



# Crops for biogas production; yields, suitability and energy balances

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Workshop 2 – Biogas: Energy throughout the whole world



# overview

which crop should I grow?

- methane potentials
- crop yields
- crop criteria
- digestate
- energy balances
- legislation

# which crop should I grow?

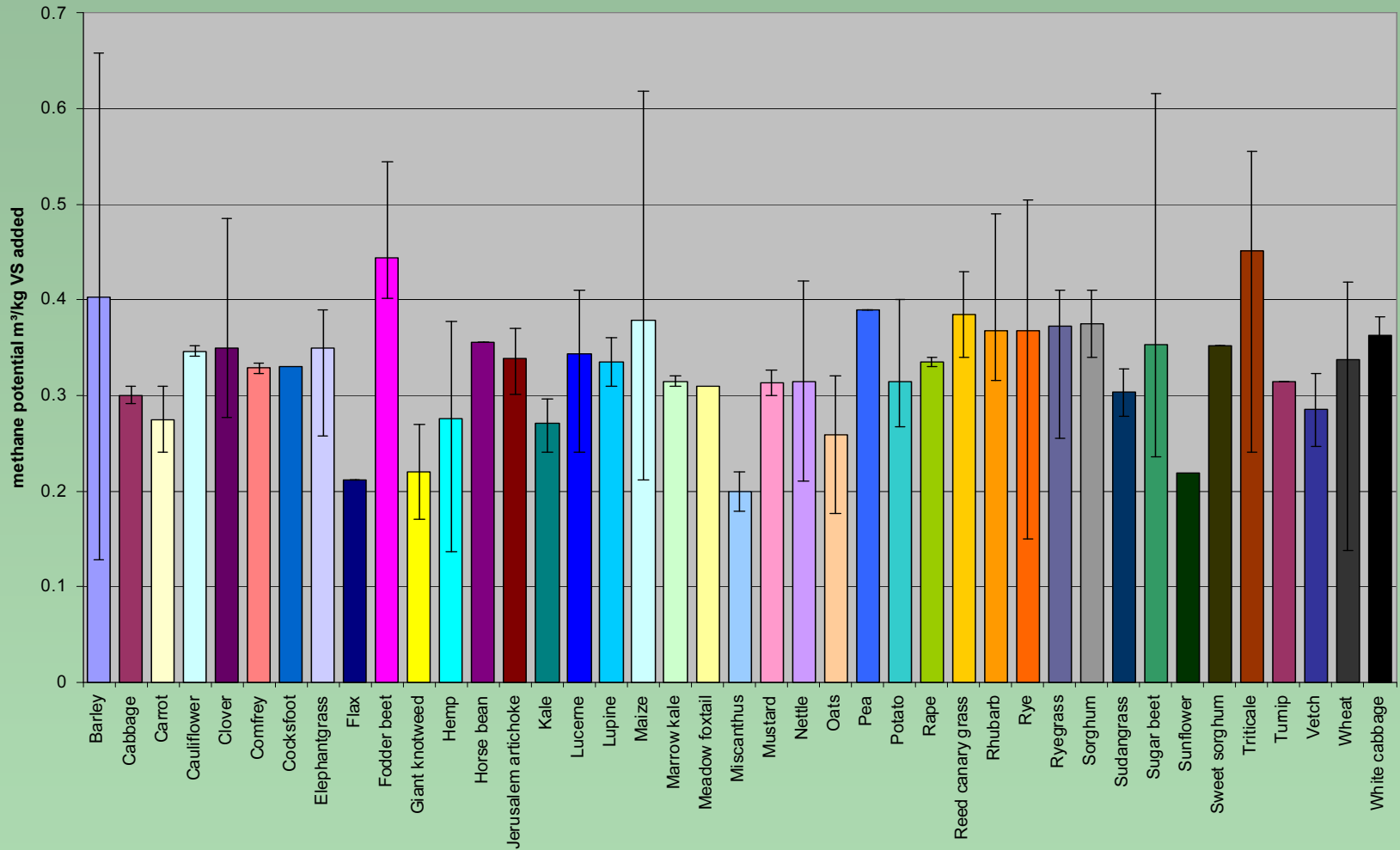
- want maximum methane yield per hectare of crop

