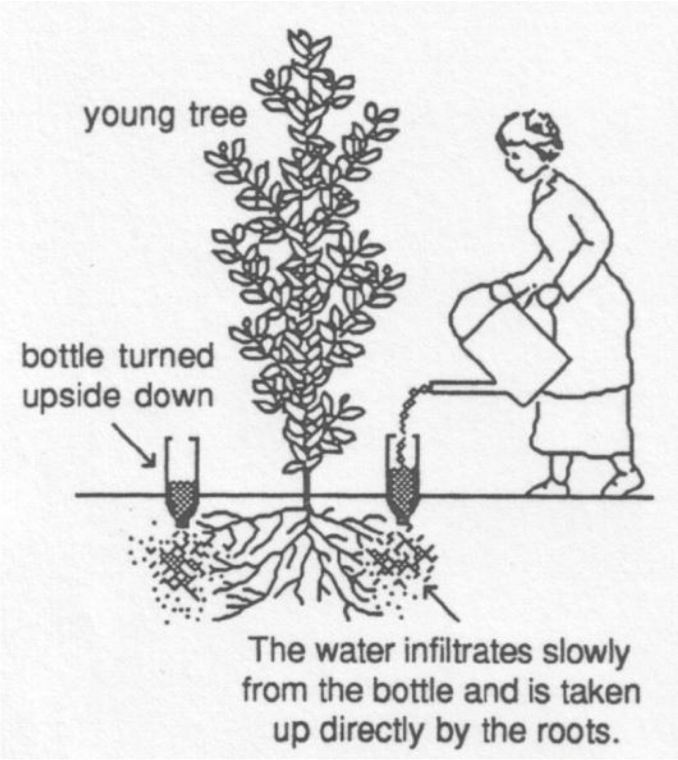
- Natural conditions
- Type of crop
- Type of technology
- Financial ability
- Previous experience with irrigation /Knowledge
- Required labor inputs costs and benefits

Source: http://nrcca.cals.cornell.edu/soil/CA3/CA0324.php

Drip irrigation

Low cost systems

Plastic bottles – simple and very efficient



Waste Water and Greywater Reuse in Agriculture - a sensitive matter -

- Huge advantages by far outweigh the risks.
- Huge available water resource in water scarce areas.
- Already existing unregulated use from rivers and streams (people are often not aware – more dangerous).
- Open discussion of possible use of waste water often reveals big sensitivities around the matter.
- Excellent water source comes with already with fertilizer.
- Global paradigm shift from parameter driven approach towards risk assessment and related measures.
- National legislations often not up to date.

Waste Water Reuse in Agriculture

In the past:

