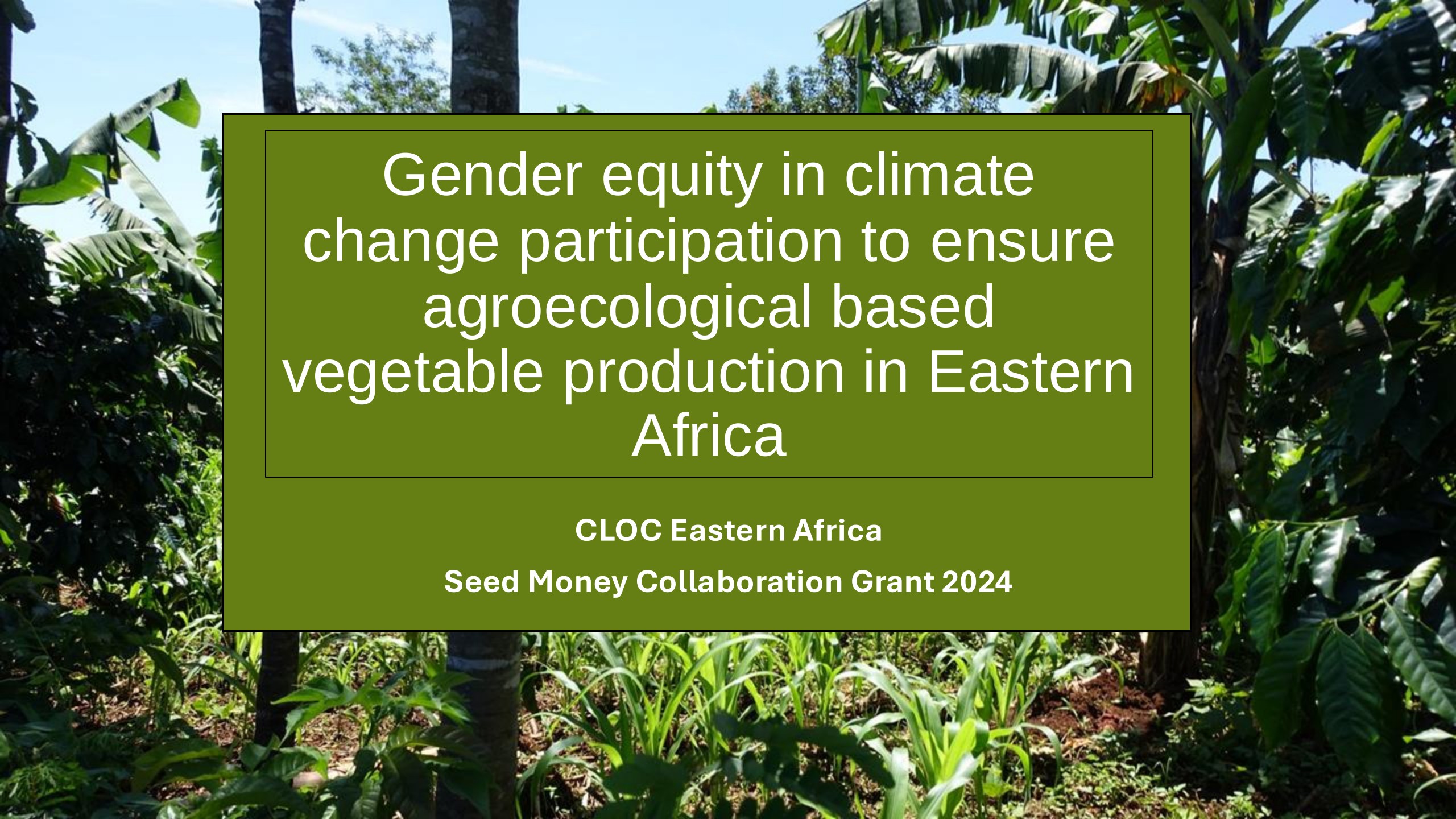


Gender equity in climate change participation to ensure agroecological based vegetable production in Eastern Africa

CLOC Eastern Africa

Seed Money Collaboration Grant 2024

WHAT HAVE WE LEARNED YESTERDAY?