yield of methane / ha =

methane potential \* crop yield

methane yield/kg ODM \* yield of ODM/ha

# methane potential

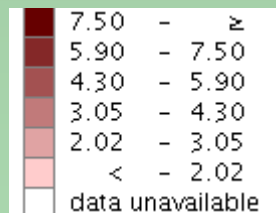
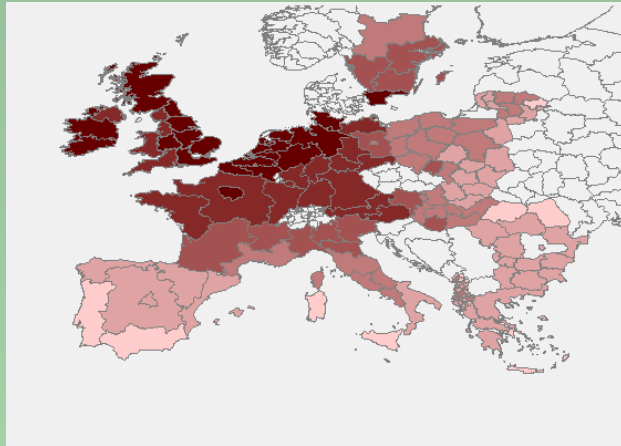


# crop yields

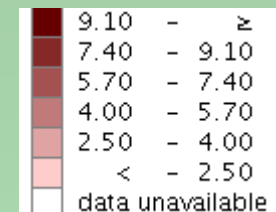
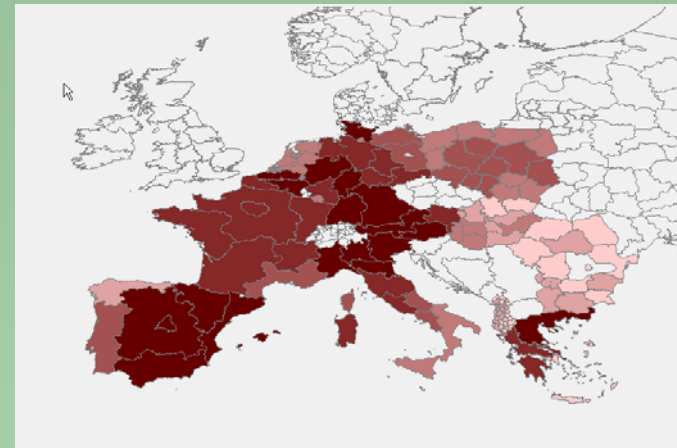
- vary according to:
  - geographical location
    - climate
    - soil type
  - growth stage at time of harvest