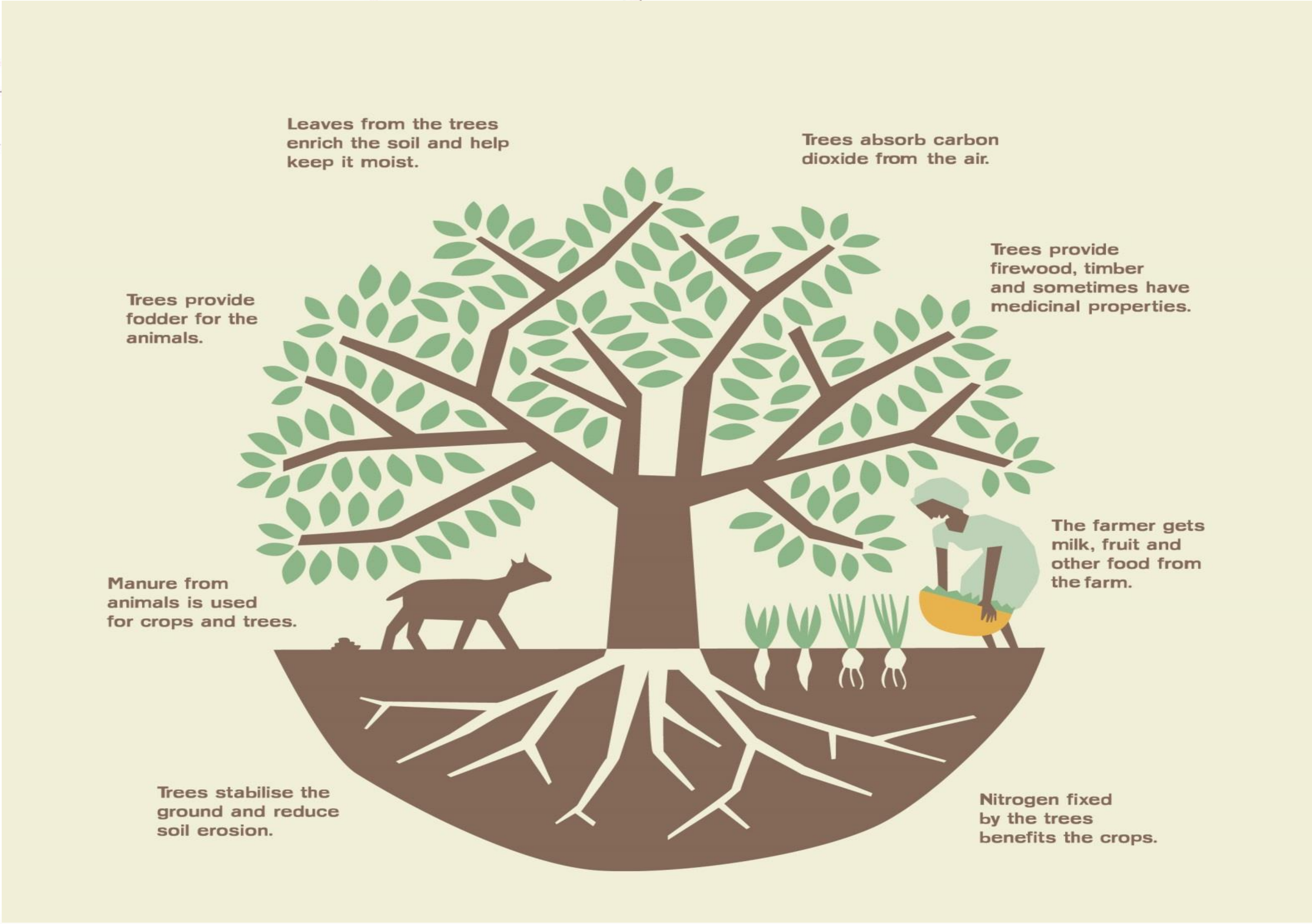
- Parameter centred approach with unjustifiably restrictive standards
- Wastewater treatment as only control mechanism – doubt on reliability of operations, financial implications, etc.
- Not supportive for WW reuse in Agriculture

Today:

- Risk assessment centred approach taking into account:
- Type of Wastewater treatment
- Type of crops produced/permitted
- Type of irrigation technique used/permitted
- Control of human exposure (Farmers, workers, neighbours, crop handlers, consumers)

Agroforestry

Climate Smart Agriculture
Concepts and Technologies



© http://www.viagroforestry.org/files/2014/05/Tree-Illustration_PLAIN-01.jpg

Ways in which trees build resilience

- **Soil restoration:**
  - more SOC, richer soil microbiology, enhanced percolation, less erosion, less degradation
- **Soil fertility:**
  - more SOC, more N if legumes, nutrient pump
- **Increased carbon accumulation**
  - 2-10 tons of $CO_{2\text{-eq.}}$ per hectare per year are common
- **Higher biodiversity:**
  - More niches for pest predators
- **Lower input requirements:**
  - fewer pesticides, fewer fertilizers
- **Better, crop yields**:
  - more soil organic matter, better plant nutrient availability, protective microclimate
- **Higher productivity:**
  - better use of water, nutrients, light
- **Better nutrition:**
  - fruits, fodder, multi-crop system support
- **Livestock farming:**
  - fodder, shelter
- **Weather resilience:**
  - roots pump water, trees offer shade and windbreaks
- **Insurance & savings:**
  - Once off timber sales
- **Income diversification:**
  - crops, fuel, fodder, timber, fruits
- **Reduced deforestation:**
  - more tree products sourced off-forest
- **Flood control & water recharge:**
  - Marketable environmental service

Agroforestry in Malawi

	yield (t/ha)
Maize only	1.30
Maize + fertilizer trees	3.05

Survey of >200 farms in six districts in 2011
(Mzimba, Lilongwe, Mulanje, Salima, Thyolo and Machinga)

Gliricidia, a leguminous coppice tree, interplanted with maize. The leaves are cut and turned over into the topmost soil layer, providing nitrogen and other nutrients.