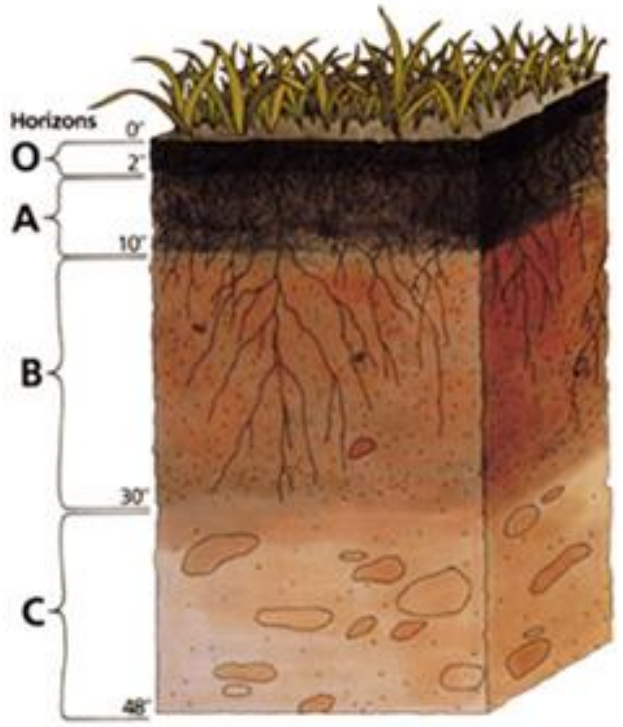

DAY 3: SOIL PROTECTION

INPUT FROM KISII UNIVERSITY EXPERT

SUMMARY – SOIL PROTECTION

- **1. Soil fertility**
- 2. Soils in Sub-Saharan Africa – Summary
- 3. Threats to these soils
- 4. Measures to protect these soils

SOIL ORGANIC MATTER



- Soil matter of living origin: composed mainly of C, O, H and N
- Essential for soil fertility and plant nutrition
- Very large specific surface
- Numerous possibilities for molecules to bind
- High CEC (availability of basic cations: K, Mg, Ca etc.)
- Creation of tissues and aggregates: clay-humus complexes: role of "cement" for the soil
    - ➢Central role in the creation and maintenance of a stable soil structure
- Essential energy source for soil life (microbes and insects)
- Crucial importance for the decomposition of organic matter and therefore for crop nutrition

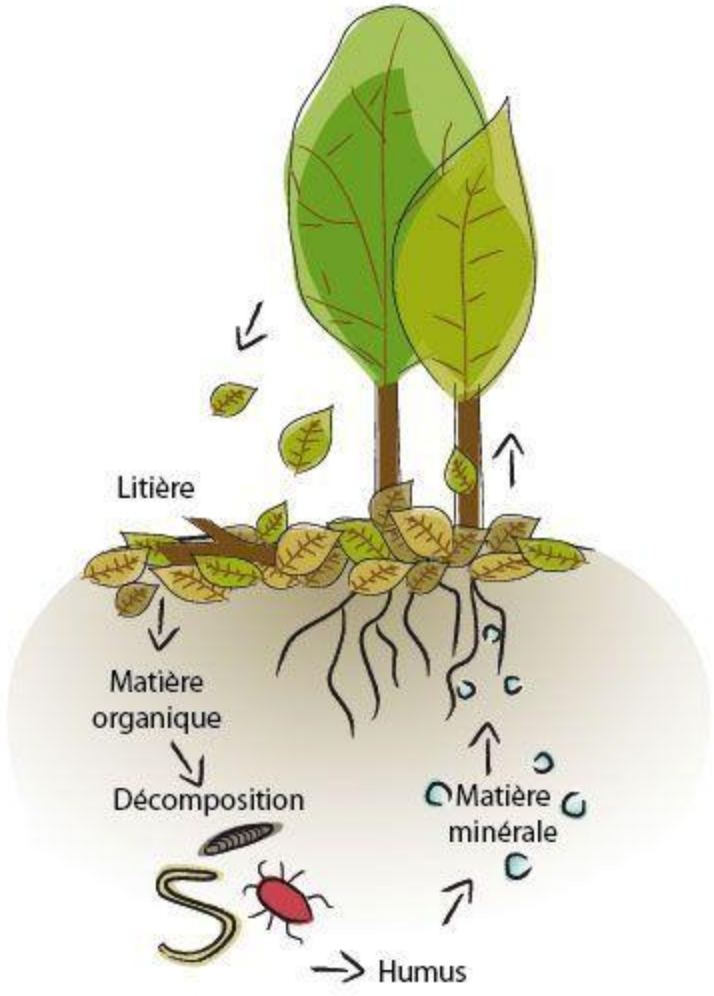
DYNAMICS OF ORGANIC MATTER

Inputs

- Animal defecation
- Plant residues (roots, stems, leaves, fruits)

Losses

- Erosion
- Leaching
- Mining
- Mineralization



MINERALIZATION OF ORGANIC MATTER (OM)

Mineralization: decomposition of OM by soil organisms and production of CO2 and molecules that can be assimilated by the plant (Nitrates, phosphates, ammonium etc.)

- Contact with the air
- Hot and humid climate: if no measures are taken: loss of OM in a few years

Mineral fertilization: causes an accentuated mineralization of OM

- PRIMING EFFECT: the contribution of nutrients (mainly N) will support the growth of microorganisms that will decompose OM
- A MINERAL FERTILIZER CONTRIBUTION MUST ALWAYS BE ACCOMPANIED BY AN ORGANIC CONTRIBUTION

CARBON HYDROGEN RELATION

- [C] / [N]

  C concentration / N concentration

- High: high carbon, low nitrogen (C/N > 20)
- Hungry for nitrogen: the plant does not grow well because of a lack of nitrogen

- Low: high nitrogen, low carbon (C/N < 15)

  Accelerated mineralization →loss of SOM →loss of fertility

- 15 < C/N < 20: ideal: nitrogen requirement covered to allow good decomposition of carbonaceous matter