# yields (MT/ha)

wheat

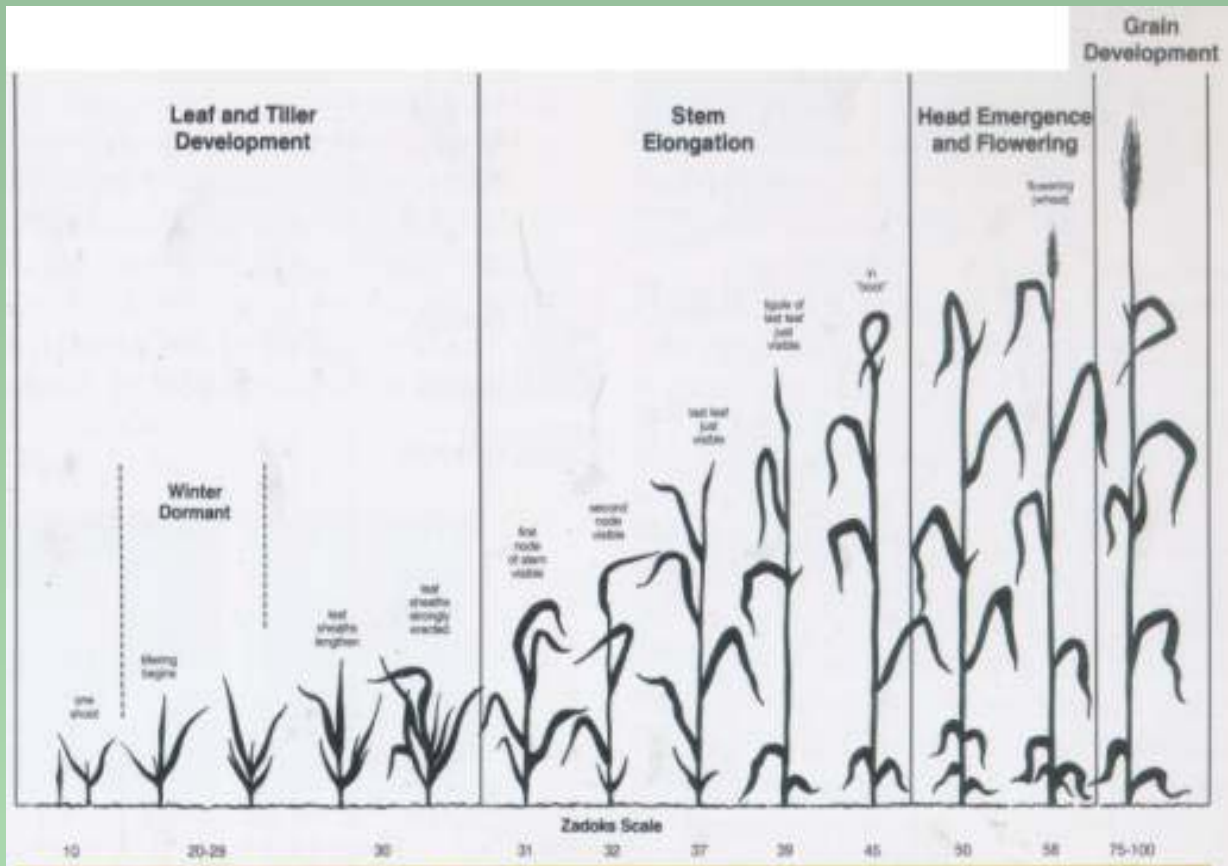


maize



(data source FAO/AGLL)

# growth stage at harvest



(J.C. Zadoks, T.T. Chang, C.F. Konzak, "A Decimal Code for the Growth Stages of Cereals", *Weed Research* 1974 14:415-421. )

- need to consider:
- total biomass yield
  - moisture content
  - storage
  - lignin
  - digestibility
  - following crop

# crop criteria

- annual vs perennial
- mono crops
- mixed crops and crop rotations
- digestibility



# annual vs perennial

- annual crops
  - planted and harvested every year
  - e.g. wheat, maize, sugar beet, beans, sunflowers
- perennial crops
  - planted one year, harvested over a number of years
  - e.g. perennial ryegrass, miscanthus

# mono crops

- one crop species grown year after year
- mostly annual - sown and harvested in the same 12 month period
- can be grown in as little as 3 months
- e.g. wheat, maize, rice

# effects of mono cropping

- high nutrient requirement
- build up soil borne pests and diseases
- bare soil
  - nutrient run off
  - erosion
- nutrient depletion
- damage to soil structure
- diversity of plant and animal life

# multiple cropping systems

- crop rotations
- inter crops
- undersown crops
- legume mixes e.g. vetch/oats, beans/wheat
- increase crop production through the use of multiple crops per year

# crop rotations

## mono-crop

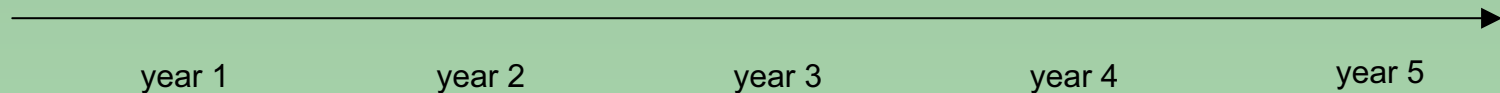
wheat      wheat      wheat      wheat      wheat

## 2 year rotation

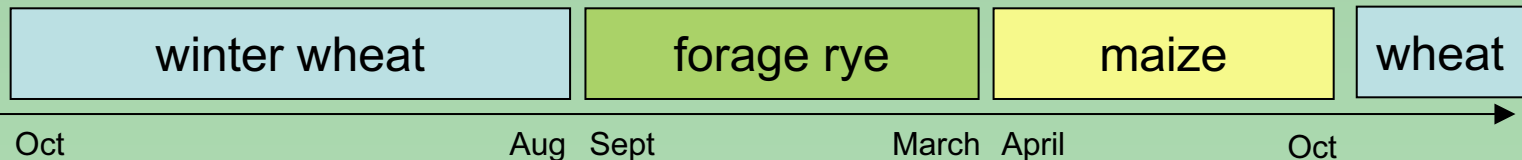
maize      soybean      maize      soybean      maize