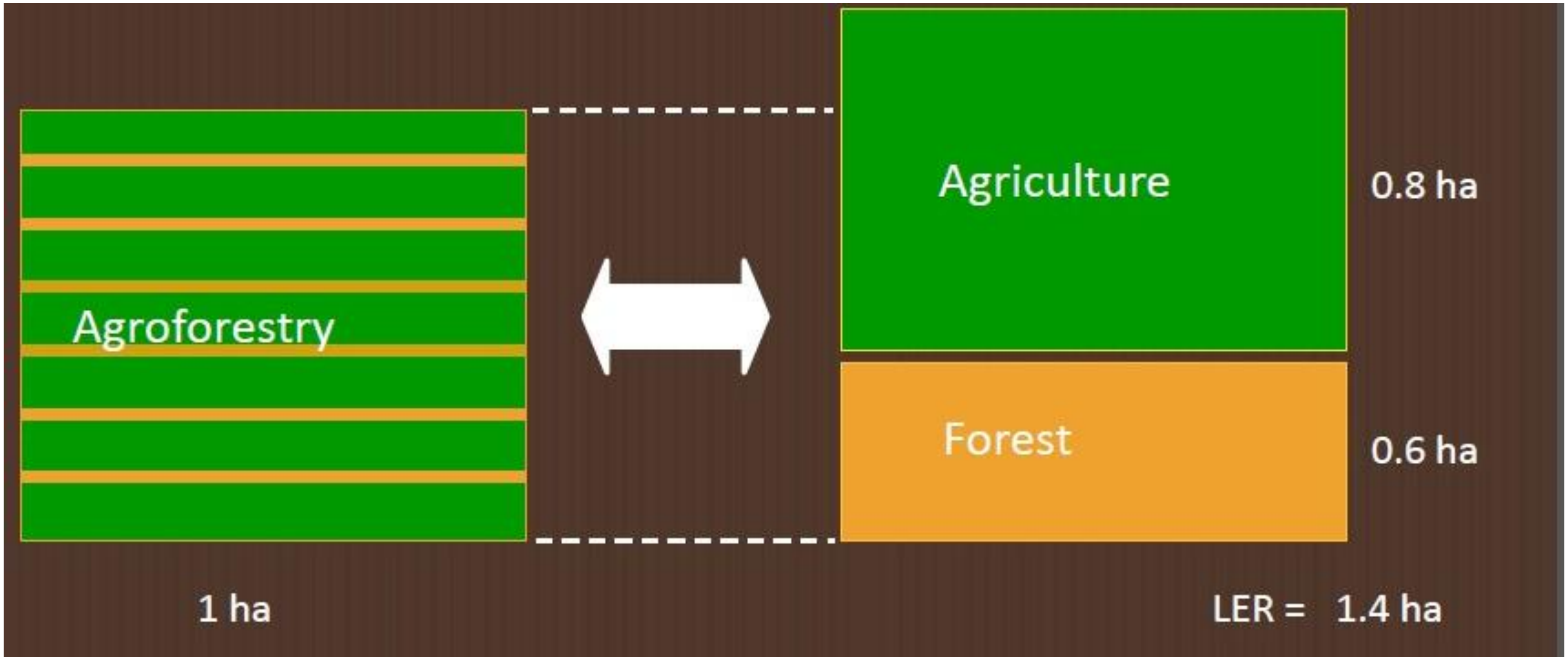
Fertilizer trees can outperform NPK

2009/2010 season; data from 6 Malawian districts

Farmer plot management	Sampling Frequency	Mean (Kg/Ha)	Standard error
Maize without fertiliser	36	**1322**	220.33
Maize with fertiliser	213	**1736**	118.95
Maize with fertiliser trees	72	**3053**	359.8
Maize with fertiliser trees & fertiliser	135	**3071**	264.31

