



AGROCYCLE

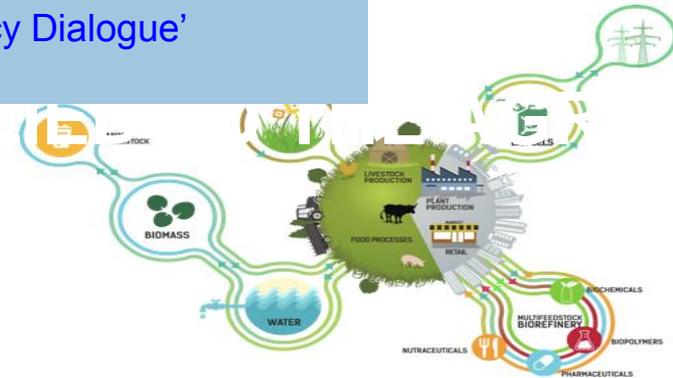
for a circular economy

The 'circular economy' applied to the agri-food sector

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AGROCYCLE



What is the circular economy in agriculture?

- Production of agricultural commodities using a minimal amount of external inputs
- Closing nutrient loops and reducing negative discharges to the environment
- Valorising agri-food wastes

IN THE LAST 50 YEARS, AGRICULTURE HAS BECOME MORE **RESOURCE INTENSIVE**, RELYING HEAVILY ON THE AVAILABILITY OF FOSSIL INPUTS IN THE FORM OF SYNTHETIC NITROGEN AND PHOSPHORUS FERTILISERS, OIL DERIVED AGROCHEMICALS AND FOSSIL FUELS.



MANKIND IS THE GREAT CONSUMER OF RESOURCES AND POLLUTER

- 6 billion people now
- Increase by 50% by 2050
- **The Western world lifestyle is the aspiration!**
- But, **this planet does not have the capacity to deliver Western standards to all, based on the current *modus operandi***

It's about ensuring that the planet can sustain 9 billion people

THE 'CIRCULAR ECONOMY' IS ABOUT THE PLANET

Waste not, want not!

Produce more from less!

Combined growth in expectations and population

The real challenge is to sustain
45 billion PRU (People Resource Units)

2016 - 15 billion PRU
2030 - 25 billion PRU
2050 - 45 billion PRU

Lifestyle enhancement
Population growth

165,000 TW
of sunlight
hit the earth
every day



‘CIRCULAR ECONOMY’

- Resource productivity in agri-food centres on:
 - **using a minimal amount of external inputs;**
 - **closing nutrient loops;**
 - **and reducing negative discharges to the environment**
- Examining the entire agri-food system reveals opportunities at all stages, from primary production using precision agricultural techniques, to the retail-consumer nexus and through to the utilisation of agri-food wastes in the bioeconomy

'CIRCULAR ECONOMY'

- 'Circular economy' principles can offer many opportunities for the full-chain agri-food industry to become more resource efficient
- **The CE is not an 'excuse' to generate waste to fuel a downstream industry!**
- **Industry will be 'forced' to comply with CE norms**
 - 'pressure' from the citizen (consumer), legislation
 - 'pull' from business opportunities



'CIRCULAR ECONOMY' IN AGRICULTURE

- 'Circular economy' in agriculture centres on the production of agricultural commodities using a **minimal amount of external inputs, closing nutrient loops and reducing negative discharges to the environment** (in the form of wastes and emissions).



THE BIOECONOMY MAY NOT NECESSARILY CLOSE RESOURCE LOOPS IN AGRICULTURAL PRODUCTION SYSTEMS.

- Resources such as crop residues and manures can remain within the agricultural system but may also be valorised to produce energy/chemicals for the wider bioeconomy, thereby not being 'circularised'.
- **Determining which pathways (closed loop agriculture vs. wider bioeconomy utilisation) are most effective** for creating sustainable agri-food systems remains a priority for researchers and policy makers.

