Theme 8: Animal housing

HOUSING & MANURE MANAGEMENT (NUTRIENT CYCLE & REDUCTION OF GREENHOUSE GAS EMISSIONS –GHGE

(Level 3)

Topic	Training & information Content
8.1	Farm structures & housing cows/calves/young stock
8.2	Construct small zero grazing unit (SNV handbook)
8.3	Prevention of heat stress in cow barns
8.4	Cow house ground floor plan design (SNV book)
8.5	Best management practice feed fences……..
8.6	Housing & cow comfort (animal welfare)
8.7	Housing & manure management (nutrient cycle & reduction of greenhouse gas emissions (GHGE)
8.8	Use of sensors (activity meter) in dairy herds

1. You will learn about (learning objectives):

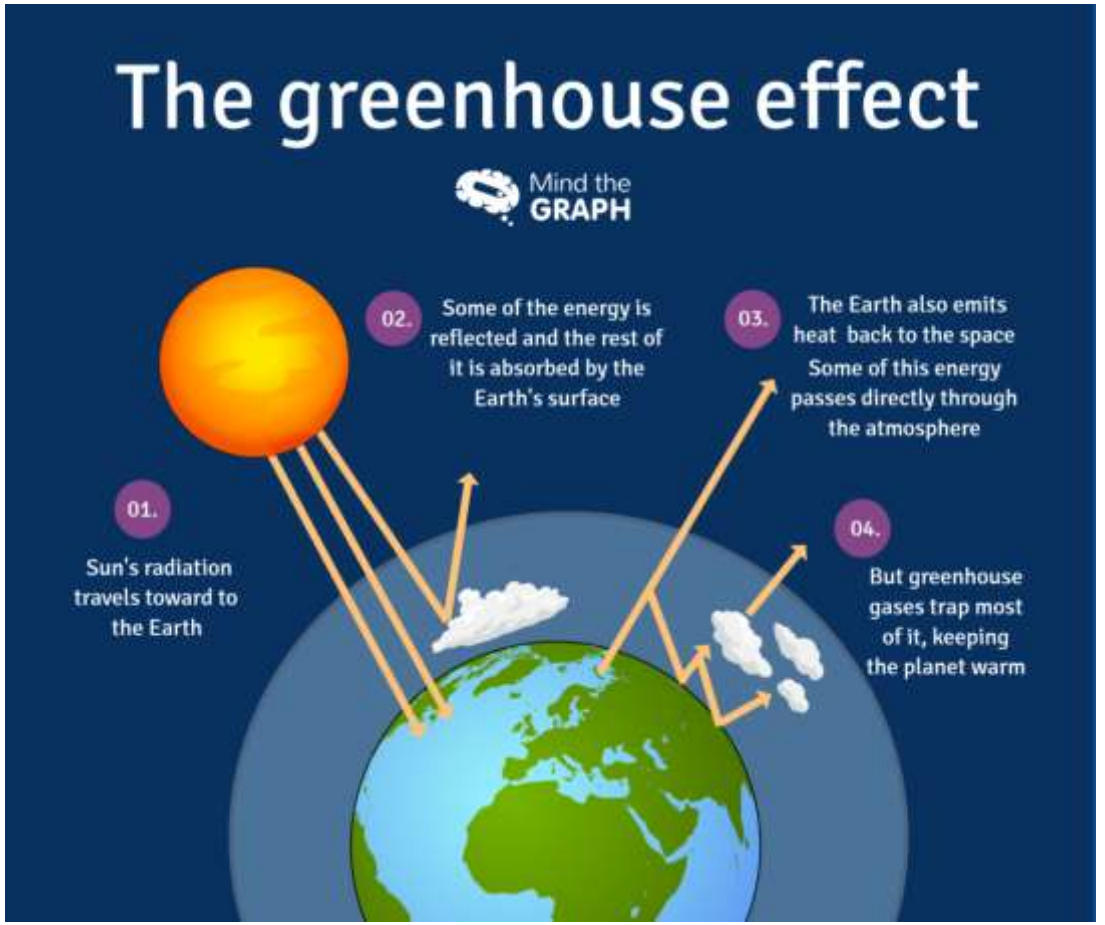
- ❑ Greenhouse gas production by dairy cows?
- ❑ Effects of poor manure management to dairy & it's environs.
- ❑ Management of manure in cow housing.
- ❑ How farmers can reduce greenhouse gas emissions through management approaches.

2. Introduction

- Greenhouse gas refers to any gas that has the ability to absorb/trap infrared radiation (net heat energy) produced from Earth's surface and reradiating it back to Earth's surface. Thereby, contributing to the greenhouse gas effect. (See image to the right)

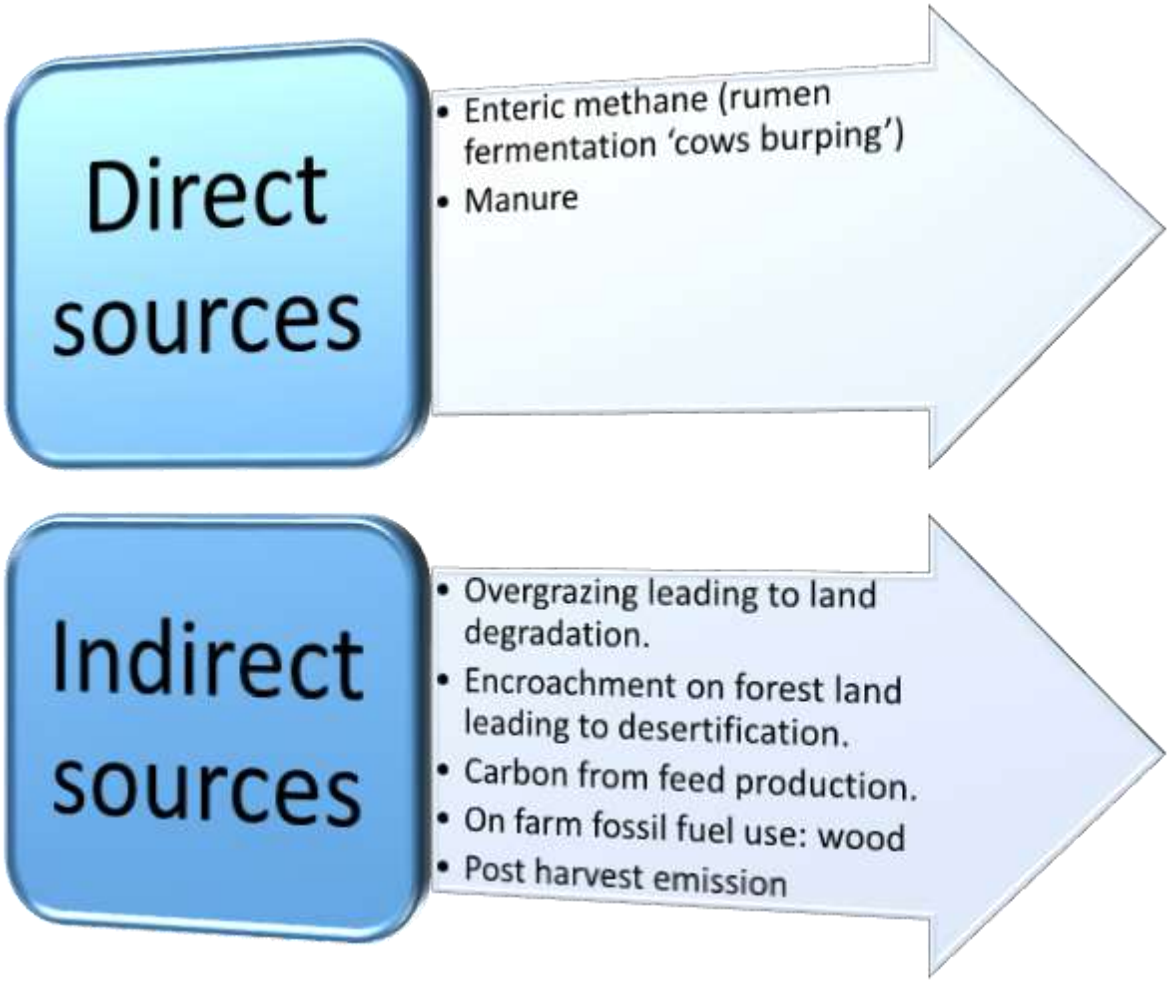
- Greenhouse gases that are important in agricultural production are: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).

- Farmers through management like better feeding & feed production, improved breeding, manure & housing management are able to manage produced in the farm.



3. Greenhouse gas production from livestock

- Livestock contribute both directly and indirectly to climate change through greenhouse gas emissions. Such emissions like carbon dioxide, methane etc.