Mwalwanda, A.B. et al (2010)

Land equivalence ratio (LER)



- $$LER = \frac{Crop\ yield\ AF}{Crop\ yield\ monocrop} + \frac{Tree\ product\ yield\ AF}{Tree\ product\ yield\ forestry}$$

(Post) Harvest Losses / Food Losses

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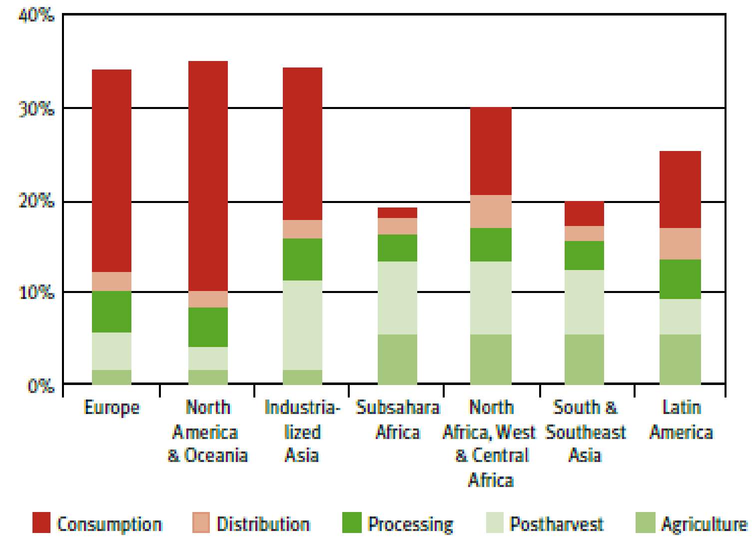
Importance

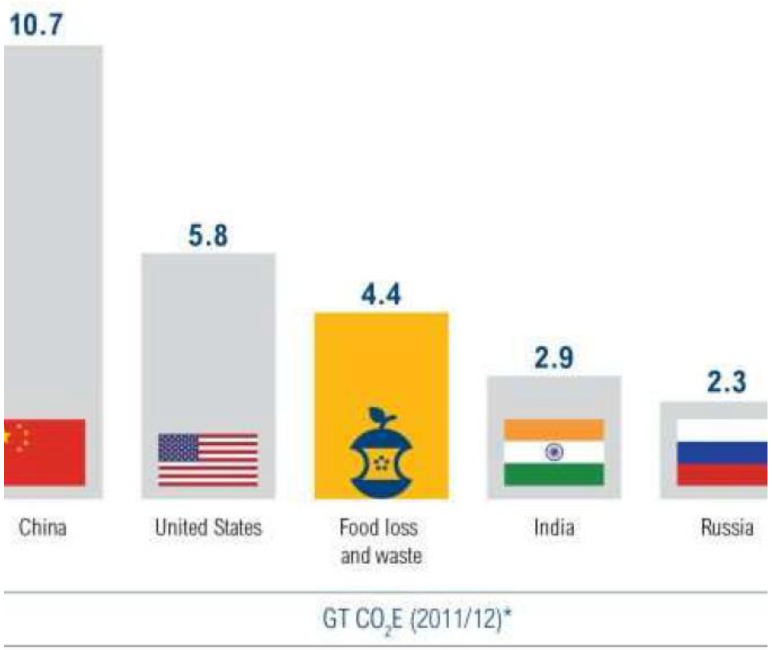
- Losses along value chains as major impediment to food security and sustainable growth
- Food loss is a highly important factor in efforts to combat hunger and raise incomes
- 1/3 of all food produced for human consumption is lost (can reach 50% for fruits, vegetables, root crops)
- In Sub-Saharan Africa, post-harvest losses have a value of $4 billion per year (equivalent to value of cereal imports 2000-07 or annual calorific requirement of at least 48 million people)