## 4 year rotation

wheat      barley      oilseed      clover      wheat



## a crop rotation for energy



# crops for biofuel production

- for biodiesel

- oilseed rape
- sunflower
- linseed
- soya
- peanut

- for bioethanol

- wheat
- sugar beet
- maize
- sugar cane
  
- *lignocellulosic material*

- for biogas

- barley
- cabbage
- carrot
- cauliflower
- clover
- elephant grass
- flax
- fodder beet
- giant knotweed
- hemp
- horse bean
- Jerusalem artichoke
- kale
- lucerne
- lupin
- maize
- marrow kale
  
- meadow foxtail
- miscanthus
- mustard
- nettle
- oats
- pea
- potato
- rape
- reed canary grass
- rhubarb
- ryegrass
- sorghum
- sugar beet
- triticale
- turnip
- verge cuttings
- fetch
- wheat

# energy balances

crop production

digestion

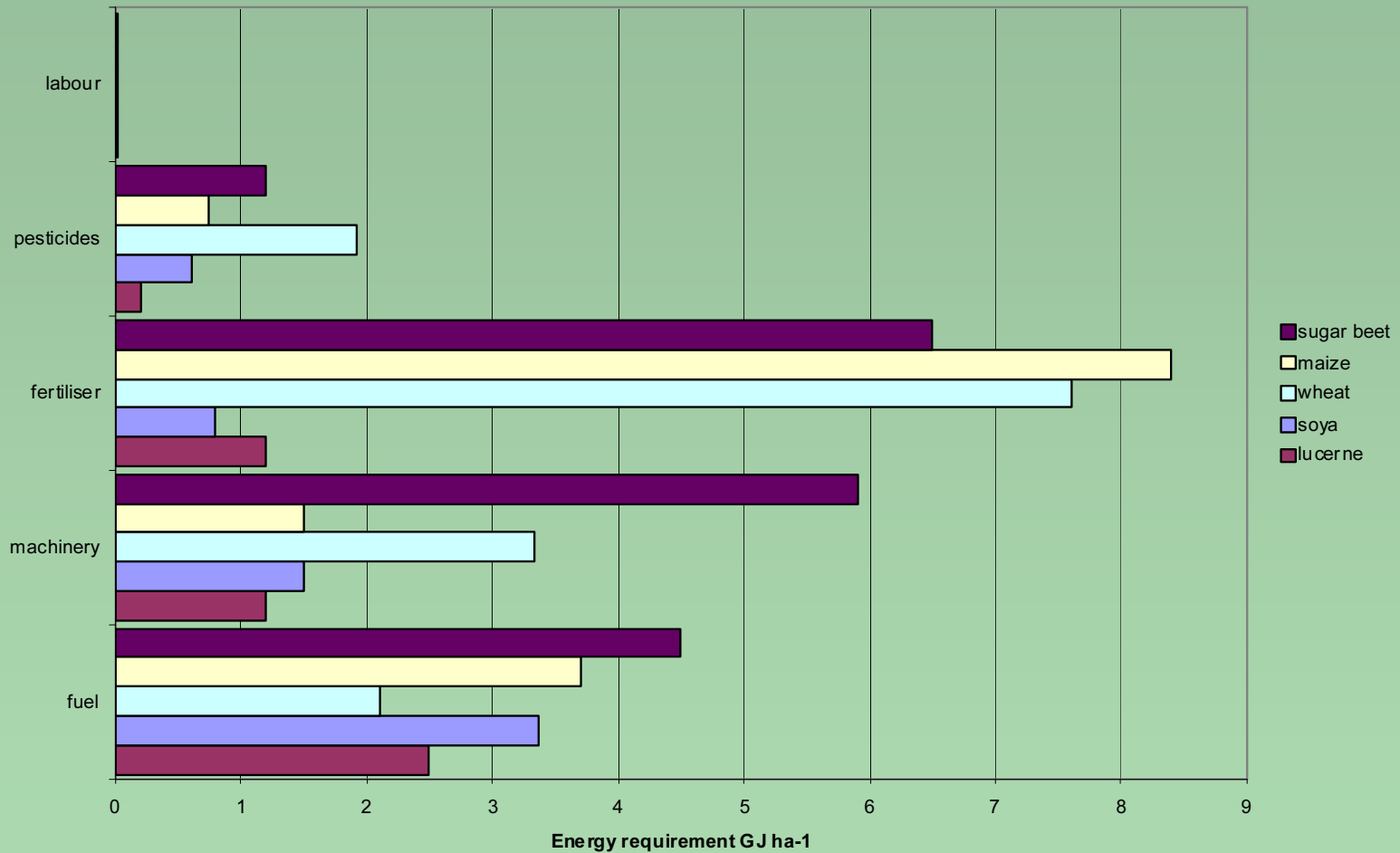
digestate disposal

# crop production

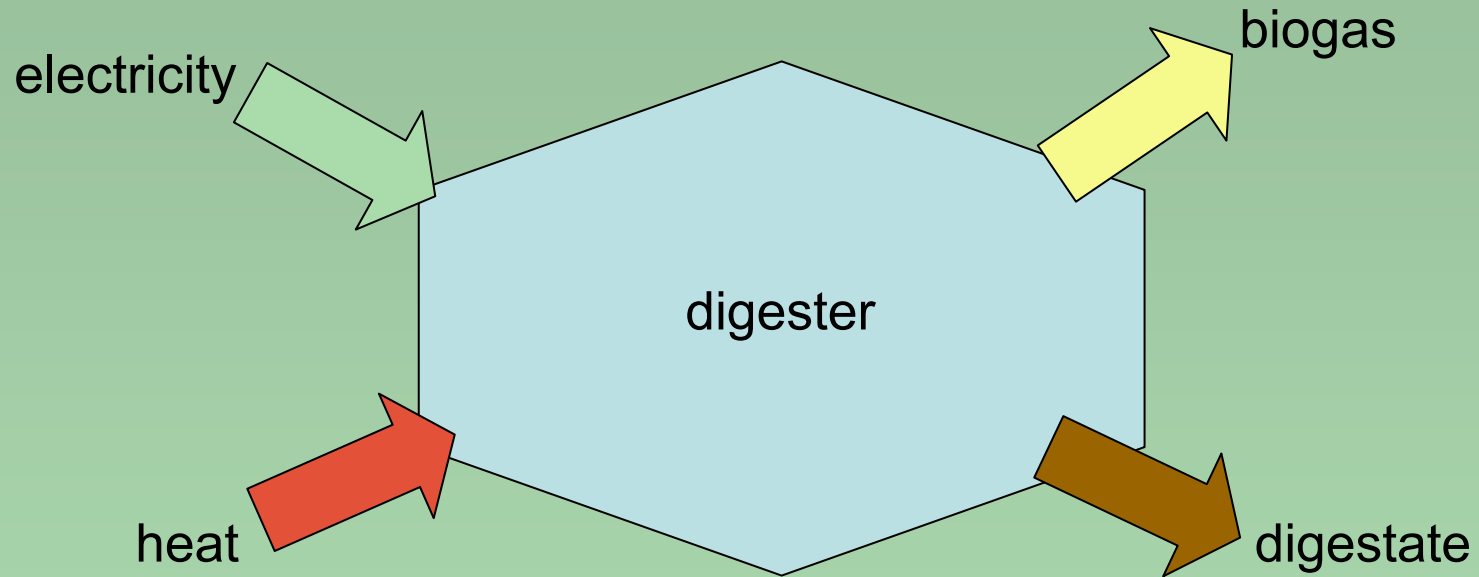
- fuel
  - fertiliser & pesticides
  - equipment
  - irrigation
  - labour
- direct and indirect energy requirements