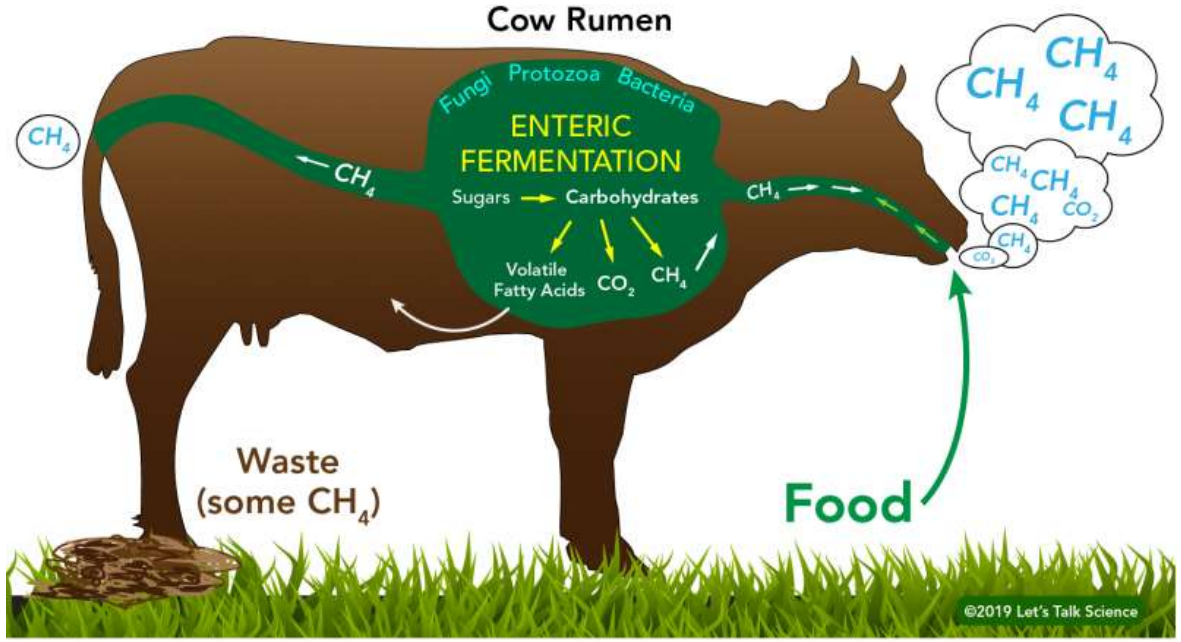
4. Enteric fermentation from livestock

- Enteric fermentation is part of the digestive process in ruminants (cows).

- It is where microbes in the digestive tract or rumen decompose and ferment food.

- In this process to release pressure caused when methane is produced as a by-product, the animal burps it out.

- However about 5% of methane also comes out of the other end.

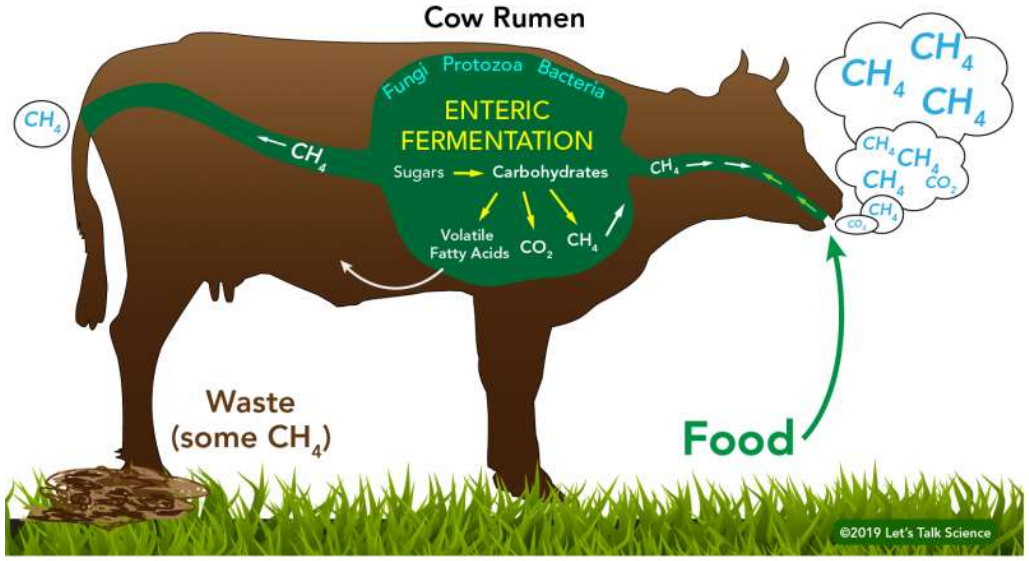


4.1 Enteric fermentation from livestock Cont'd…

- Methane in ruminants is produced by 3% of the large number of microbes that live in the rumen.

- These microbes belong to a group called archaea and they are able to live in environments with no oxygen.

- Reduction of enteric methane emissions varies across production systems and regions due difference in regional conditions, farming practices and supply chain management.



4.2 Enteric fermentation from livestock Cont'd…

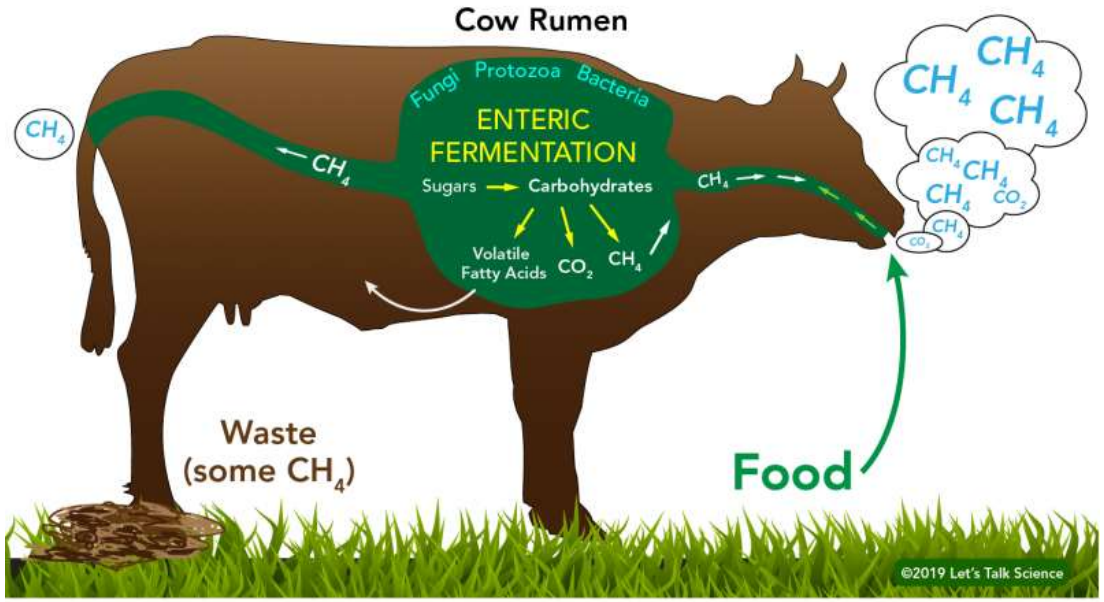
- Enteric methane is measured as grams per cow per day.

g/cow/day.

- One can measure the intensity of methane gas emissions per litre of milk produced per cow using the formula below:

Intensity (g/l 'milk') = Enteric methane emission (g/cow/day)
- Milk yield (L/cow/day)

- With better manure management practices farms get to reduce the intensity of methane gas emissions per litre.



5. Manure production

- Most livestock-associated organic by-products are animal manure.

- Manure produced by livestock (cows) has many recyclable uses.

- It can be used as fertilizer, energy source (biogas or direct fuel) and even construction material.

- The amount and consistency of manures varies with animal type, climate, feed ration, animal age, health and other factors.

5.1 Manure production Cont'd…

- Manure production & characteristics changes over time, as an animal gets larger they produce more manure.

- The shift of production systems to confined system has improved quality of rations fed to animals, increasing the amount and consistency of manure produced.

- Manure acts as a source of both methane (CH_4) and nitrous oxide (N_2O).

6. Manure storage in dairy farms

- Farming system influence manure management method. This systems can either be extensive, semi-intensive and intensive systems.

- Farms can either decide to spread manure, store it or use it for both purposes.