- 1% reduction in post-harvest losses => $40 million/yr economic gain - most would directly benefit smallholders
- Quantitative/qualitative losses seriously affect livelihoods; contamination with mycotoxins as severe problem for consumer health and livestock productivity

If food loss were a country, it would be third largest GHG emitter

- Food loss and food waste generate 4x more GHG emissions than aviation.
- Sources of emissions
  - On-farm for producing food that is ultimately lost or wasted;
  - Production of electricity and heat used to process food that is ultimately lost or wasted;
  - Energy used to produce, transport, store, cook food that is ultimately lost or wasted;
  - Landfill emissions from decaying food;
  - Emissions from land use change and deforestation associated with producing food that is ultimately lost or wasted
- Reduce food loss and waste as win-win strategy for climate and economy



Importance

Harvesting/field drying	4-8%
Transport to homestead	2-4%
Drying	1-2%
Threshing/shelling	1-3%
Winnowing	1-3%
Farm storage	2-5%
Transport to market	1-2%
Market storage	2-4%
Cumulative loss from production	10-23%

Causes of harvest losses

Before harvest

- Poor choice of varieties
- Poor crop and livestock management
- Poor soil and seed quality
- Incorrect moisture levels during growth
- Pest infestations and diseases during growth

During harvest

- Premature harvesting
- Physical damage during harvest

After harvest

- Poor storage facilities after harvest
- Spillage and damage during handling, transport, packaging, marketing

And

- Weak economic infrastructure
- Inappropriate practices at different stages

Post Harvest - Best Practices

Before Harvest:

- Identify pests and diseases and learn their life cycle
- Monitor fields and crops consistently
- Use biological controls (e.g. predatory insects, pheromones)
- Use pest-resistant crop varieties
- Remove dead plants that show signs of disease

During / After Harvest:

- Harvest during lowest temperature of the day (→ Horticulture)
- Do not harvest when raining or dew or produce is wet (→Grains)
- Ensure proper drying (<12 % hum.)
- Use tools and techniques to minimize damage during harvest
- Create shady spot in the field to store harvested crops
- Use cartons, wooden crates, plastic containers and closed bags to ensure produce is protected.

Post Harvest - Best Practices - Examples

- Shelling an threshing: Use methods which ensure minimum damage to the gains, damage grain should not go to the storage and be sorted out and consumed first – not suitable for storing.
- Drying of grains (moisture under 13-12 %)
- Natural methods- using plant parts as traditional insecticides (Eucalyptus, Neem)
- Use of Biocides e.g. Aflasafe – for displacing aflatoxin-producing fungi
- Storage of dried product in closed bags or silos
- Storage location easy to inspect, distance from floor and walls, frequent inspection to detect infestation at early stage.

Regional and traditional storage solutions

Post-harvest management in smallholder farms, Zimbabwe

Drying crib

Granary

Importance of improved storage

WFP

Uganda:

maize quality after 100 days of traditional storage (left)

and

storage using improved locally-
produced silos (right)

Improved storage bags

Tom Campbell/Purdue

- Hermetic storage bags – triple bagging
  - Eliminate pests/molds by depleting oxygen levels
- Pesticide free
- Crow pea, millet, sorghum, maize
- Losses reduced by up to 90%
- Reusable and affordable (2.5 $)
- Local business opportunity

Indigenous varieties / breeds

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Importance of local varieties

Adapted to agro-ecological and production conditions such as:

- Hot/cold climate (e.g. heat tolerance of seedlings)
- Low soil fertility (e.g. low P)
- Variable rainfall conditions (e.g. drought, temporary flooding)
- Pest/disease pressure

Source: Haussmann et al., 2013

Over the past 100 years, Latin America and the Caribbean has lost 75 per cent of genetic crop diversity.
Many cultivated crops, such as potato, tomato, cocoa and maize, originate from Latin America and the Caribbean.

