



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?

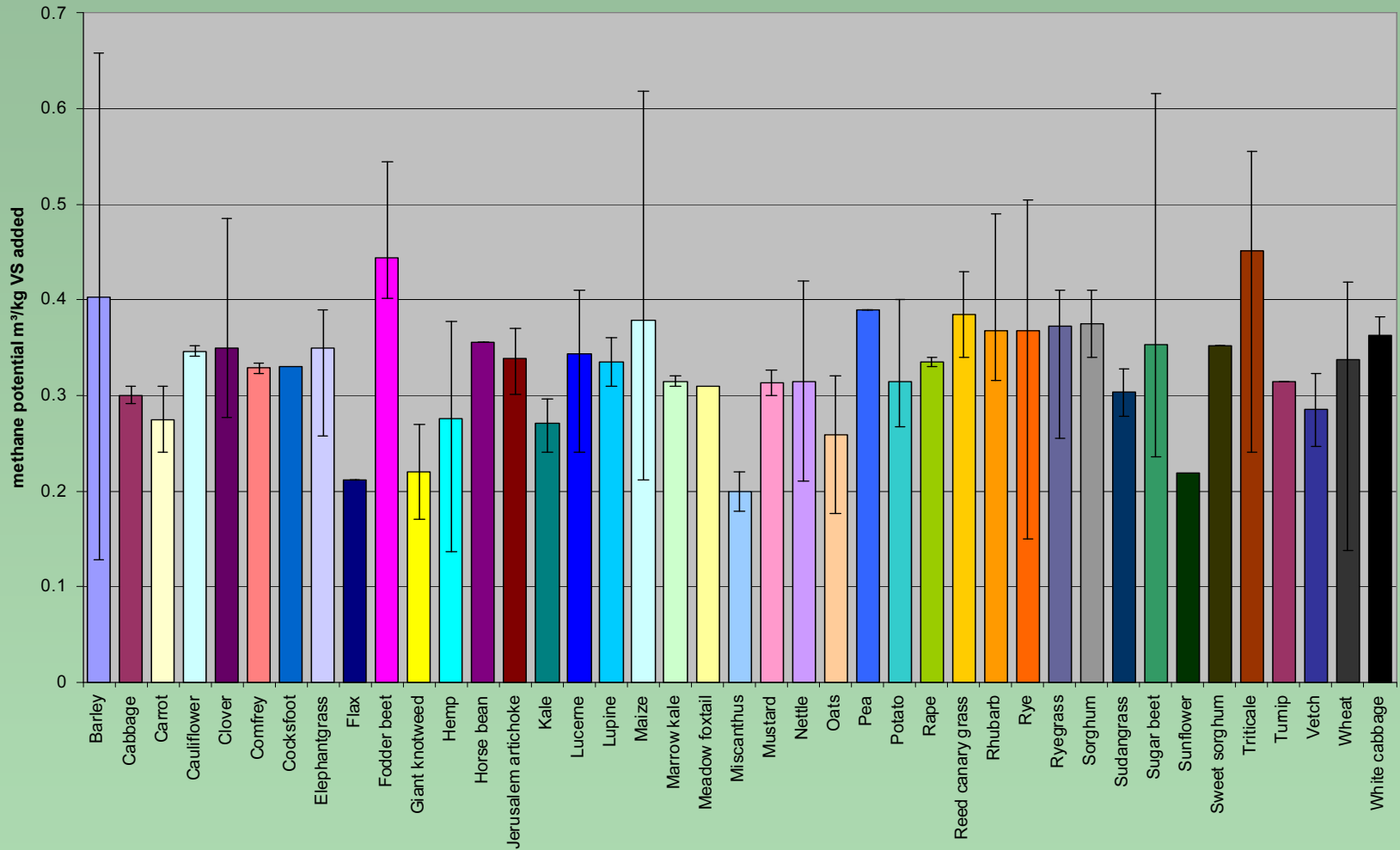
- want maximum methane yield per hectare of crop