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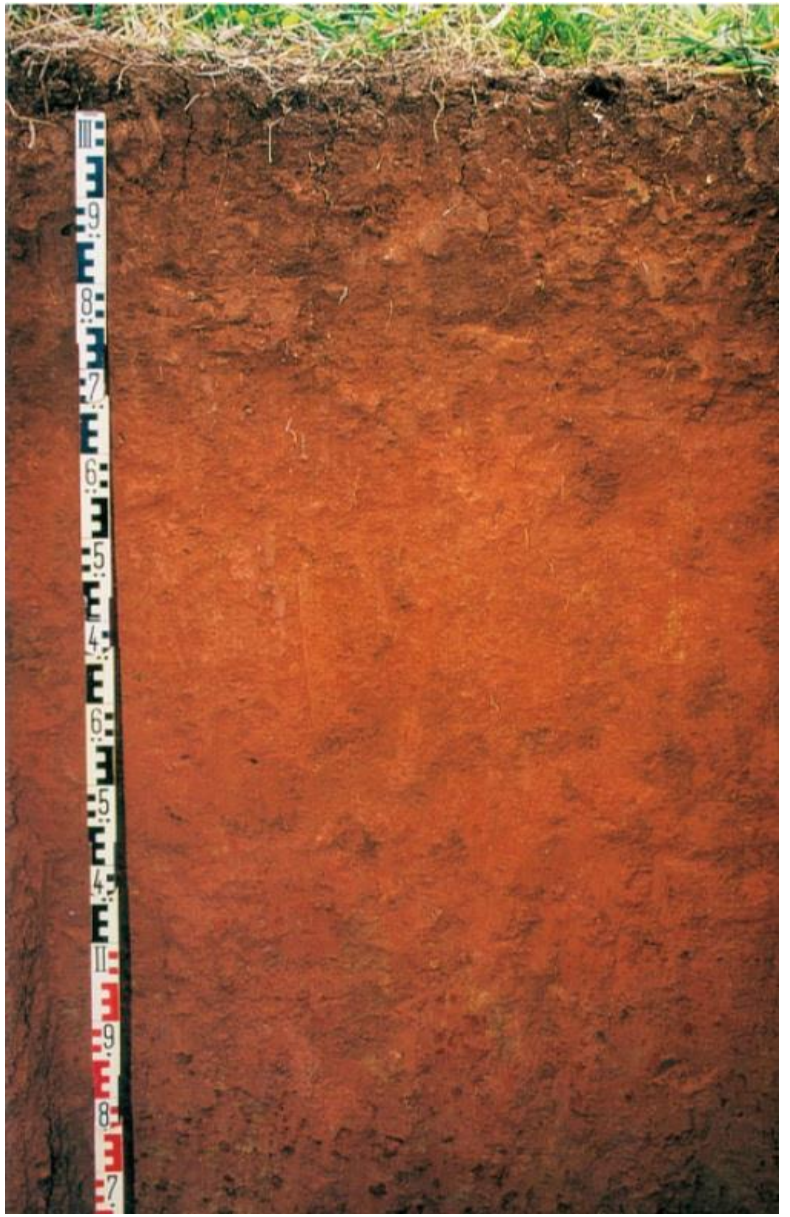
SUMMARY

The mineral horizons of tropical soils often have :

- Poor water and nutrient retention
- Low CEC: low availability of basic cations
- Phosphorus fixation
- Low content and availability of nutrients
- Low or very low pH

Conclusion:

- Organic matter is of crucial importance.
- High water and nutrient retention
- High CEC
- Reservoir of nutrients
- Buffer effect against acidity
- No Phosphore fixation



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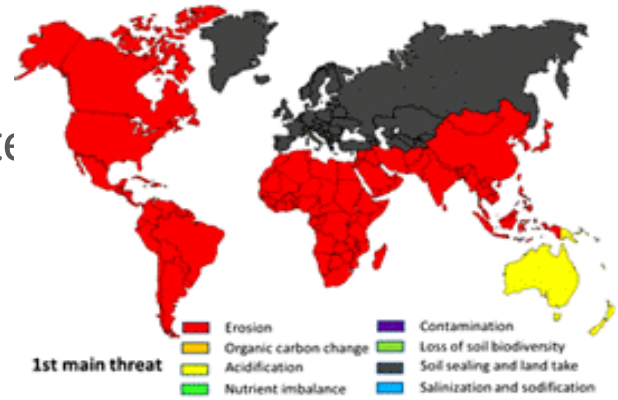
THE DANGERS FOR AFRICAN SOILS

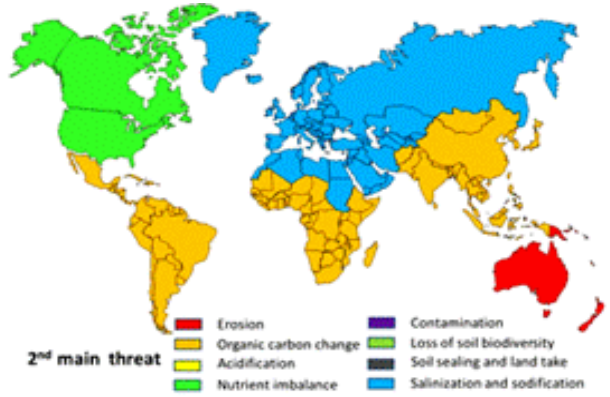
- Main danger: loss of organic matter
- Difficult task, mainly linked to hot and humid climate (strong decomposition) and to rainfall (erosion, leaching)
- In the absence of primary forest, during cultivation, measures must be taken to protect, and constant input of organic manure must be amended to compensate for losses.