Source:UNEP, 2010

The use of local breeds

Strengths in

- Familiar with local conditions (feed, climate, high elevations..)
- High resistance and tolerance to specific diseases
- High tolerance of climatic extremes (heat, cold)
- Less fertility problems and longer life expectancy
- Multi purpose animals
- Cheap local breeding animals

Deficiencies in

- Lower yields and slow growth
- Low final size and weight
- Little selection and breeding
- Almost no records
- Little knowledge and research

Integrated Pest Management (IPM) and Biological Pest Repellents

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Integrated Pest Management (IPM)

Traditional pest control involves the routine application of pesticides

IPM, in contrast:

- Focuses on pest prevention
- Uses pesticides only as needed
- IPM is not a single pest control method but rather involves integrating multiple control methods

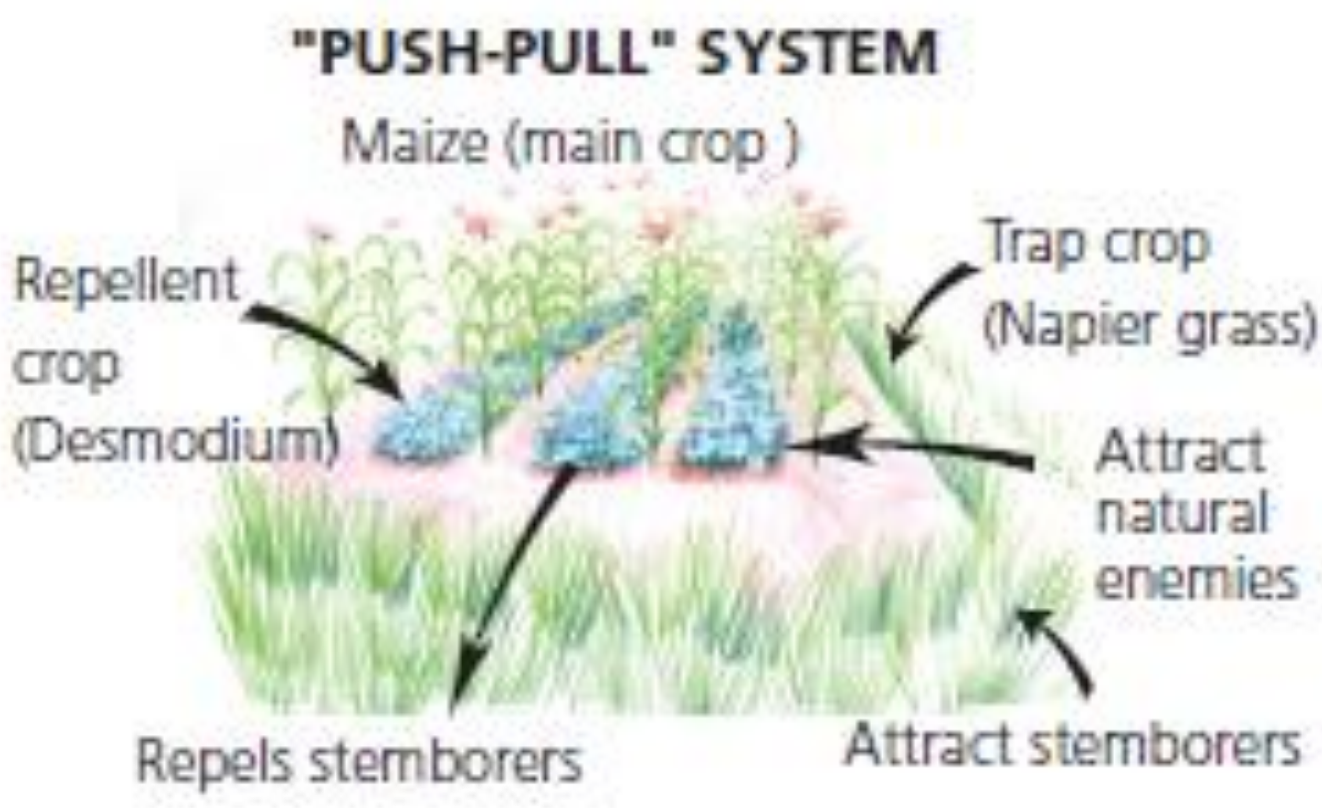
Control methods include for example:

- Pest trapping
- Physical removal
- (Bio) Pesticide application

How do Bio-pesticides work?