- Proper storage of manure ensures that manure is protected against influence from;
  - sunlight
  - wind
  - water/rain

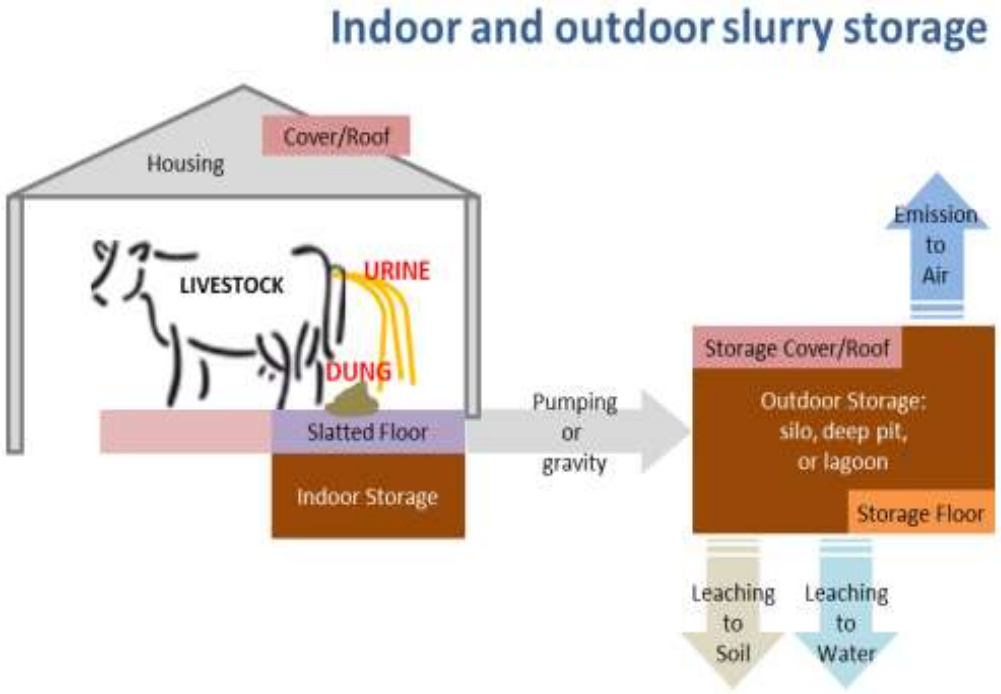
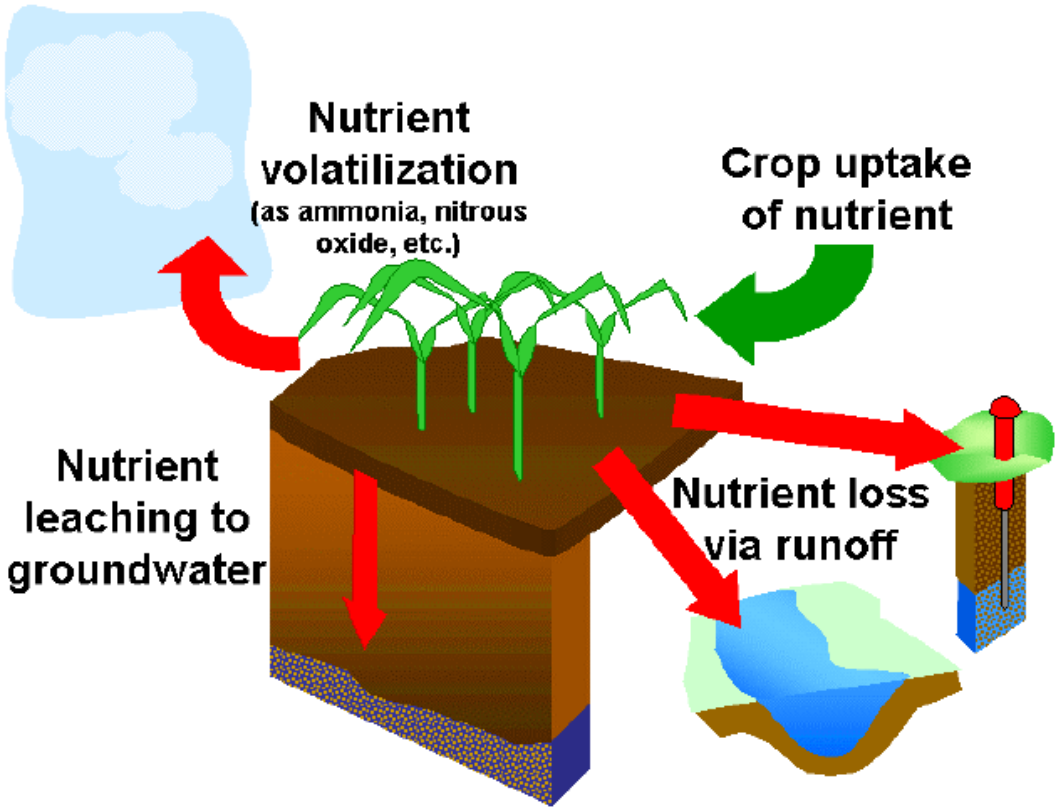


Image from: https://edepot.wur.nl/362491

6.1 Manure storage in dairy farms Cont'd…

- Proper storage preserves crop nutrients until time of application.
- Storage roofing prevents runoff of nutrients to the soil and water.
- Storage flooring prevents leaching of nutrients into the soil water.
- Covering nutrients in a air-tight storage prevents nutrients from volatilization to the air.



7. Manure management in extensive systems ‘grazing’

- For small scale farms with few animals that practice grazing over a large area of land and likely keep the cows in a boma at night are most likely to spread the little amount of manure on farms from the night bomas.

- Caution should be taken to avoid adding manure to saturated soils (soils filled with water) however,

- When considering manure storage farmers should avoid storing manure for a long period.

8. Manure management in intensive or confined systems ‘zero-grazing’

- Cows in confined (zero grazing) system compared to other system deposit more manure at a given area necessitating proper manure management style.

- The dung and urine collection is easily collected since cows are kept in a particular area which necessitates often cleaning and flooring helps in collection.

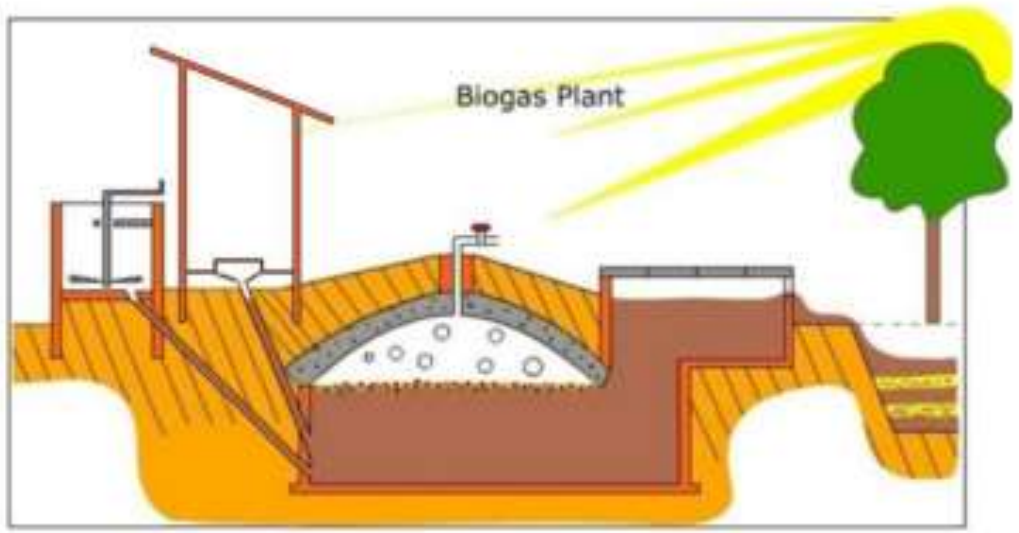
- Roofed housing prevent volatilization of nitrogen from manure leading to less nitrogen losses and

8.1 Manure management in intensive or confined systems ‘zero-grazing’ Cont’d…

- Manure from animal housing is easily directed to biodigesters and provides cheap clean energy for the farm.

- Solid – liquid separation/storage of manure reduces greenhouse gas emissions. Through studies it is identified that about 35% of methane emissions are reduced.

- Storage of digested solids (manure) with limited oxygen (anaerobic) increases nitrous oxide emissions.



9. Manure management in semi-intensive systems ‘semi-zero-grazing’

- Semi-zero grazing systems are open to all method of manure management within the farm all depending on management and scale of production.

- Farms can either;
- ➢ Evenly spread manure dropped by cows in grazing fields.
- ➢ Collected manure in animal housing and either;
  - ▪ Sell to other farmers.
  - ▪ Heap for spreading on the shamba.
  - ▪ Direct to a biodigester system.

10. Manure storage options

1. Stockpiling – Involves placing manure in a sealed and compact manner to avoid manure nutrients from leaching into soil.

2. Dry stack – Involves placing manure in storage facilities with impervious floor and three walls used to contain the manure.

3. Composting – Method of collecting and storing manure an other plant materials so that it can decay and later added to soil to improve its quality.