MAJOR RISKS FOR SUB-SAHARAN AFRICAN SOILS

- The major risks to these soils are as follows (Montanarellaet al., 2016):

- Mineralization of organic matte
- Erosion and leaching
- Nutrient mining
- Acidification





DANGERS FOR AFRICAN SOILS
MINERALIZATION OF ORGANIC MATTER

- Hot and humid climate
- Lack of organic fertilization (uncompensated losses)
- Soil exposed to the air (bare soil)
- Soil turned over (ploughing, tuber harvesting) →exposed to air
- Mineral fertilization : Priming effect
- Burning
- No or insufficient fertilization.
- Nutrient mining

DANGERS TO AFRICAN SOILS

EROSION AND LEACHING

DANGERS TO AFRICAN SOILS

EROSION AND LEACHING

DANGERS TO AFRICAN SOILS

EROSION AND LEACHING

- Intensive rainfall
- Low soil cover, bare soil
- Soil turned over →soil structure destroyed →loose particles are carried away by water
- Lack of anti-erosion measures (ridges, hedges, stone barriers, drains)
- Insufficient SOM
- Burning

BURNING

During fire:

- Mineralization of SOM
- Volatilization of nutrients
- ➢75 % N
- ➢50 % P

After the fire:

- Bare and exposed soil
- Erosion
- Leaching
- Mineralization of SOM

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SOIL PROTECTION MEASURES

5 objectives to protect the soil:

- 1. Protect the soil and its OM from rain (leaching, erosion)
- 2. Protect the soil and its OM from the air (mineralization, loss of nitrogen by volatilization)
- 3. Add organic matter to compensate for losses
- 4. Add nutrients to compensate for losses/exports
- 5. Increase or stabilize the pH to avoid acidification

- Different measures to meet one or more of the objectives

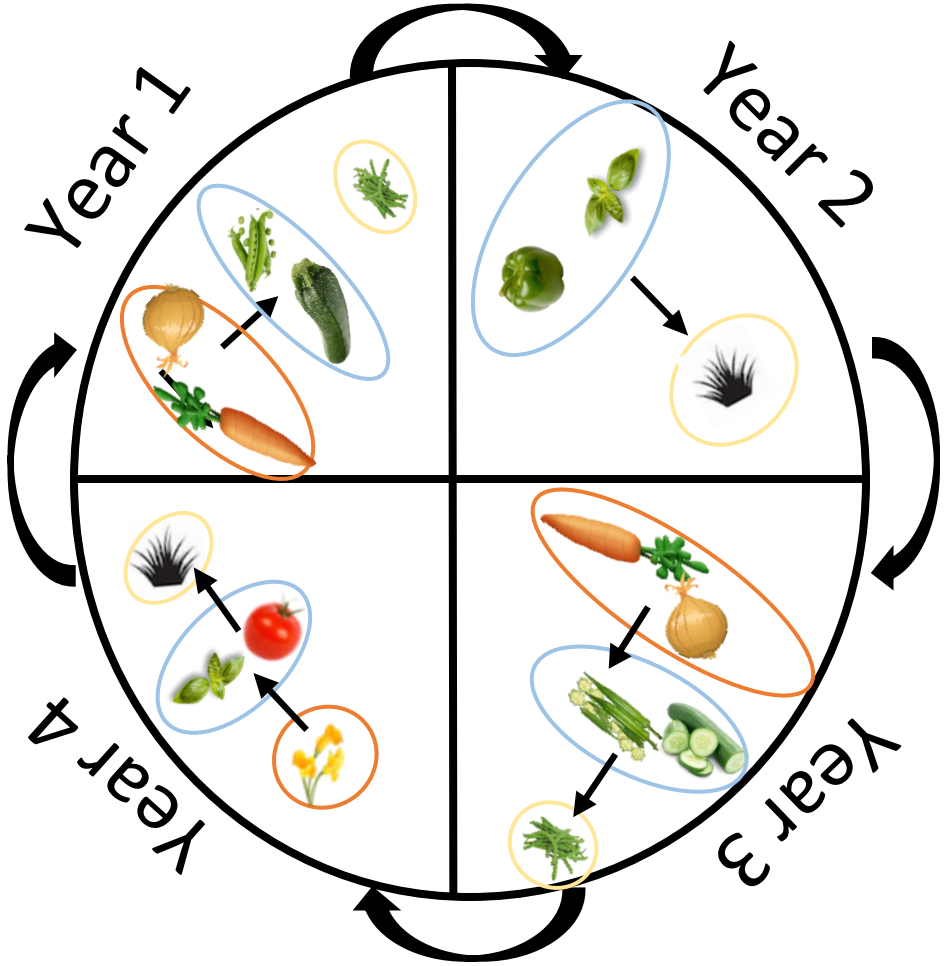
SOIL PROTECTION MEASURES
CROP ASSOCIATIONS