yield of methane / ha =

methane potential * crop yield

methane yield/kg ODM * yield of ODM/ha

methane potential

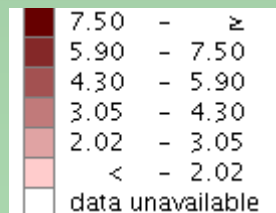
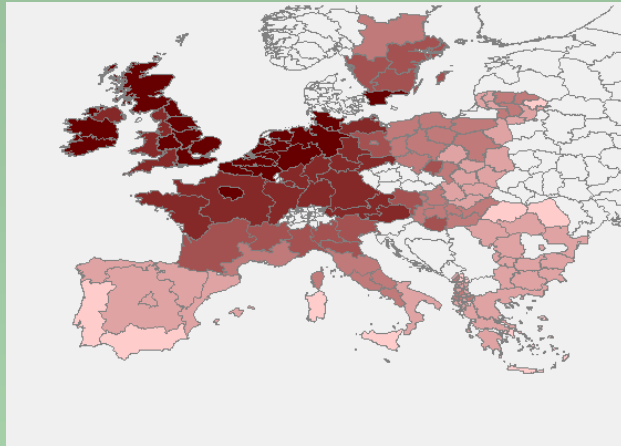


crop yields

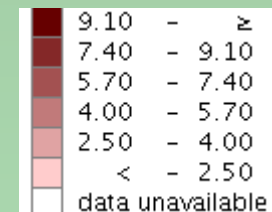
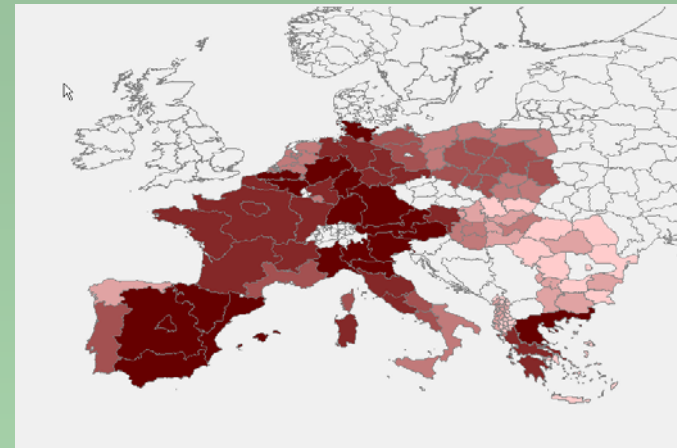
- vary according to:
 - geographical location
 - climate
 - soil type
 - growth stage at time of harvest

yields (MT/ha)