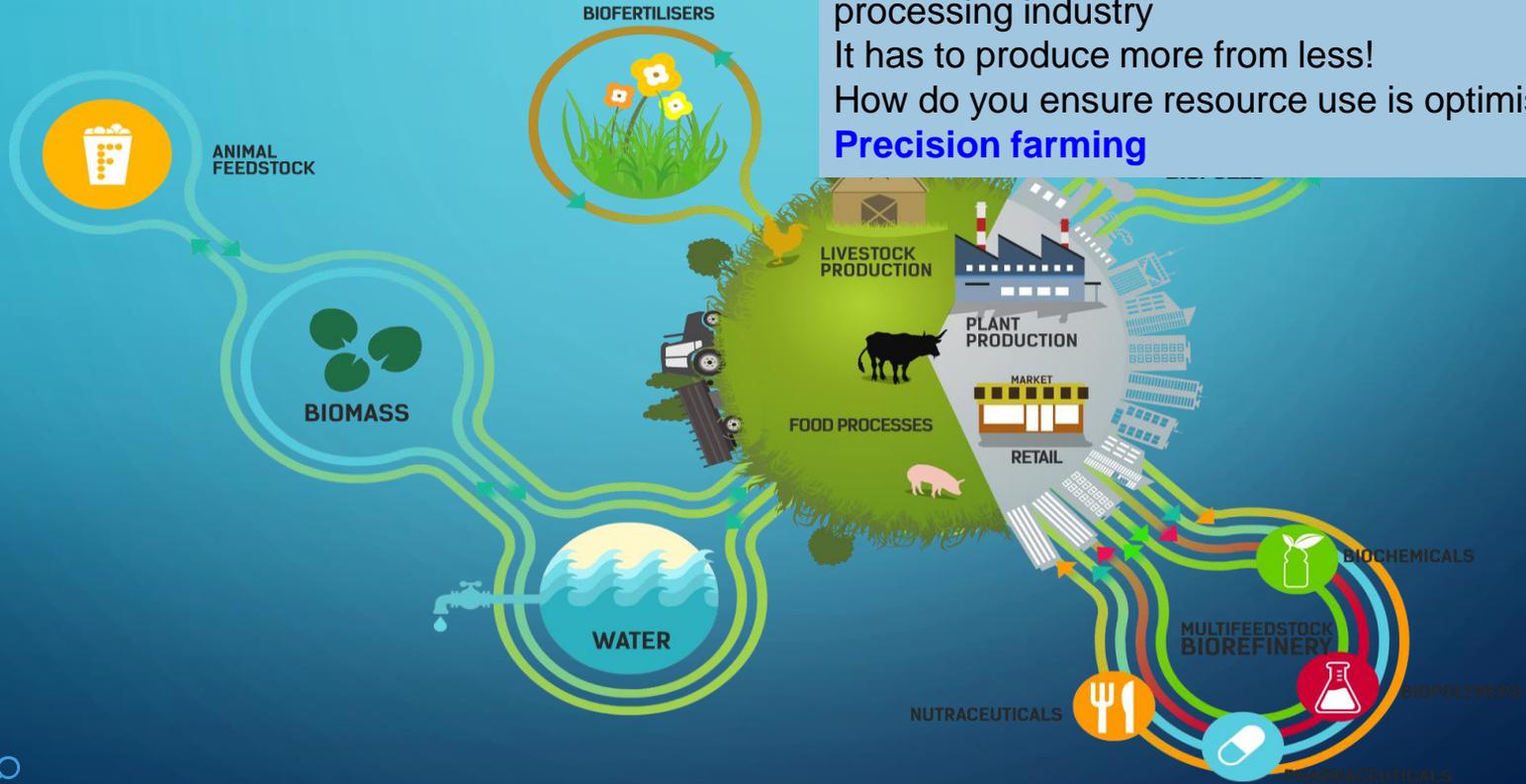




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for a circular economy

Efficient agricultural production is essential
Agriculture's mission is to feed the world
- to produce ample high quality wholesome food
It is NOT to provide feedstock for a downstream
processing industry
It has to produce more from less!
How do you ensure resource use is optimised?
Precision farming



Q. DOES 'PRECISION AGRICULTURE' HAVE ANY REAL ROLE TO PLAY IN A 'CIRCULAR ECONOMY' (AS OPPOSED TO SUSTAINABLE AGRICULTURAL PRODUCTION)?

- Industrial **farming is energy intensive**: requires between 10 and 60 J fossil energy input per 1 J of protein produced (Pimintel, 2003)
- Livestock production can be quite wasteful of resources - **overall nitrogen use efficiency in animal production for the EU27 is around 15 - 17%, crops approximately twice as efficient**, when accounting for the full chain from fertiliser application to N in edible produce.



NEW FRONTIER THAT'S FUNDAMENTAL TO THE CE

- Precision agriculture provides enhanced control over the input fertilisers and agrochemicals, reflecting geo-spatial variability in soils, microclimate and other relevant husbandry parameters.
- Precision agriculture utilises information technology systems to optimise the application of agricultural inputs (e.g. fertiliser, agro-chemicals) by delivering **'the right amount, at the right time, in the right place'**, thereby ensuring that the minimum resources needed are used at the production stage in order to achieve optimum performance with minimal environmental impact.
- While not directly contributing to 'circularisation', precision agriculture addresses the use of minimal levels of invested resources - essential to achieving sustainable agricultural production.
 - The PA tools are there – the knowledge is not!
 - **BIG DATA in Agri-food is the new frontier!**





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CREATING DEMANDS FOR PERCEIVED 'WASTES' CREATES A TRADE IN WASTE.