Optimization of space →Better soil coverage

- Fills gaps between rows of a slow starting crop
- Cultivation of trees helps intercept raindrops
- Combine destructive crops with protective or regenerative crops

SOIL PROTECTION MEASURES
CROP ROTATIONS

- Cover the soil at all times
- Allow to alternate greedy and less greedy crops
- Allow to alternate destructive crops with regenerative crops
- Allow to alternate crops with different nutritive needs
- Avoid leaving bare soil!
- Between 2 crops, sow a green manure
- Mulching



RECOMMENDATIONS FOR AN EFFICIENT ROTATION

- Cultivate species of the same family in decreasing order of requirement and sensitivity
- Always cover the soil: protection against erosion, leaching and loss of organic matter.
  - If no crop is planned, sow a green manure.
- In dry season, provide a green manure or mulch, or leave the crop after harvesting the seeds.
- Provide a green manure every 4 years minimum

UNDERGROUND CROPS

- Involves intensive soil turnover and low soil cover
- Risks of erosion, leaching and loss of organic matter.
- They are destructive crops (except sweet potato)
- Alternate them with regenerative crops (legumes or green manures)
- Cultivate them maximum 1 year out of 4
- In case of cultivation with soil protection measures (mulching, associated crops, agroforestry), they can be cultivated 1 year out of 2
- Respect also the necessary breaks for the families to which they belong.

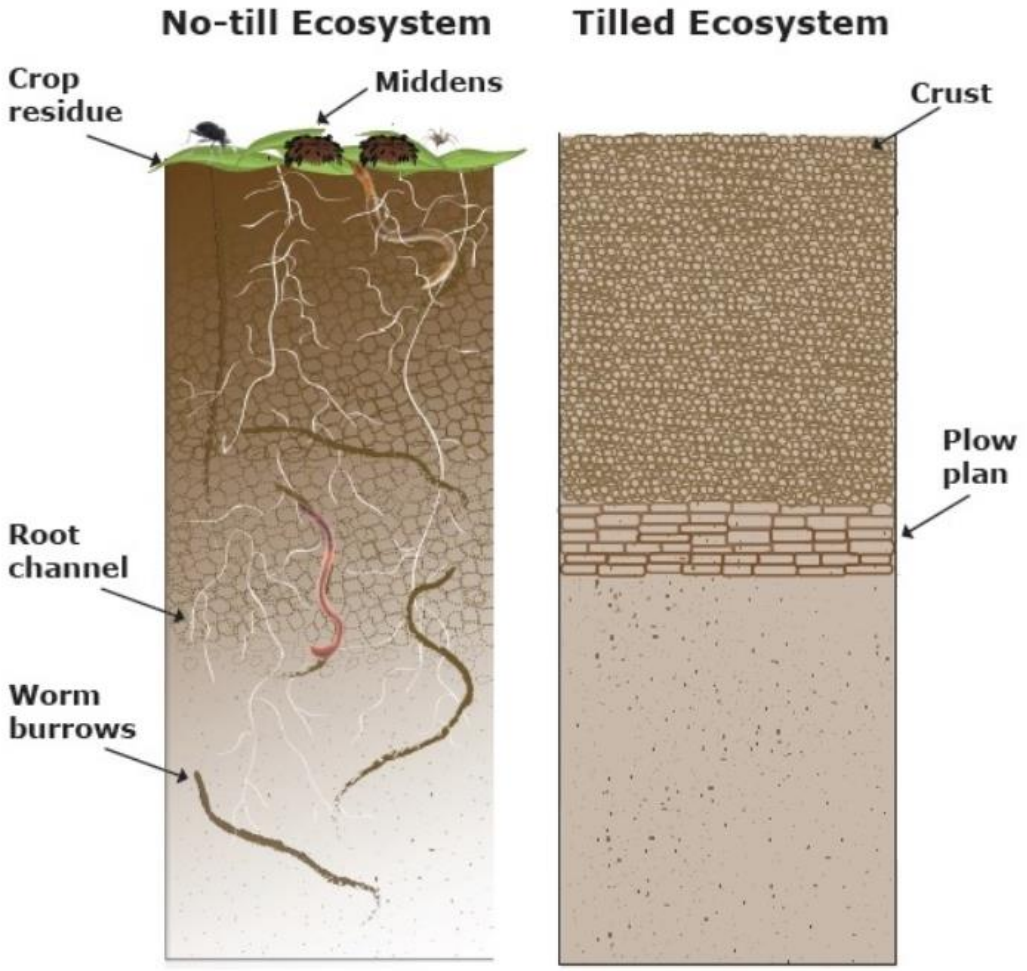
SOIL PROTECTION MEASURES

MULCHING

- Soil cover between crop rows
- Can be covered in the dry season
- Maintains humidity
- Limits weed growth
- Serves as a refuge for many beneficial organisms

SOIL PROTECTION MEASURES

CONSERVATIVE TILLAGE



SOIL PROTECTION MEASURES

HEDGES

- Limit runoff and erosion
- Recycle leached water and nutrients
- Recommended around plots to keep water and soil in the plot
- Must be placed perpendicular to the slope following the contour lines
- Other advantages...
- Biodiversity, forage production, barrier against pests and climatic hazards