wheat

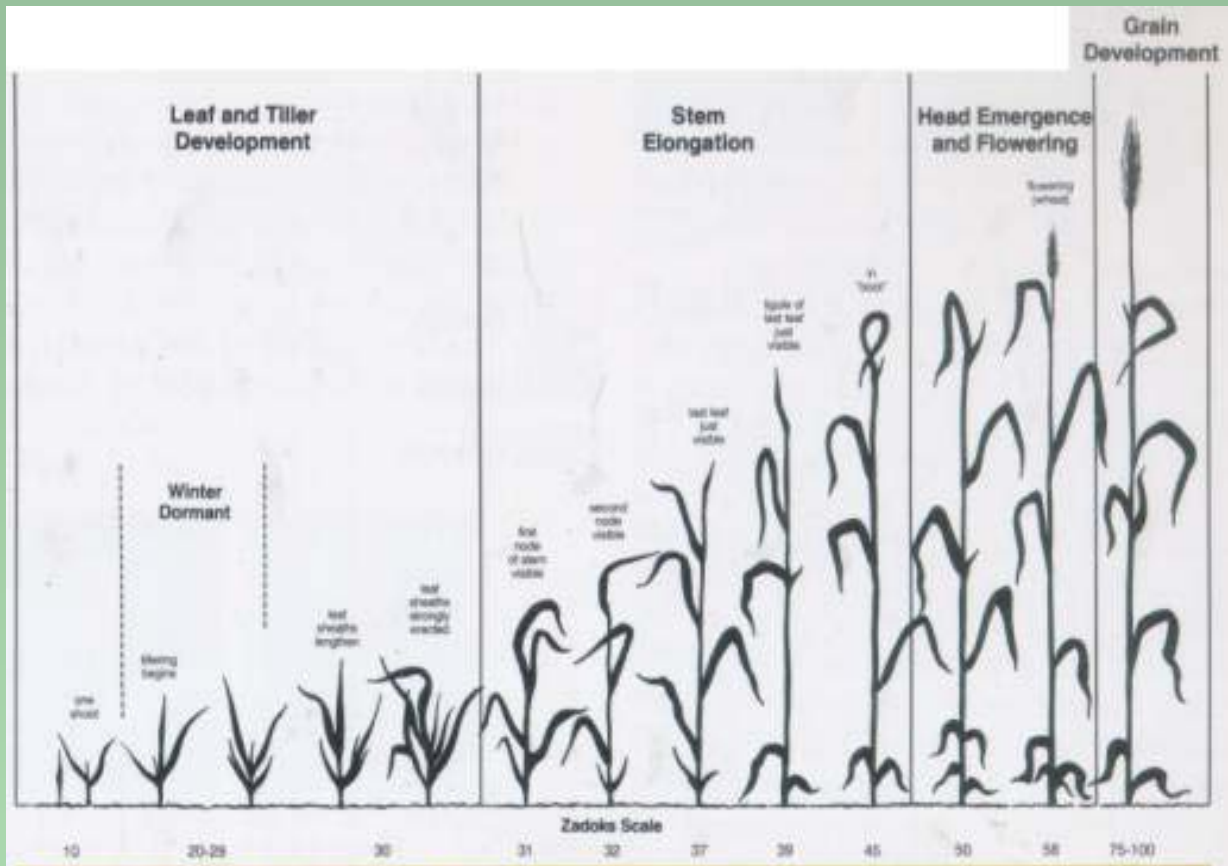


maize



(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

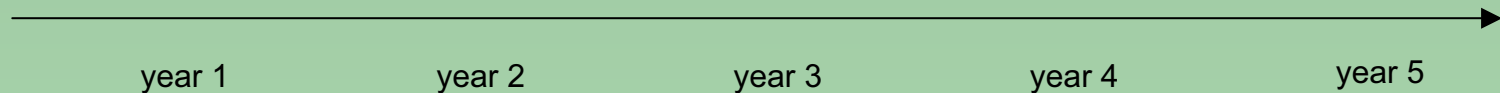
wheat wheat wheat wheat wheat

2 year rotation

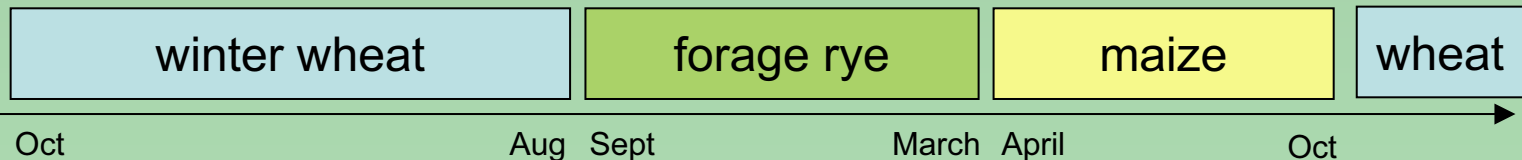
maize soybean maize soybean maize