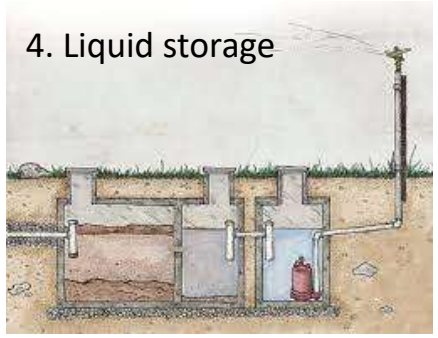
4. Liquid storage – Involves collecting liquid manure into pit structures and afterwards can be pumped and spread on land.

5. Hauling away – Refers to spreading manure to cropland/soil, this is possible for farms producing small amounts of manure daily.

1. Stockpiling

2. Dry stack

4. Liquid storage



11. Factors affecting methane emissions

- ✓ Animal productivity.
- ✓ Feed quality.
- ✓ Environmental temperature.

Animal productivity

- The genetic make up of a cow is related to the type and amount of methane producing bacteria found in a cow's stomach.

- With scientific selection scientists can genetically modify genetic makeup to produce cows that produce less methane, coupled with better feeding. This will go a long way in reducing methane production.

11.1 Factors affecting methane emissions Cont'd:
Feed quality

- The more fibre a cow eats the more methane it produces.

- Including forage legumes and various oils in the cows ration helps in reducing methane production.

- Improving feeding makes animals more productive, and more productive animals results in less methane produced per litre of milk.

- Substituting low yielding grasses and forages with higher yielding crops reduce grassland requirements and reduce deforestation by reducing land use change.

- The energy content in feed is transformed during digestion and partly lost as chemical compounds in faeces, urine and fermentation.

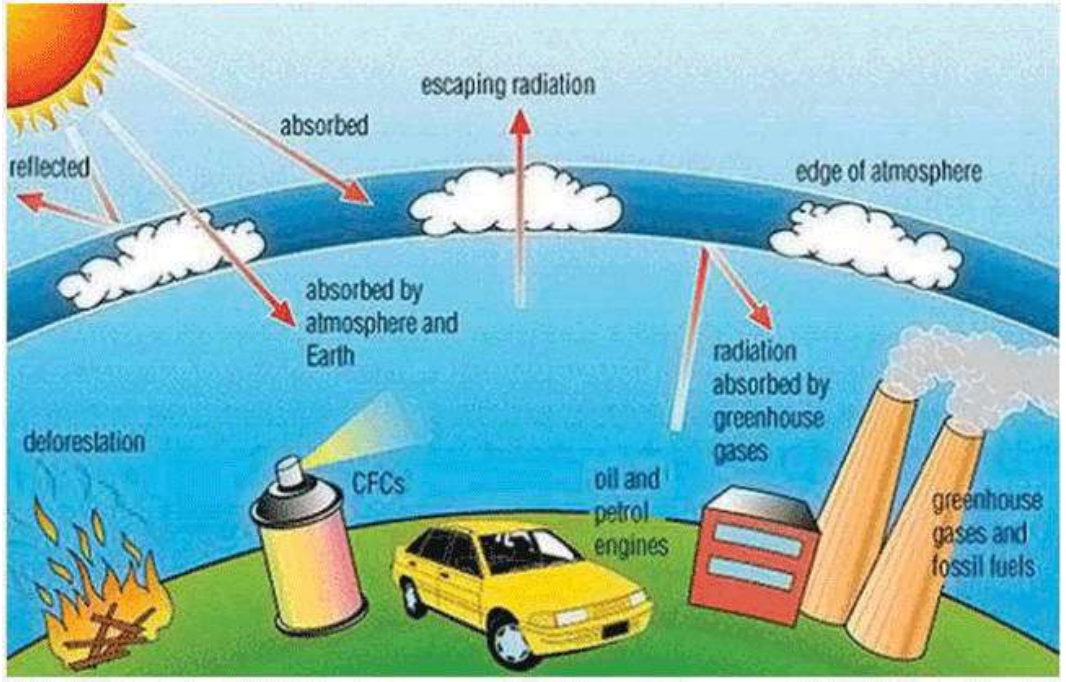
11.2 Factors affecting methane emissions
Cont'd: Environmental temperature

- Concentration of greenhouse gases on Earth vary over a period of time and environmental temperature.

- During warm periods, greenhouse gas concentrations are particularly high compared to cold periods.

- The higher the concentration of CO_2 in air the higher the environmental temperature.

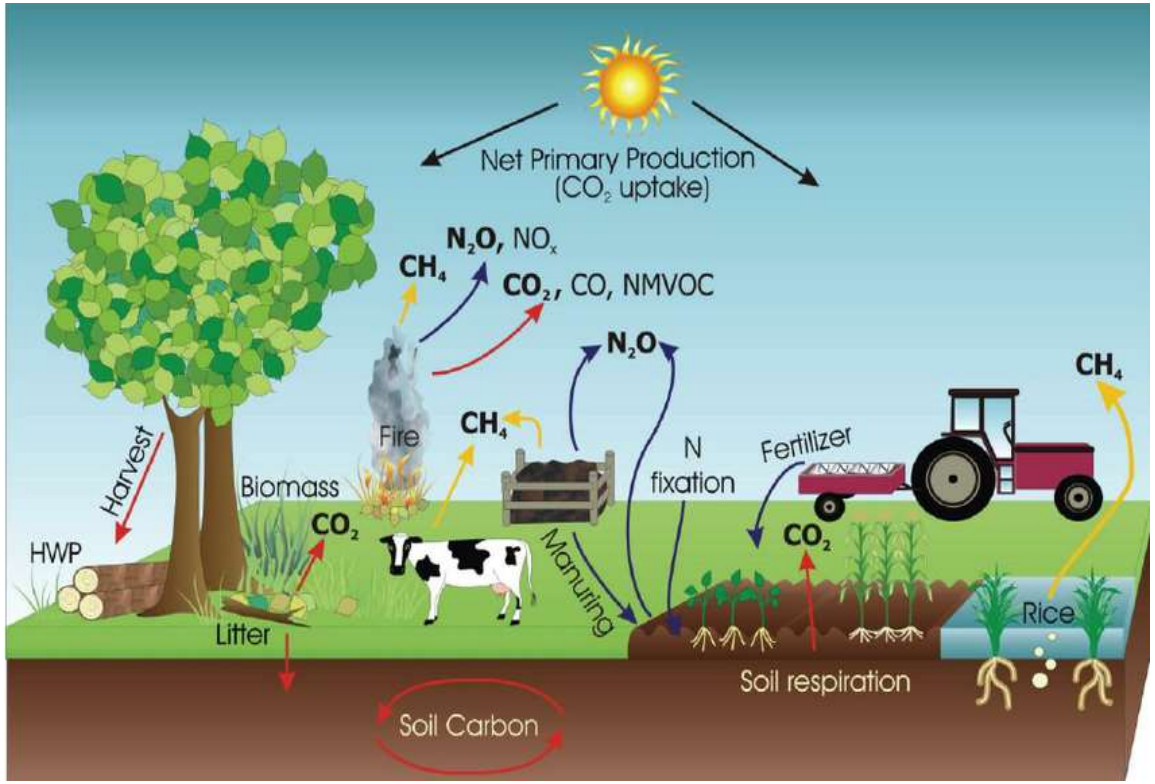
- Greenhouse gases mainly carbon dioxide causes air temperature increase resulting in climate change (global warming).