SOIL PROTECTION MEASURES

STONE WALLS

- Limit runoff and erosion
- Recommended around plots to keep water and soil in the plot
- Must be placed perpendicular to the slope following the contour lines
- Other advantages...
- Refuge for the beneficiaries

GREEN MANURE OR COVER CROP

- A green manure is a crop that is grown to protect/regenerate the soil
- Produce a large amount of biomass
- Mobilize soil nutrients
- Nitrogen and other other nutrients input, according to species

USES OF COVER CROPS

- The organic matter produced and the nutrients mobilized can be returned to the soil as :
  - Incorporation in soil
  - Mulching
  - Composting
- Other uses:
  - Fodder crop
  - Weed control
  - Hedgerows and grass barriers
  - Human consumption
  - Seeds can be sold

GRASSES

- Demanding in nitrogen(N) and phosphorus(P)
- Recycles nutrients from the deepest layers
- Enriches the soil with organic matter
- Deep and powerful root system
- High biomass production

LEGUMES

- Not very demanding, except in phosphorus (P)
- Fix nitrogen and mobilize soil P
- Used to enrich the soil in nitrogen

WHAT COVER CROP SPECIES DO YOU USE ?

MUCUNA

PIGEON PEA INTERCROPPED

VIGNA UNGUICULATA

SESBANIA SEBAN

CALLIANDRA CALOTHYRSUS

BRACHIARIA RUZIZIENSIS

PANICUM

PENNISETUM

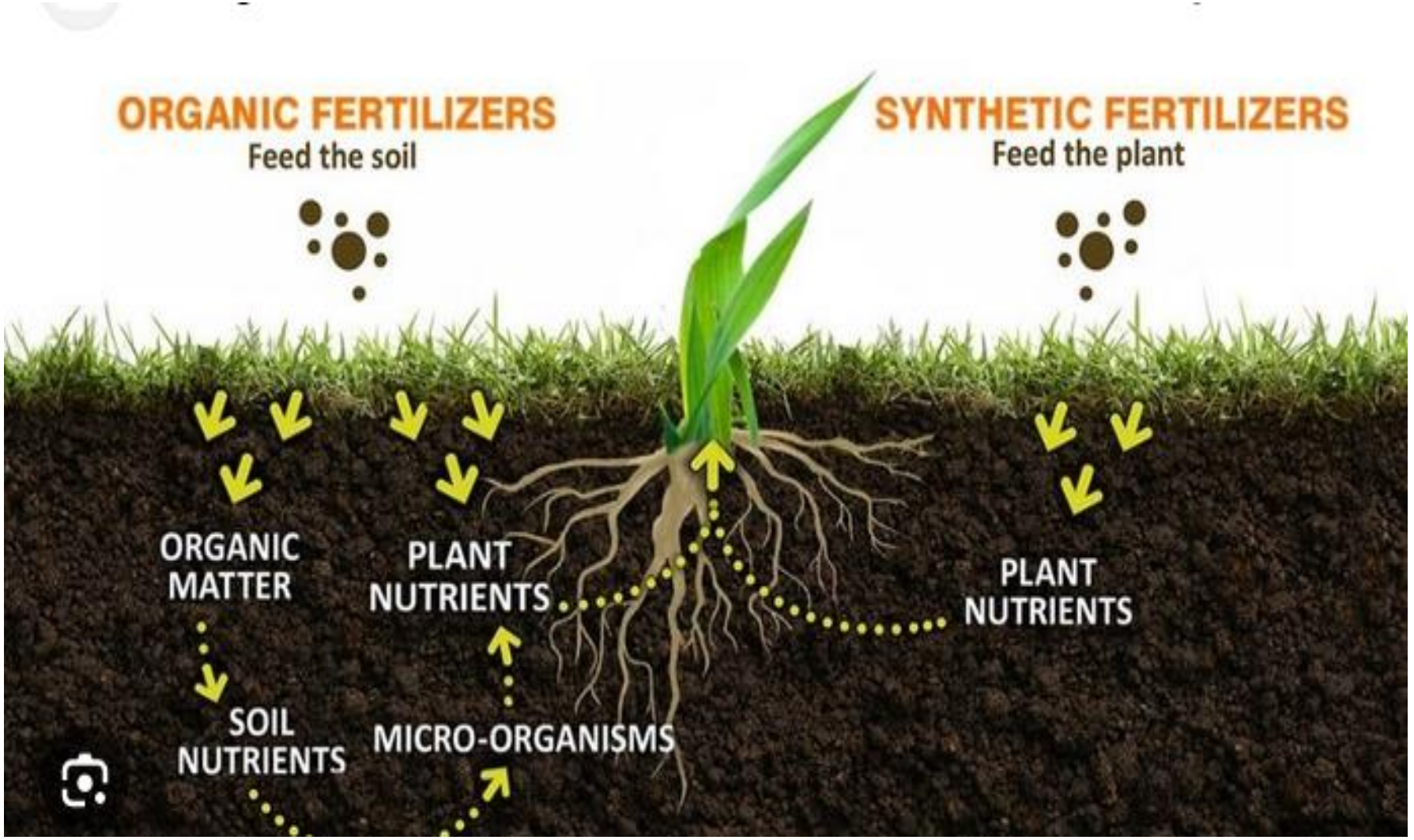
ARACHIS PINTOI (PINTO PEANUT)

Organic Fertilizer

•An organic fertilizer is a fertilizer that is derived from organic sources, including

- ✓organic compost
- ✓cattle manure
- ✓poultry droppings
- ✓green manure and composted agricultural wastes, and
- ✓ domestic sewage.