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

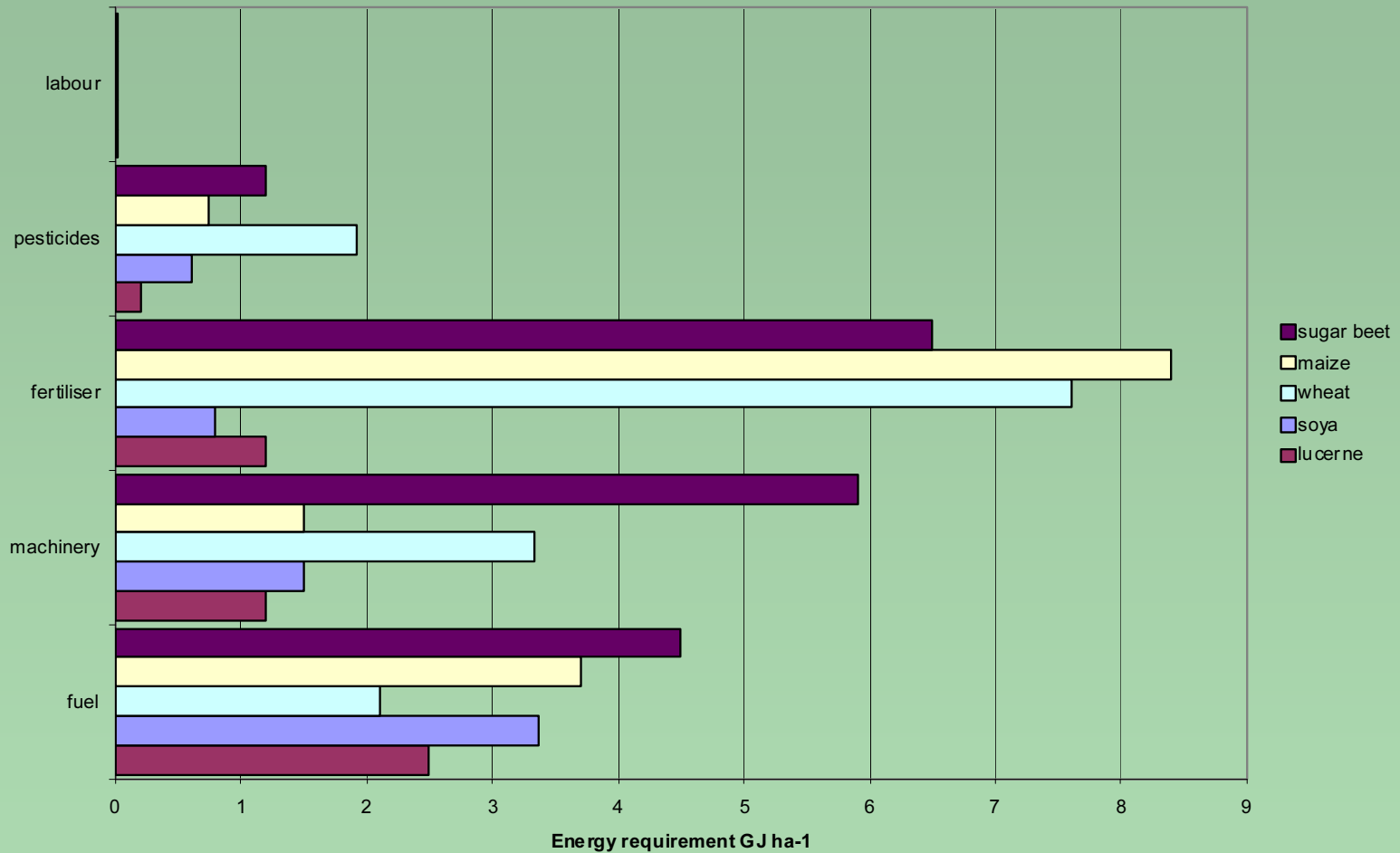
digestion

digestate disposal

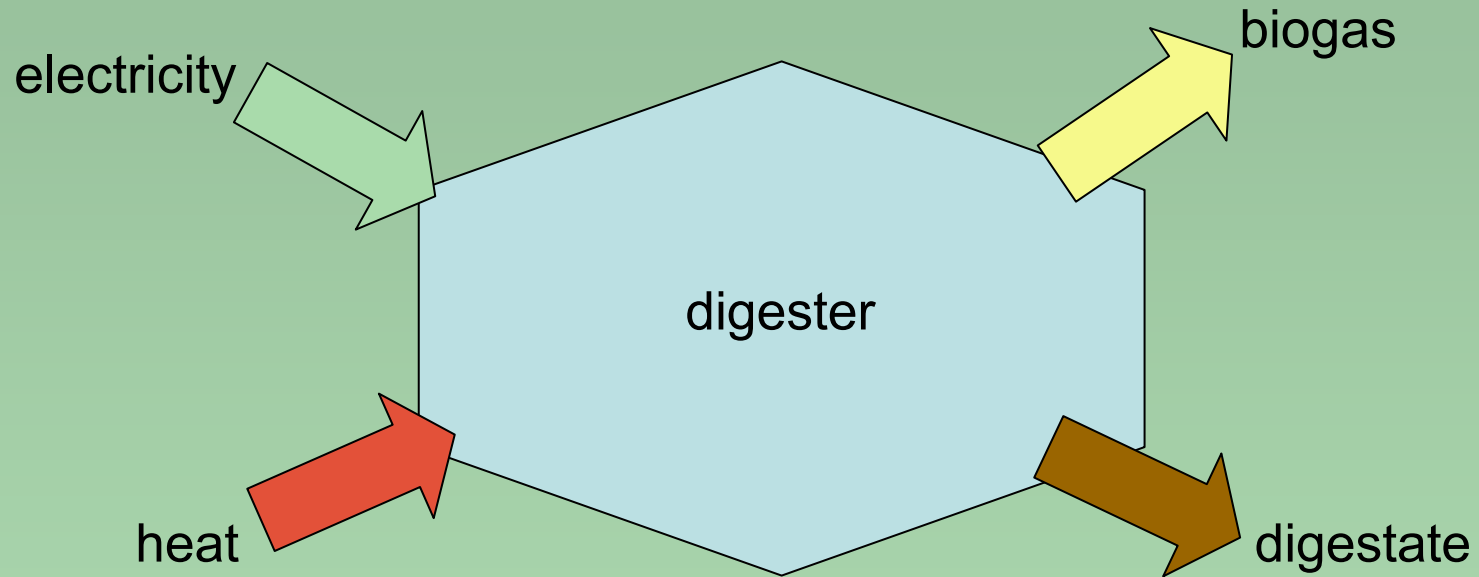
crop production

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

energy requirements in crop production

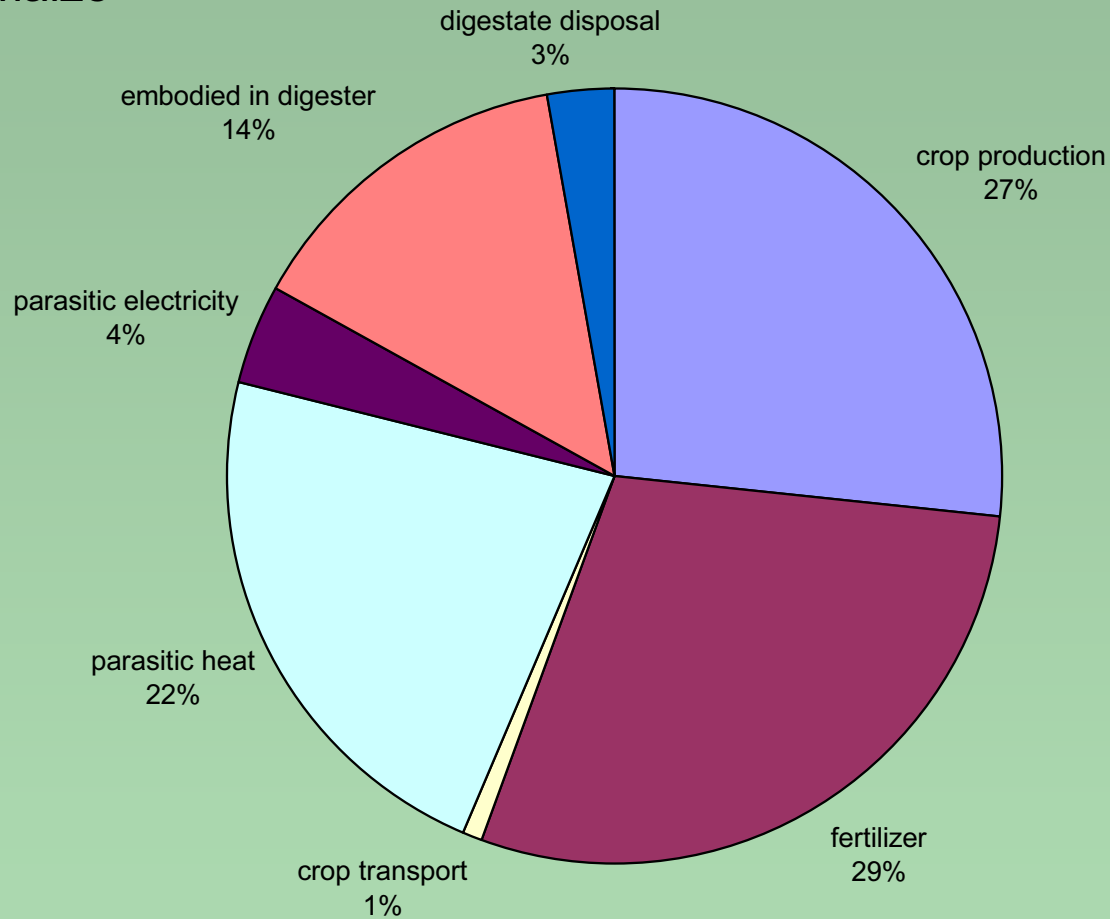