12. Greenhouse gas production in the world

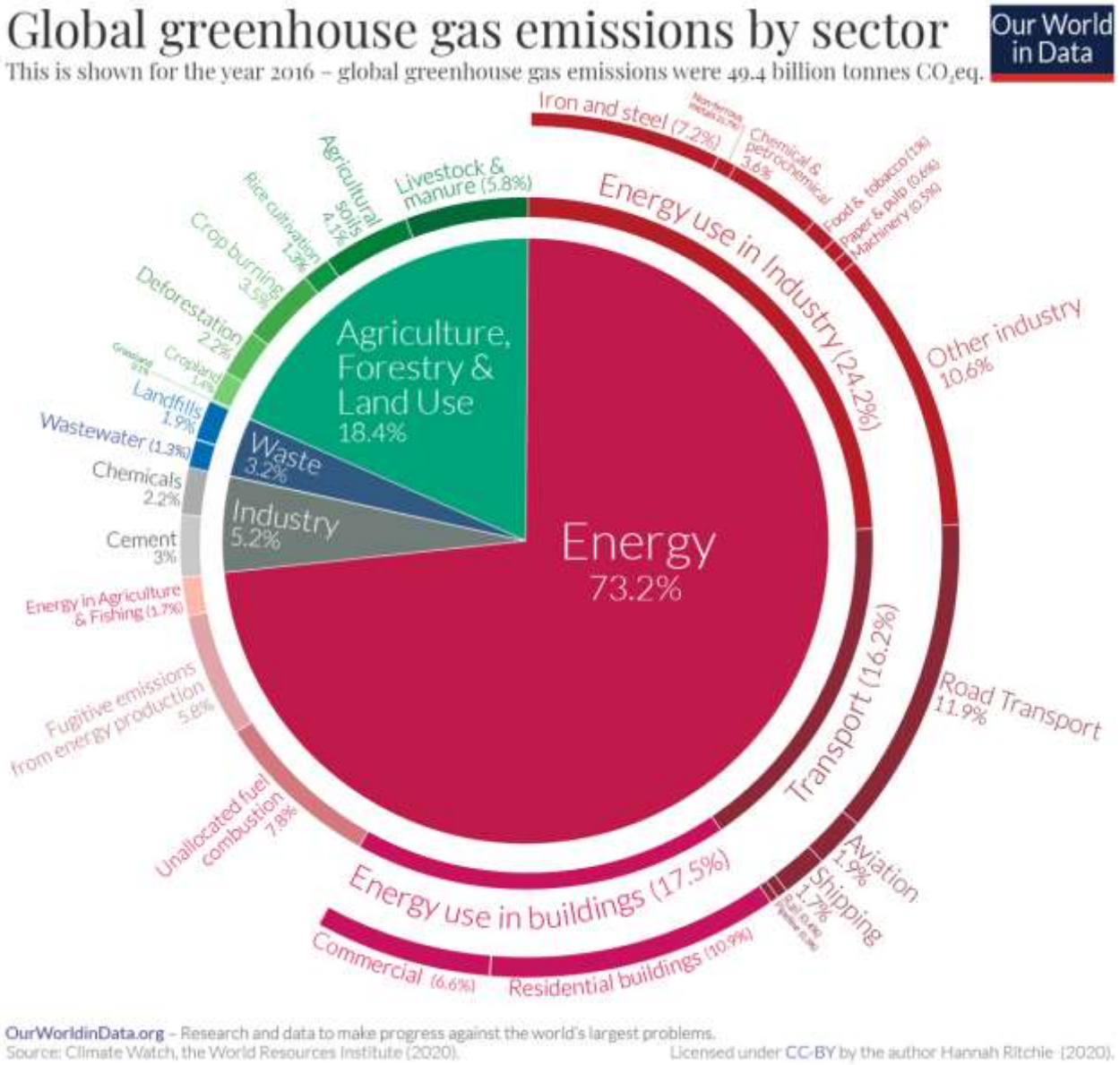
- Over the millennium greenhouse gases have stabilized in the atmosphere leading in an average surface temperature of 15°C making the earth habitable.

- Natural processes are contributing to increasing levels of atmospheric greenhouse gas and in addition greenhouse gas ability to retain heat are now contributing to additional warming (climate change).



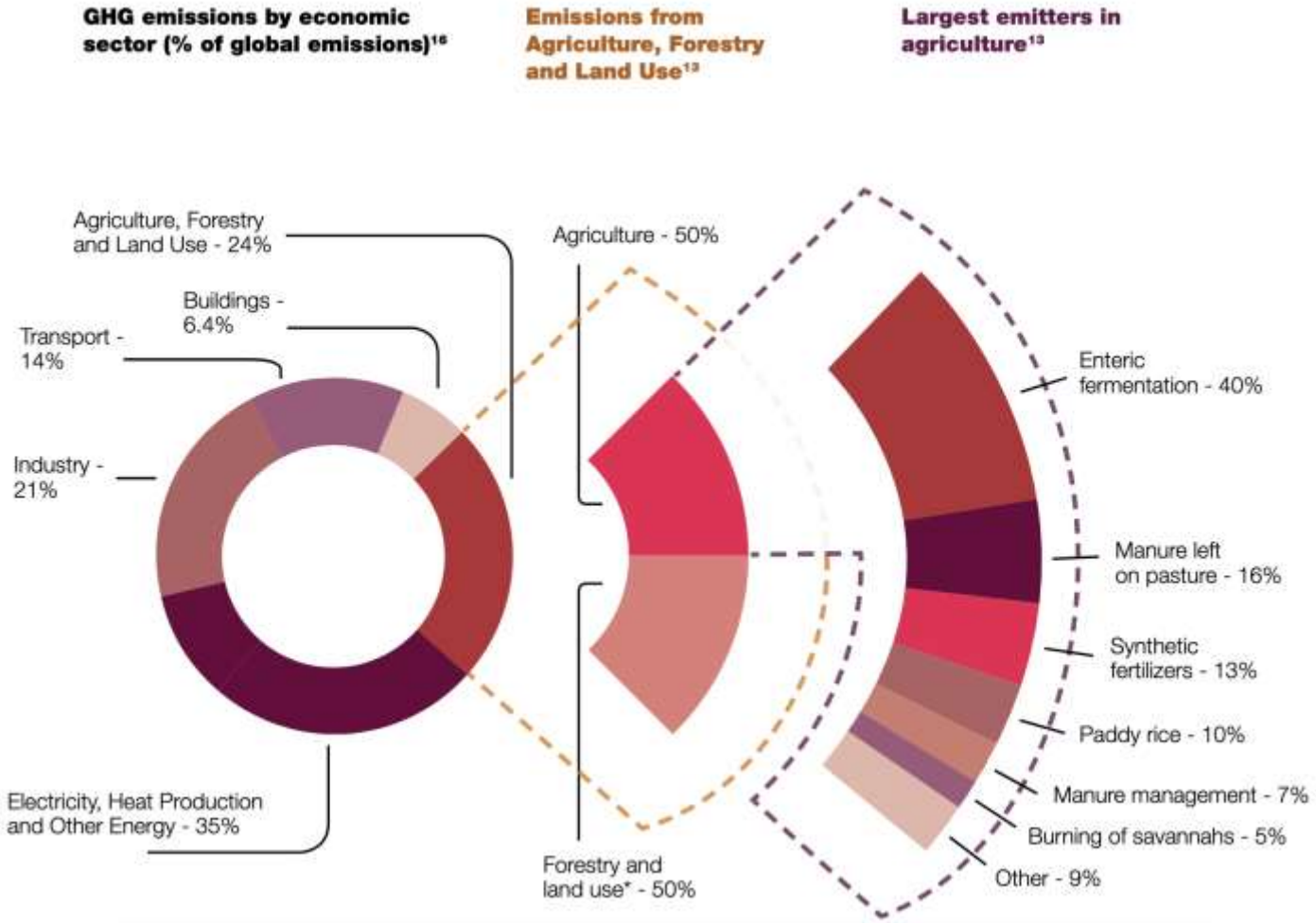
Watch: https://www.youtube.com/channel/UCQnms_RWQ8-7_-mEv6RMJSQ

13. Data on greenhouse gas production in the world



14. Greenhouse gas production in the worlds from agriculture

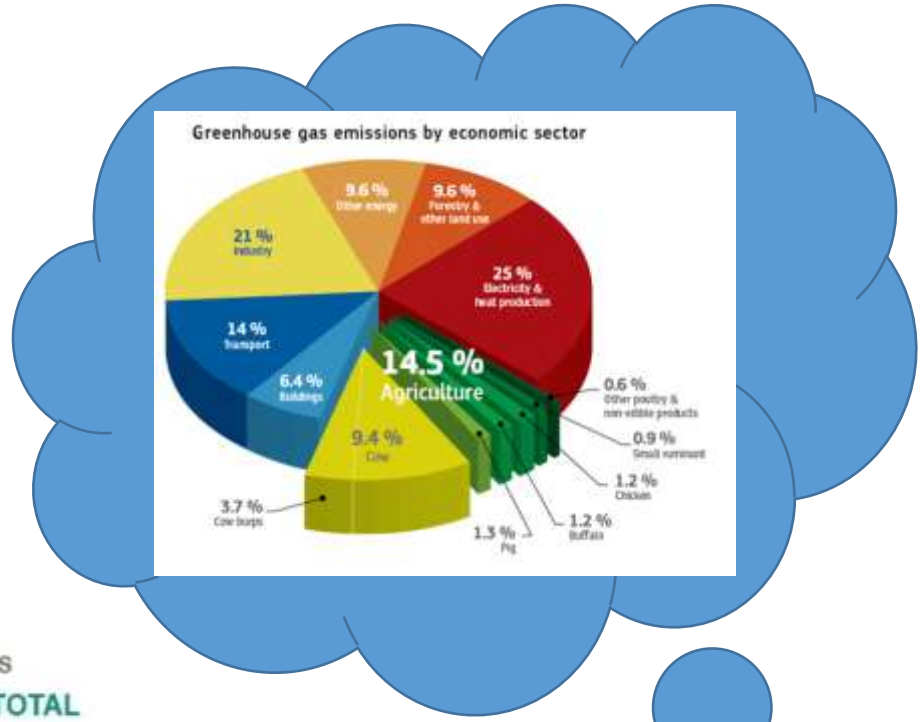
- Agricultural production is responsible for about a quarter of the anthropogenic green house gas emissions with livestock contributing 2/3 of this.