•Organic fertilizers have been widely used in Asia (Diana, 2012), Central America (Watanabe et al., 2002) and Africa (Longwe et al., 2010; El-Sayed, 2013


ORGANIC FERTILIZERS
Feed the soil
SYNTHETIC FERTILIZERS
Feed the plant
ORGANIC MATTER
PLANT NUTRIENTS
PLANT NUTRIENTS
SOIL NUTRIENTS
MICRO-ORGANISMS

OF

Cont'…

- They provide essential nutrients to plants and improve soil structure and fertility over time.

- Unlike synthetic fertilizers, which are made from chemical compounds,
  - ✓organic fertilizers release nutrients more slowly and contribute to the long-term health of the soil.

CONT'…

- Common Types of Organic Fertilizers:

1.Compost: Decomposed organic matter, often from kitchen scraps, garden waste, and manure.

- ➢ It improves soil structure and provides a wide range of nutrients.

2.Manure: Animal waste, typically from cows, chickens, or horses.

- ➢ It is rich in nutrients like nitrogen, phosphorus, and potassium but should be composted before use to reduce the risk of pathogens.

3.Bone Meal: A powder made from ground animal bones, high in phosphorus and calcium, which is beneficial for root development.

CONT'..

4. Blood Meal: Dried and powdered animal blood, a high-nitrogen fertilizer that helps in the growth of leafy plants.

5. Fish Emulsion: A liquid fertilizer made from fish waste, rich in nitrogen, phosphorus, and potassium, often used as a foliar feed.

6. Seaweed: Contains a broad spectrum of trace minerals and growth hormones that help improve plant health and resilience.

7. Green Manure: Cover crops like clover or rye that are grown specifically to be tilled back into the soil, enriching it with nutrients and organic matter.

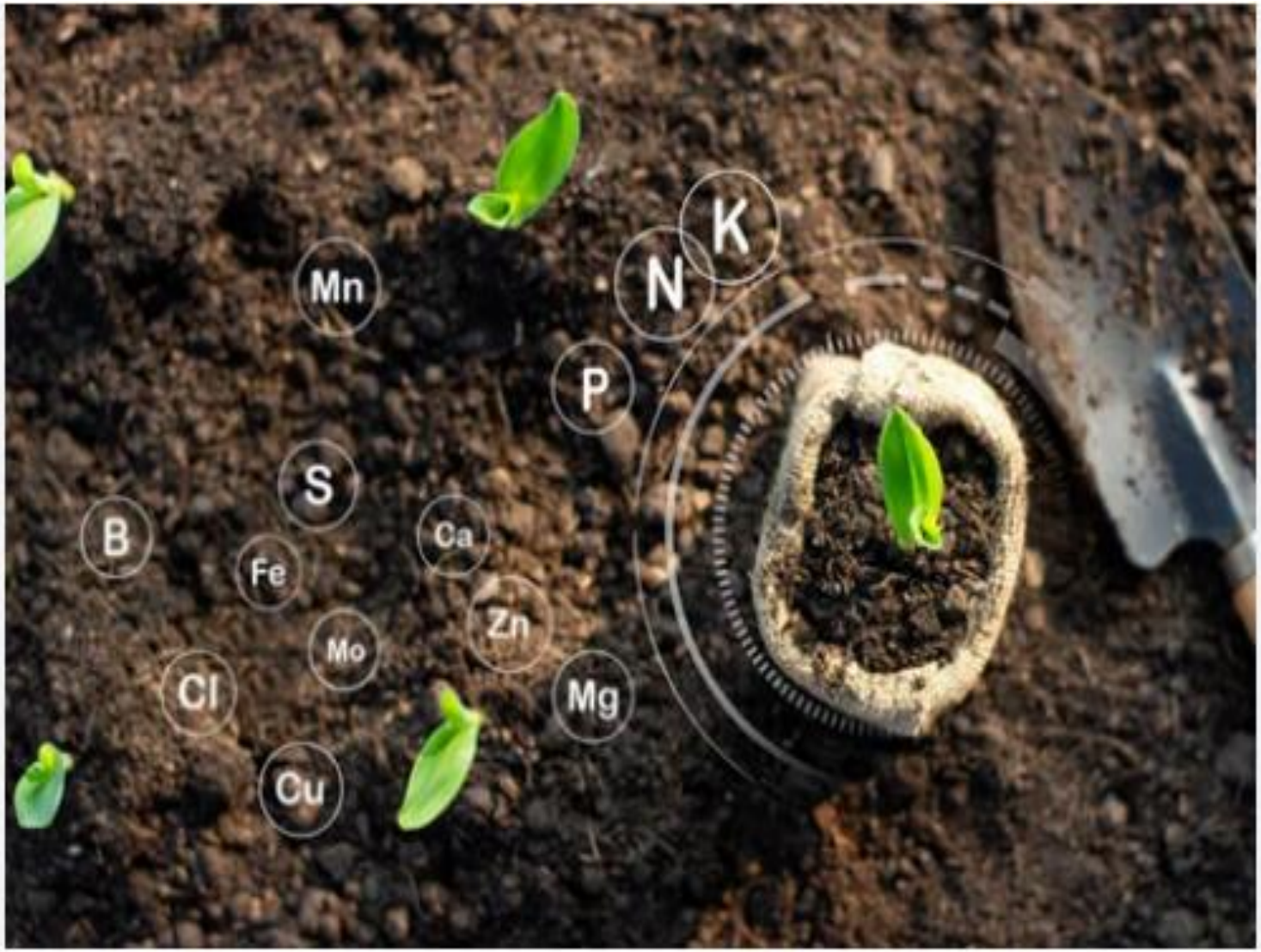
8. Vermicompost: Compost produced by earthworms, which is rich in beneficial microorganisms and nutrients.