digestion process



energy requirements

forage maize

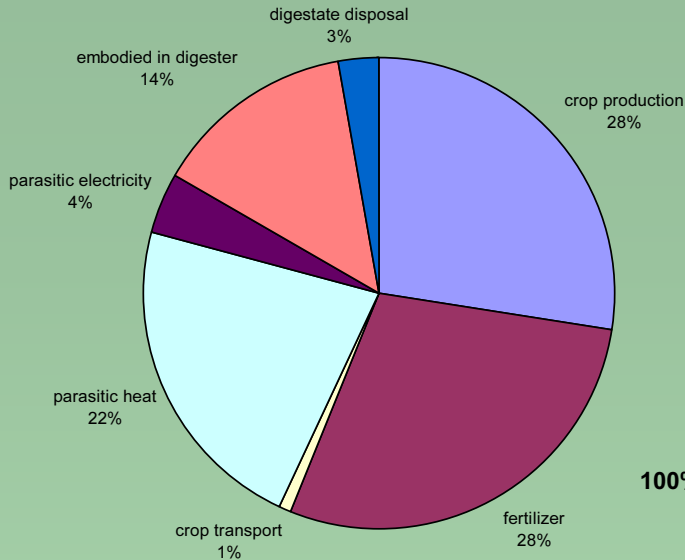


digestate

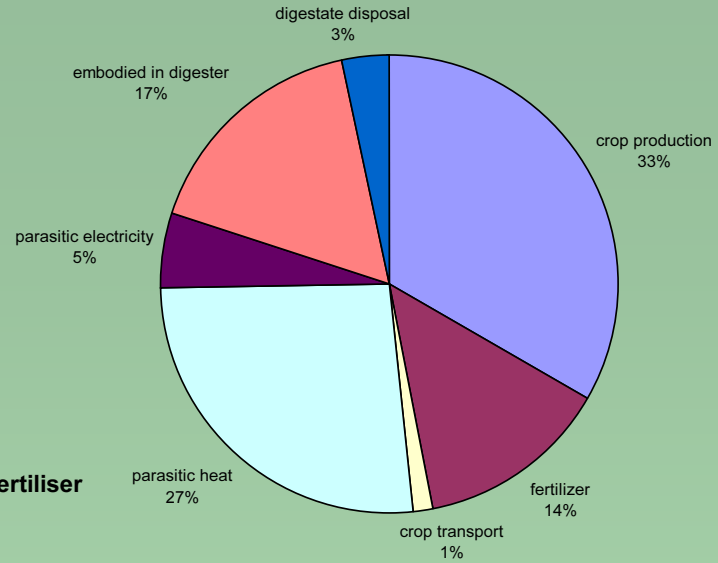
- contains most of the nutrients from the original feedstock
- improved nutrient availability