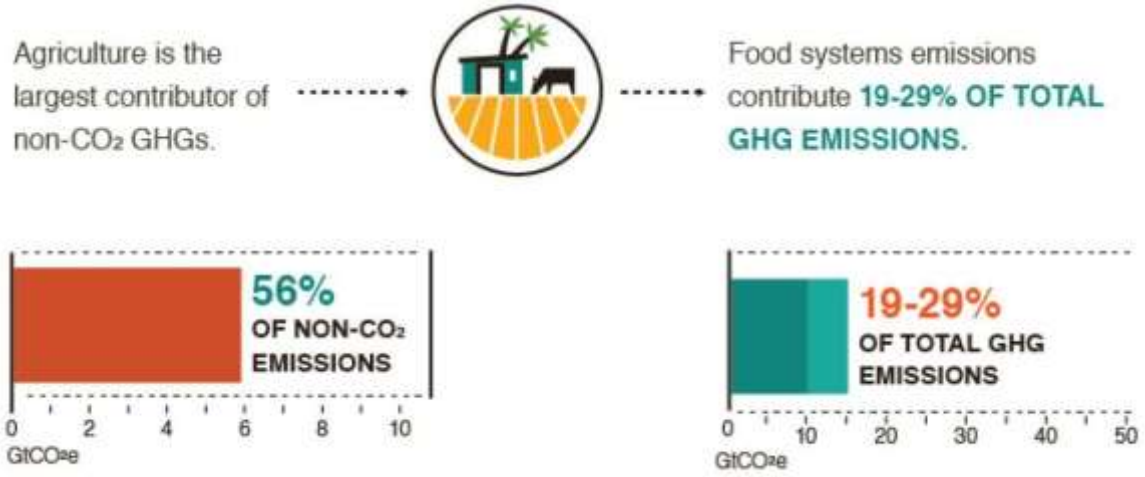


14.1 Greenhouse gas production in the worlds from agriculture Cont'd…

- Ruminants kept for production of their meat or milk account for as much as 30% of the global anthropogenic methane emissions.

- On average a ruminant produces 250-500 litres of methane daily, through burping and a small amount from farting. Methane produced is equal to 3.1 gigatonnes of carbon dioxide into the atmosphere yearly.





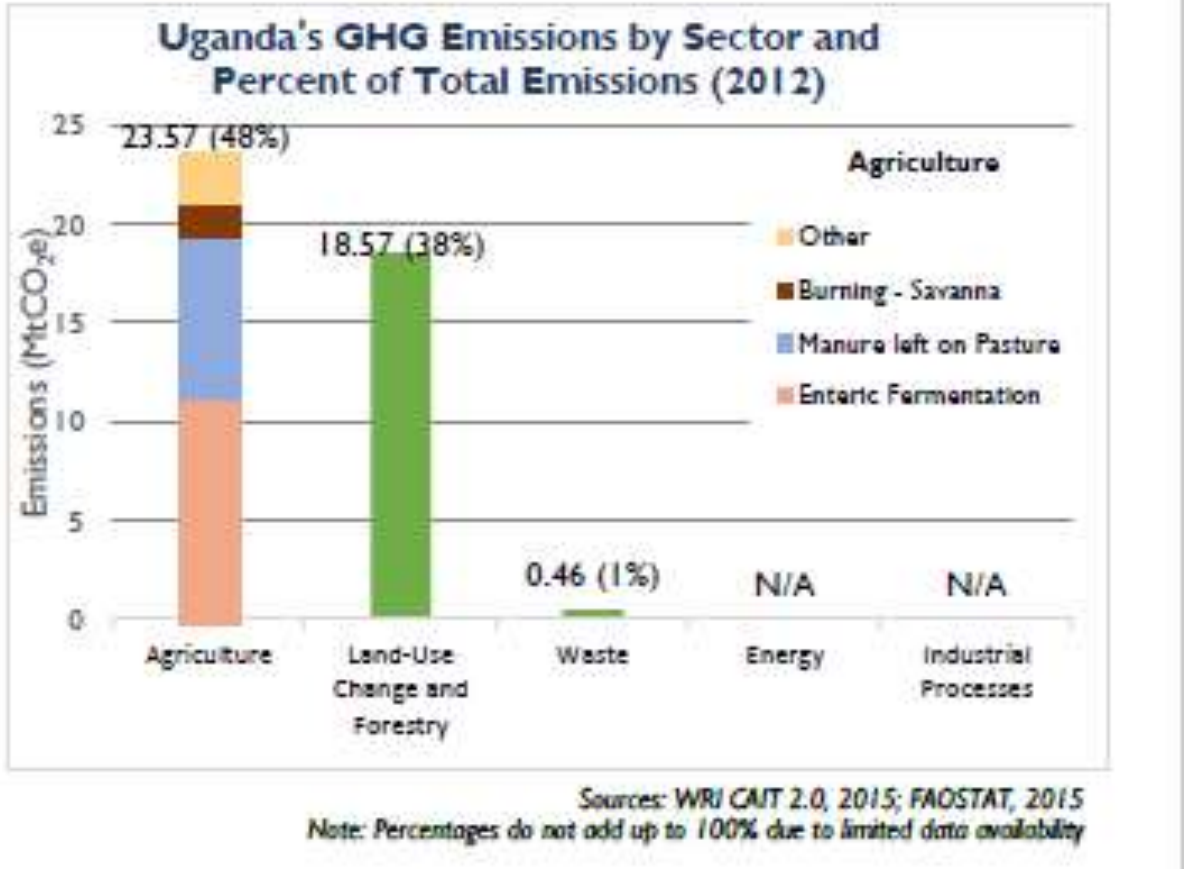
https://ccafs.cgiar.org/news/big-facts-focus-food-emissions

15. Greenhouse gas emissions in Uganda

- In the year 2012 Uganda emitted 49 million metric tons of greenhouse gases, with agriculture being responsible for 48% of emissions.

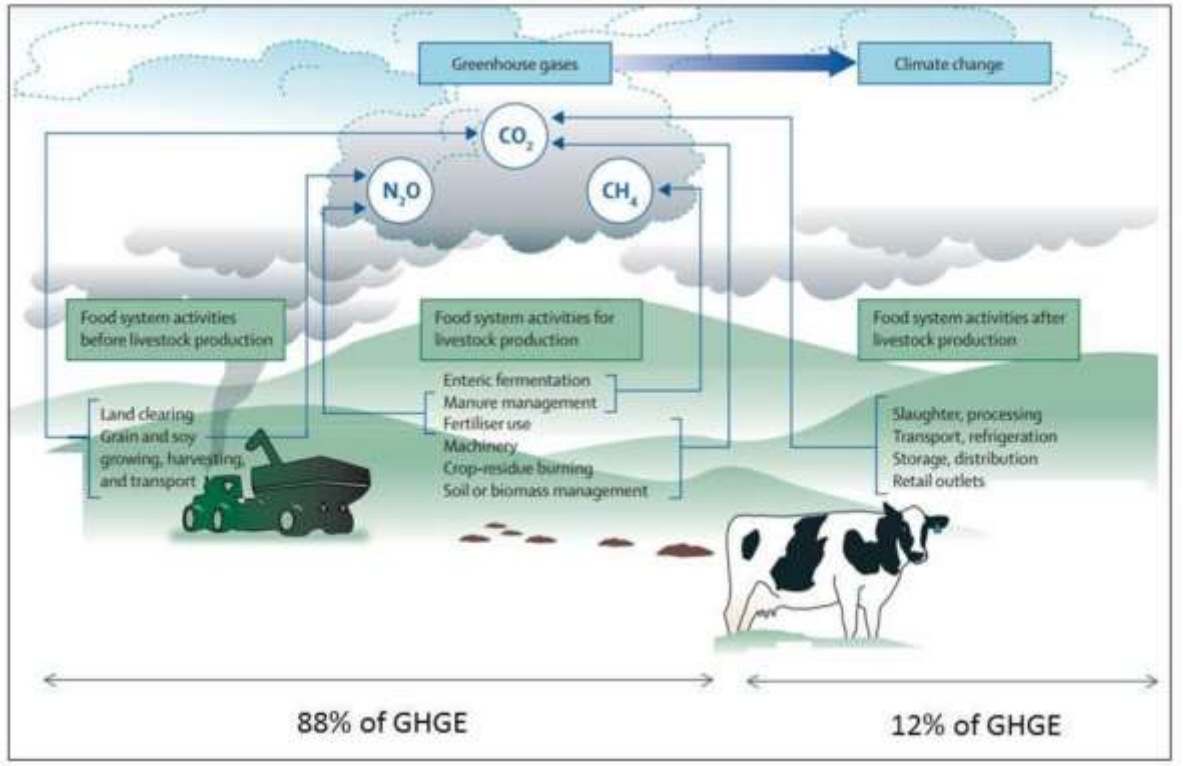
- Agriculture was the leading source of GHG emissions followed close by land use change and forestry sector with a contribution of 38%.