# energy requirements in crop production

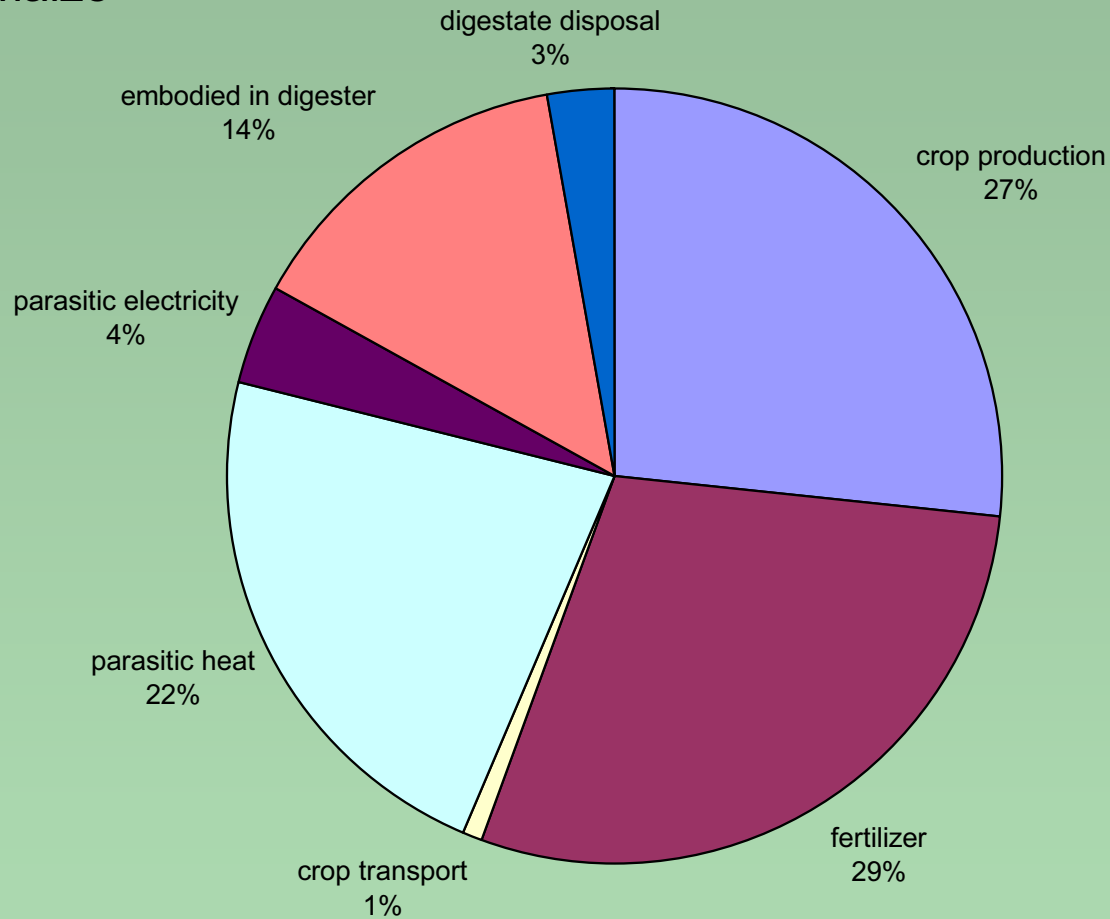


# digestion process



# energy requirements

## forage maize

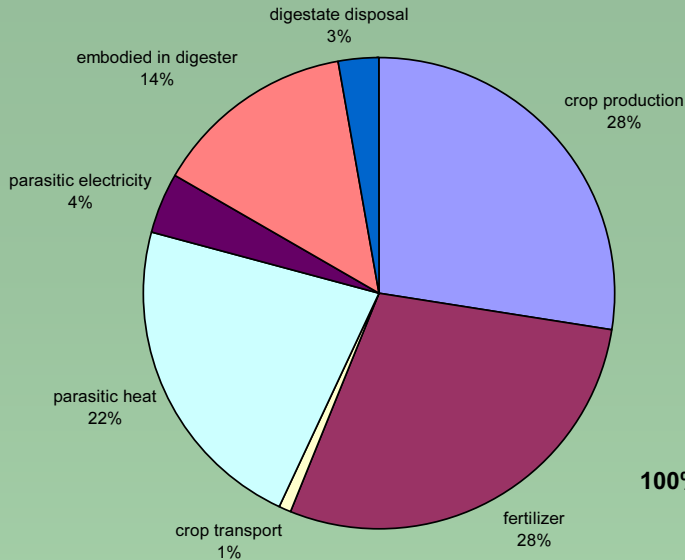


# digestate

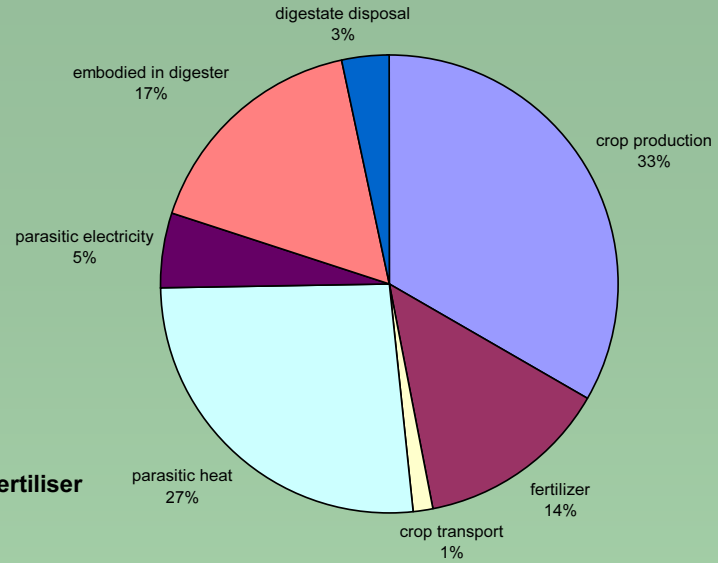
- contains most of the nutrients from the original feedstock
- improved nutrient availability
- can be separated into liquid and solid components
- high fertiliser value

# digestate as fertiliser

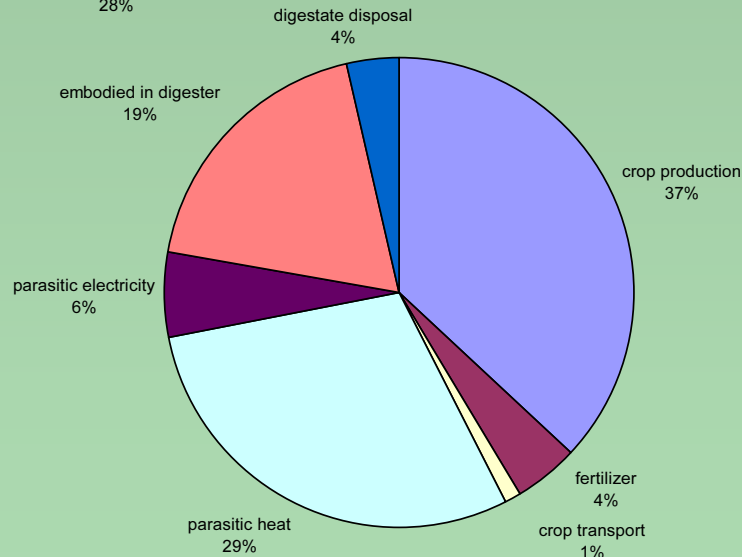
mineral fertiliser



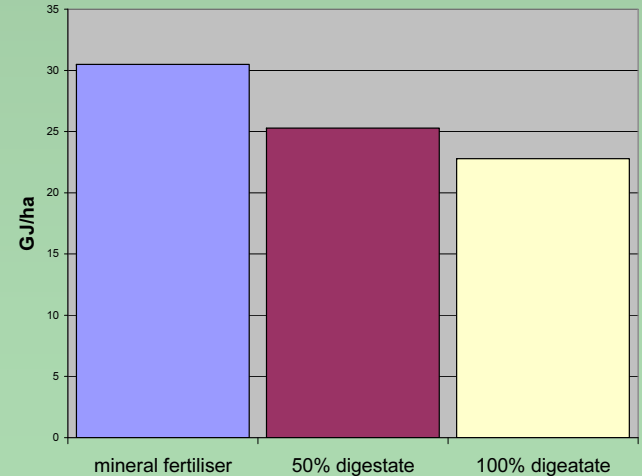
50% N from digestate fertiliser



100% N from digestate fertiliser



Energy requirement per hectare



# CO<sub>2</sub> and carbon sequestration

- minimising fossil fuel use minimises CO<sub>2</sub> released
- perennial crops increase soil sequestration of carbon
- in a crop based AD system CO<sub>2</sub> released is CO<sub>2</sub> absorbed by the plants

# legislation

- slurry and digestate storage and application
- subsidies, single area payment
- set-aside
- animal by-products
- waste and waste disposal

# conclusion

## – which crop should I grow?

- simplest answer is – the one that gives the best yield
- there is no single ‘best crop’
- what grows best in your fields?
- what will give the most sustainable crop production
- need to consider economics vs global impacts



# Thank you



[www.cropgen.soton.ac.uk](http://www.cropgen.soton.ac.uk)

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