- Bio-pesticides
  - less toxic than conventional pesticides
  - affect only the target pest and closely related organisms
  - most are effective in very small quantities and decompose quickly
- Different types of Bio-pesticides are available:
  - Biochemical pesticides
    - naturally occurring substances that control pests by toxic or non-toxic mechanisms
    - include substances that interfere with mating, e.g. insect sex pheromones, various scented plant extracts that attract insect pests to traps
  - Microbial pesticides
    - microorganism (e.g., bacterium, fungus, virus or protozoan) as active ingredient
    - control many different kinds of pests, though each active ingredient is relatively specific for its target pest[s]

IPM- Example: Push-Pull approach to prevent stemborer and striga



Source: ICIPE, Intern. Centre of Insect Physiology and Ecology, Kenya

Agricultural Risk Insurance

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Agricultural Risk Insurance

Relatively new topic but with high potential for the future

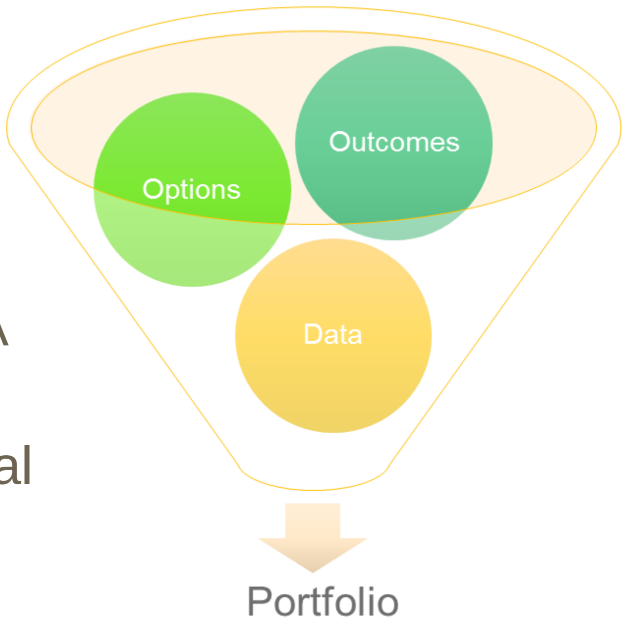
- Buffering farmers from negative effects of climate change, preventing financial breakdowns related to climate impacts on agricultural production → positive impact on food security
- <u>Different strategies:</u>
    - Crop and livestock insurance possible
    - Re-planting guarantee in case crops die at early growth stage
    - Index based insurance (yield or weather)
        - Insurance pays out if farmers produce significantly below official average production rate in a defined area

Agricultural Risk Insurance II

- Weather Index based Insurance: Insurance pays out based on weather data for a defined area (no or low rains etc.).
    - Pre-condition: Good agricultural practice is applied, possibility to make CSA a condition. Incentive for further CSA adoption possible.
- Insurance fees can be bundled with input prices or supported through smart (input) subsidies or national/regional insurance schemes.
- Investment into insurance solutions instead of dealing with increasing compensations of farmers will turn into attractive solution for national governments in future.

Steps in planning CSA measures

- Assess context: vulnerability assessment
  - target groups, value chains, etc.
- Define outcomes
- Generate and evaluate evidence
  - existing evidence, feasibility studies, piloting
- Identify, prioritise and select of appropriate CSA practices
  - technically and economically feasible for local context, socially and culturally acceptable
- Elaboration of action plan
  - integrated planning: including agriculture, forestry, fisheries and water at different levels – local, watershed, regional
- Explore possibilities for “climate finance” (NEPAD, GCF…)



Conclusions

- There is uncertainty about the future extent of climate change events/impacts, but there is also sufficient information and knowledge to take action - now.

Video: https://www.youtube.com/watch?v=FO46sPwm4xk

Thank you and hope to see you again!