- As at the year of 2018 Uganda's greenhouse emissions was at 54,870 an increase by 1.71% from the previous year (2017).



16. Reducing greenhouse gas emissions

- ✓ Feed cows based on nutrient requirements.
- ✓ Include additives in the ration to supress enteric methane production in the rumen.
- ✓ Increase production by keeping the herd healthy and breeding practices.
- ✓ Composting.
- ✓ Implement covered manure storage covers and /or anaerobic digesters (biogas).
- ✓ Include additives in manure to suppress unwanted biological activity.



16.1 Feed cows based on nutrient requirement

- What cows feed on greatly impacts the quality of manure.

- Feeding cows on improved good quality feed improves feed efficiency while reducing enteric methane production.

- When cows digest the feed they have eaten they largely produce methane through belching.

- Other emissions are produced when cows excrete manure and during storage of the manure.

16.1.1 Feed cows based on nutrient need Cont'd…

- By proper feeding for example testing feed to ensure nutrient feed content matches quantity fed to cows manages overfeeding of nutrients and thereby losing them in manure.

- Inclusion of forage legumes and/or maize silage in the ration will produce less methane than grass-fed cows.

- Farmers can also consider including feed additives like calliandra which contain tannins (anti-nutritional factor) which affects the methane producing bacteria.

- This helps lower methane production when cows belch.

16.2 Increasing herd productivity

- Farmers should be purposeful in when considering breeding. For example: breeding for cows at the right age, heat and diseases resistance.

- Breeding that considers herd health in the long run reduces death/mortality leading to increased production efficiency in cows.

- Unproductive cows contribute methane same as productive cows the difference comes where productive cows contribute less methane per litre compared to unproductive cows that produce more methane per litre at either low to zero production per litre of milk.

16.2.1 Increasing herd productivity Cont'd…

- When cows are high producing the amount of methane per litre is reduced.

- Young stock that get inseminated by 14-15 months get to be productive earlier compared to those inseminated at 2 years or more.

- By the time the cow inseminated at 2 years gets to contribute to the production of the farm the youngstock inseminated earlier (14-15 months) will be a lactation producing for the farm.

- Youngstock inseminated late consume equal almost equal to producing herd and still contribute equal amount of methane to the environment.

16.3 Composting

- Composting is a biological process in which organic portion of refuse (manure) decomposes under controlled conditions.

- Composting imitates the decomposition of organic matter on the soil surface to turn manure into humus.

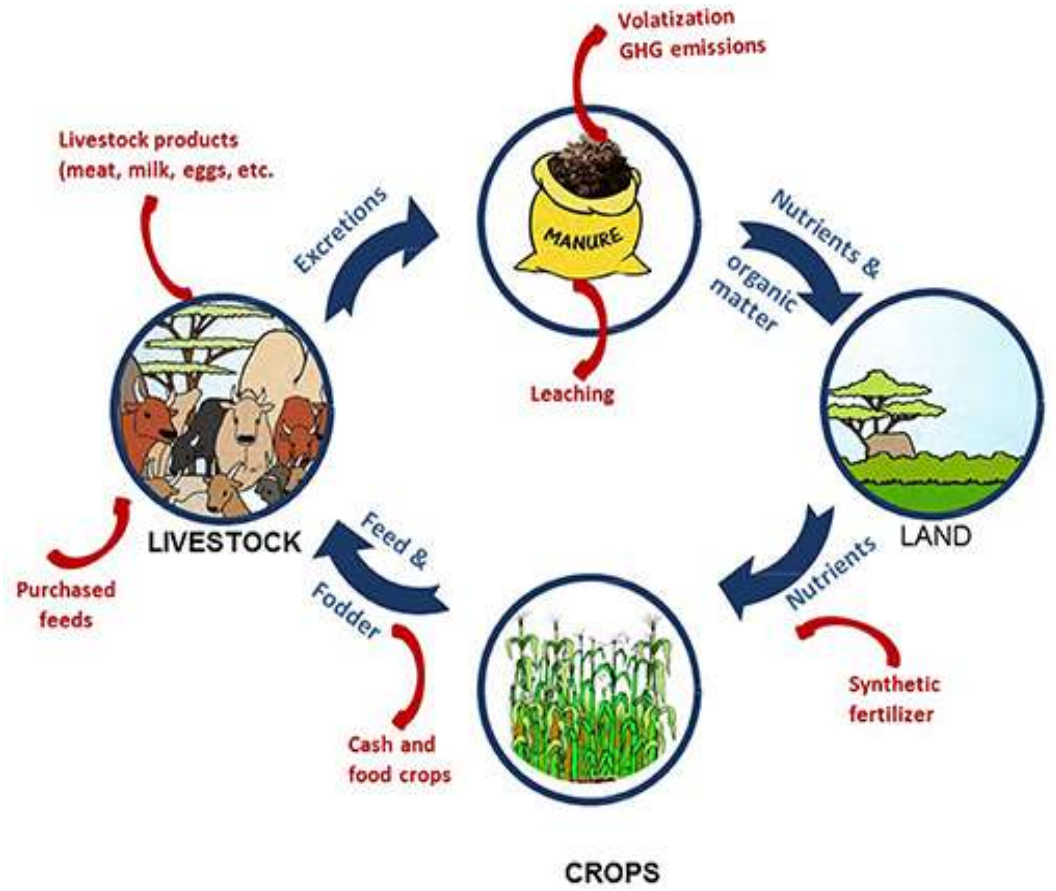
- Composting reduces methane emissions by making the compounds in manure more stable and reduces amount released in air.

- **See module on: Use of natural resources compost making**

16.3.1 Composting Cont'd…

- In composting aerobic organisms consume the nitrogenous and carbon compounds with oxygen.
- The composting process takes between 4-8 months and the end products are organic matter, carbon dioxide and heat.
- Pure manure is frequently high in nitrogen and moisture , to be well composted it is mixed with carbon sources to balance the carbon to nitrogen ratio.
- Carbon sources are for example; straw, stovers, coffee hulls, leaves or wood chips.

Nutrient (manure) cycle



16.4 Manure storage covers

- It is important to reduce exposure of manure to the environment, that is farmers should minimize air/wind movement over manure, rain and sunlight to reduce ammonia emissions.

- Heaping together manure and covering reduces the surface area of exposed material reducing contact with air.

- Nitrogen, in the form of ammonia is lost from organic manure when it comes in contact with air. Ensuring that solid manure is covered helps prevent loss of nutrients in the manure and reduce odour in the air.

- Covers can be as simple as straw/hay, synthetic covers or permanent covers. Organic matter that float to the top also serve as a natural cover.