- can be separated into liquid and solid components
- high fertiliser value

digestate as fertiliser

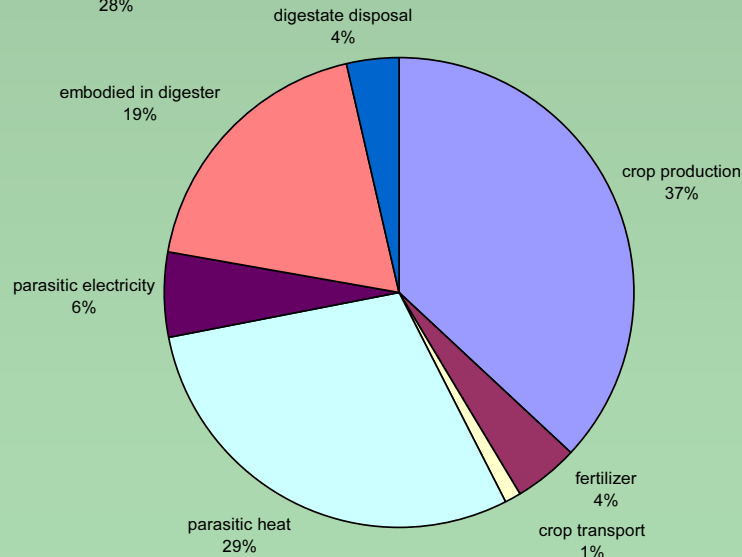
mineral fertiliser



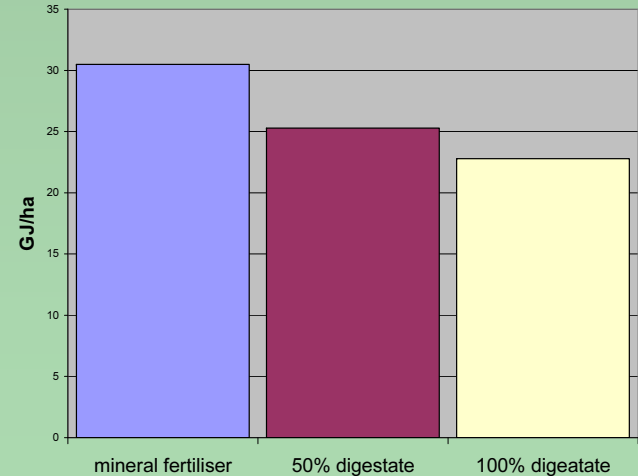
50% N from digestate fertiliser



100% N from digestate fertiliser



Energy requirement per hectare



CO₂ and carbon sequestration

- minimising fossil fuel use minimises CO₂ released
- perennial crops increase soil sequestration of carbon
- in a crop based AD system CO₂ released is CO₂ 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



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