CONT'…

Figure. Types of organic fertilizers

BENEFITS OF ORGANIC FERTILIZERS:

- Soil Health: Improve soil structure, water retention, and microbial activity.
- Sustainability: Made from renewable resources and typically less harmful to the environment than synthetic fertilizers.
- Nutrient Release: Release nutrients slowly over time, reducing the risk of over-fertilization and nutrient runoff.
- Safety: Generally safer for humans, animals, and the environment when compared to chemical fertilizers.


Mn
N
K
P
S
B
Ca
Fe
Zn
Mo
Cl
Mg
Cu

DRAWBACKS:

- Slower Results: Nutrients are released more slowly, which may not provide the immediate boost that synthetic fertilizers can.
- Consistency: Nutrient levels can vary between batches of organic fertilizer.
- Volume Needed: Often requires larger quantities than synthetic fertilizers to achieve the same nutrient levels.
- Organic fertilizers are ideal for those looking to improve the long-term health of their soil and grow plants in a more environmentally friendly way.

Animal manure:

- When they are located in the fields, their manure is spread to ensure a homogeny nutrient supply but is not collected.
- In their enclosure, a collecting system must be established.
- The manure must be stored in a sealed pit, with a cover sheet to limit contact with the air and protect it from the rain.

ORGANIC WASTE:

- Organic wastes such as kitchen residues or crop residues,
  - which can be eaten neither by men nor animals, are composted before being used as organic amendment.

Organic waste from kitchen

- **Fertilisation:** Compost, crushed biochar and biogas digestate must be mixed a few weeks before applying.

- This mixture, as well as ruminant manure are amended during soil preparation before sowing by incorporating it into the soil to limit volatilisation.

- Chicken manure is applied at cereal earing an at tuber/root/bulb initiation.

- **Fertilisation and nutrient demand**

- *The amount is given in kg / plot and in g/m-lin on the line. The first value is used to know the quantity needed for the plot, the second is used during the application. Crops not presented here are not fertilized specifically.*

		Manure Input per plot [kg]				Manure input on the lign [g/m-lin]				
Crop		Ruminant	Chicken			Ruminant	Chicken			
		Plantation	Flowering	Fructification	1st harvest	Plantation	Flowering	Fructification	1st harvest	Total
1.1	Chard	383	0	0	0	170	0	0	0	**170**
1.1	Cauliflower	337	104	0	0	299	92	0	0	**392**
1.2, 3.1	Maize	368	0	66	0	408	0	74	0	**482**
1.2	Pumpkin	121	19	19	0	204	32	32	0	**267**
1.3	Beetroot	253	0	0	0	170	0	0	0	**170**
1.3	Carrot	231	0	0	0	156	0	0	0	**156**
1.3	Onion	282	0	0	0	190	0	0	0	**190**
2.2	Pepper	374	81	135	54	208	45	75	30	**357**
3.1, GH	Watermelon	255	39	39	0	255	39	39	0	**334**
3.2, GH	Cabbage	225	69	0	0	299	92	0	0	**392**
3.2, GH	Cucumber	168	26	26	0	255	39	39	0	**334**
3.2, GH	Lettuce	183	0	0	0	167	0	0	0	**167**
4.1, GH	Tomato	474	102	171	68	237	51	85	34	**408**
	Total	**4021**	**440**	**522**	**122**					

Manure application rate for different vegetables (kg)

	Planting		Flowering		Fructification	
	g per 1m line	for 30m line	g per 1m line	for 30m line	g per 1m line	for 30m line
Carrot	156	**4.68**	0	**0**	0	**0**
Onion	190	**5.7**	0	**0**	0	**0**
Beetrot	170	**5.1**	0	**0**	0	**0**
Pupmkin	204	**6.12**	32	**.96**	32	**960**
Cabbage	299	**8.97**	92	**2760**	0	**0**
Cucumber	255	**7.65**	39	**1170**	39	**1170**
Lettuce	167	**5.01**	0	**0**	0	**0**

Thank you!