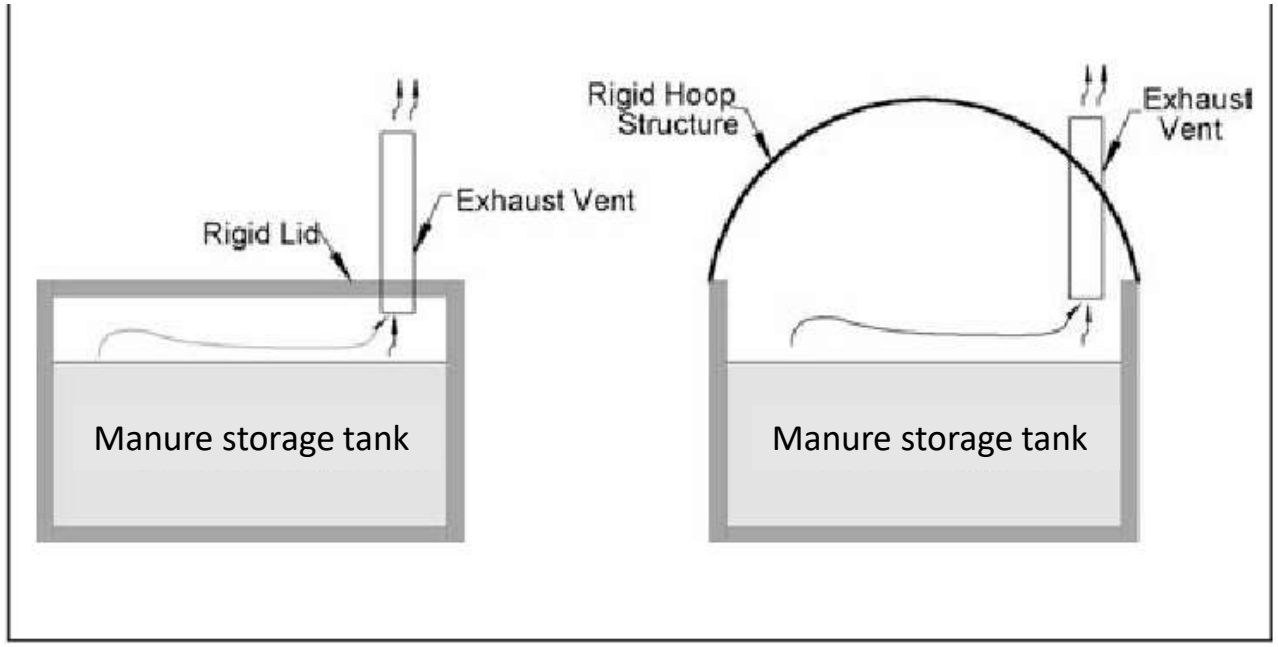
Manure storage tank

16.4.1 Manure storage covers Cont'd…

- Allowing the slurry to develop a natural crust can reduce ammonia emissions during storage by up to 40%.

- Similar effects can be achieved by adding chopped hay/straw or LECA (light expanded clay aggregate) pellets to non-crusting slurry as long as it does not cause management issues.

- These fibres rise to the surface and reduces interaction between air movement and nitrogen in the slurry. However natural crust does not prevent rainfall entry into the store.



16.5 Manure additives

- Manure additives are products used to reduce odour in manure or increase fertilizer value.

- Types of manure additives are for example: microbial, adsorbent & absorbent and other chemical additives.

- Manure additives use in farms can either be by; adding directly to manure, fed to animal or sprayed in the air depending on specification by manufacturer.

- **Note:** Context does not relate to East Africa as other cheaper methods can be applied.

17. Biogas and animal housing

- Directing manure from housing to a biogas digestor is an important way of managing manure in dairy farms.

- Biodigester has to be fed with fresh manure every day.

- Biogas is directly burned for heating application, captured and combusted to generate electricity in dairy farms.

- The effluent leaving the digestor (digestate) has a modified chemical content and has less degradable biomass than the original substrate (manure).

17.1 Biogas and animal housing Cont'd…

- This causes a change in organic matter leading to reduction in GHG, ammonia emissions during storage and after land application.

- The gas produced in biogas digestors has to be used (burned) otherwise if released to the environment it still posses the same threat by releasing greenhouse gases to the environment.

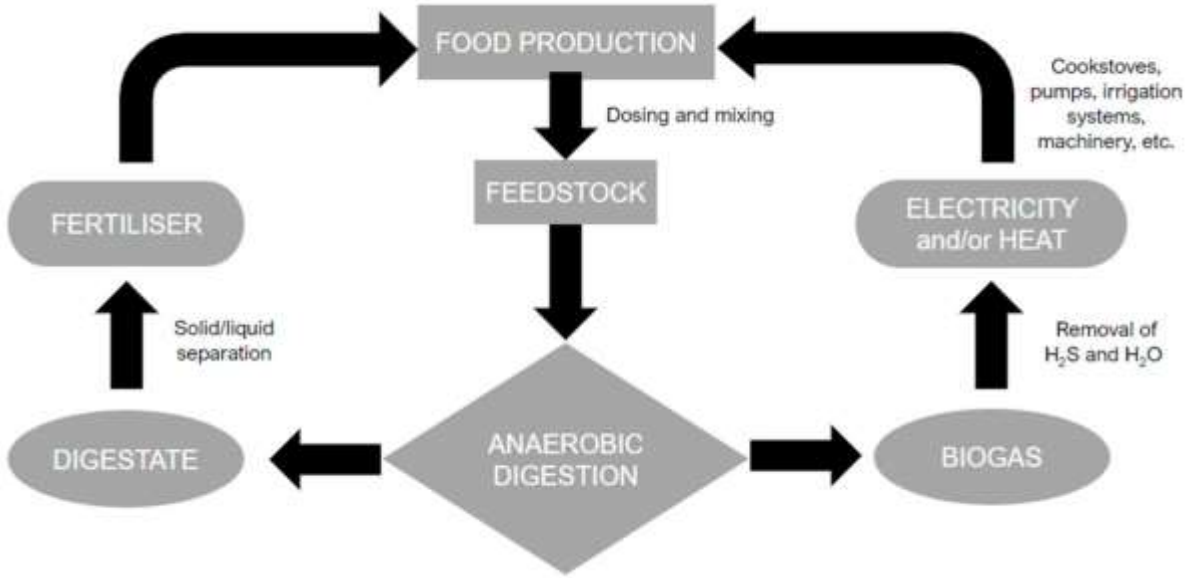
18. Benefits & disadvantage of biogas (anaerobic decomposition)

- During the anaerobic decomposition of organic matter methane is released while ammonia is produced during manure ammonia decomposition.

- Final product of the process has higher ammonium since anaerobic microbes tend to use less nitrogen than aerobic microbes.

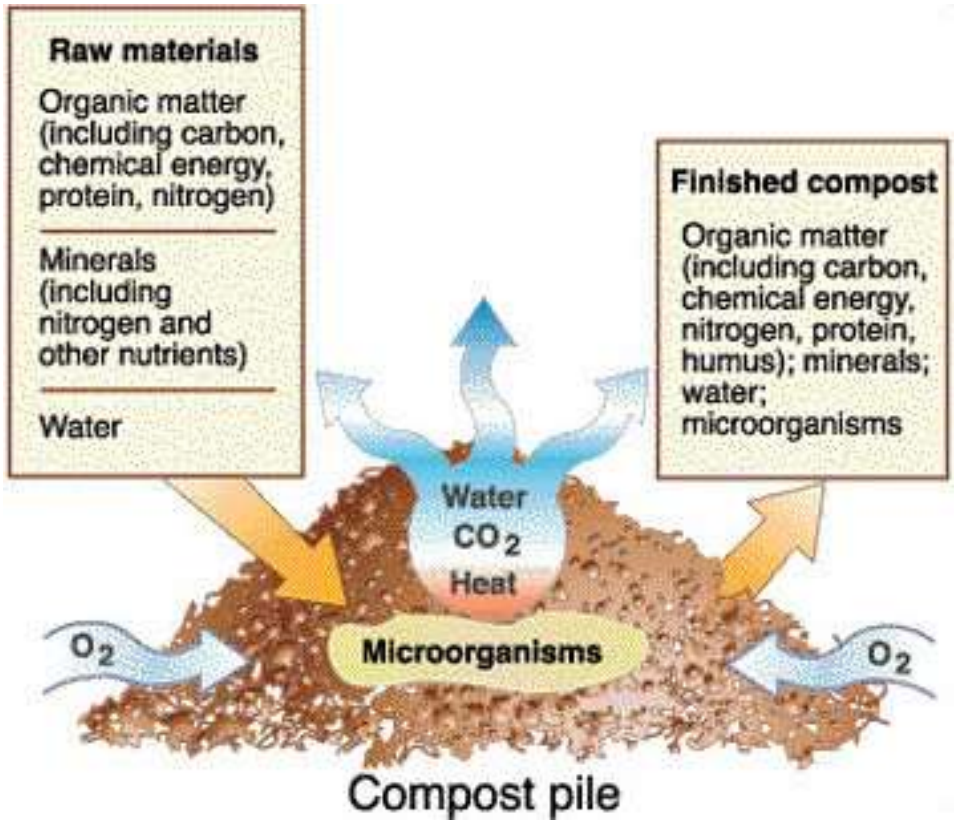
- Anaerobic composting requires less work.

- The process produces more usable humus per volume of original composting ingredients compared to aerobic method.



19. Storing manure in the air (aerobic decomposition)

- Aerobic processes are most common in nature
- Manure exposed to the air also gets exposed using aerobic microorganisms that breakdown organic matter.
- The products obtained from the process (aerobic decomposition) are; carbon dioxide, ammonia, water, heat and humus.
- There is no accompanying bad smell when there is adequate oxygen present.
- During oxidation of carbon to produce carbon dioxide a lot of energy is released in the form of heat.



20. Benefits of aerobic manure management

- Reduced odour/smell around the farm.

- Conversion of ammonia to nitrate through nitrification leading to reduce ammonia emissions.

- Final output of aerobically composted manure is readily available to crops however it is also prone to leaching.

- Reduces greenhouse gases especially methane compared to anaerobic treatments

- Separated manure solids encourages aerobic environments, eliminating anaerobic conditions necessary for methane production.