- The UK Refit scheme for AD, for example, made it economically profitable to transport crops large distances from the Republic of Ireland to Northern Ireland as feedstock for AD plants – **but not viable to supply local AD plants.**
- This example highlight the potential trade-off between environmental and economic benefits created by policy-based 'circularisation' strategies that use economics as an implementation 'driver'.



CIRCULAR ECONOMY: A GLOBAL CONCEPT

- **Guano**
 - South America main source (Peru)
 - Superb soil fertiliser
 - high in N,P,K
 - Used for millennia
 - **Inca Empire** used it extensively
 - **and punished any disturbance of the birds with death!**
- Traded globally
- It enabled sustainable agricultural systems to flourish in the 19th C
- Industrial nitrogen fixation generated ammonia-based fertilisers in early 20th C
- **There is an reliance on external nutrients inputs at farm level!**



**Global Agri-Food Industry
Atmosphere & economics
cannot be 'ring-fenced'**

Who pays?

If the world wants beef, is it the beef producing countries that take all the 'environmental burden' or is it the consumer?

**BUTTERFLY FLAPS ITS WINGS ...
ENVIRONMENTAL SYSTEMS ARE
GLOBAL!!**

SCALE OF THE 'CIRCULAR ECONOMY'

- The 'circular economy' needs to address **the scale of loops**, in order to prevent the exploitation of resources in one area to satisfy demand in another.



SHIFTING ENVIRONMENTAL BURDENS ...

- The impacts of global livestock production can be widespread and when a country **substitutes imported for domestically produced meat, the environmental burdens are effectively shifted abroad**, affecting distant countries where the commodities are produced.



20% OF GLOBAL WATER USED IN AGRICULTURE IS TRADED AS 'VIRTUAL' WATER

- The global volumes of international 'virtual' water flows mean that about **20% of the global water used in agriculture** is aimed at producing products for export



EU AGRI-FOOD SYSTEMS RELIANT ON 'VIRTUAL P'

- **Virtual nutrient trade** is also a relevant issue for the 'circular economy'
- The global trade in phosphorus has made the EU reliant on imported 'virtual' phosphorus. The contribution of 'virtual' P flows to the total P 'footprint' of the EU has increased by 40% from 1995 to 2009.



Value (£ / t or £ / m³)

3. Low Mass and High Value

Secondary demand exists because output is valuable. As the value increases there is a risk that demand will drive the generation of greater mass forcing to class 4.

Tail wagging the dog!!



4. High Mass and High Value

Waste should not be considered as waste. As market value and driver to support reduction of mass. If part of a waste stream then there is significant upstream efficiency to create the valuable resource. Indicative of sub-system optimisation. The Incentive to reduce is

1. Low Mass and Low Value

Arises because there is either little waste produced or system has been modified to reduce waste. Low value either because resource has little inherent value or there is too little available to make utilisation worthwhile. If use is found, could be forced to class 3. The incentive to reduce is high.

2. High Mass and Low Value

Arises because system inherently produces too much waste. No real post-process market for outputs. If use found could be forced to class 4 rather than reduced to class 1.

Mass (or volume)

UNAVOIDABLE WASTE FEEDSTOCK FOR THE BIO-ECONOMY

- **Unavoidable agri-food waste arising from an efficient system is a suitable feedstock resource for the bio-economy**, as such waste cannot be prevented – it is a byproduct
- Avoidable wastes, on the other hand, represent mismanagement and inefficient use and are not a sustainable feedstock source for a bio-economy

BIO-ECONOMY FEEDSTOCK PASSPORTS

- The provenance and environmental burden of the feedstocks need to be quantified
- The establishment of '**raw material passports**' would specify provenance and quality
 - providing information on the origin of input nutrients to ensure that recycled and recovered nutrients can compete with fossil-based alternatives.
- Without this passport information, many valorisation pathways may be damaging the environment due to the use of inappropriate feedstock.

HOW MUCH TO PRODUCE V. IMPACT PER UNIT OF PRODUCTION?

- LCA has been predominantly used to assess the environmental impacts of a system, **but social LCA and life cycle costing (LCC) are becoming established methods that allow for a holistic analysis of the potential implications of policy** – and their integration into **life cycle sustainability assessment (LCSA)**
- These tools help us understand critical thresholds, how much of something should we produce (as opposed to looking at impact per unit production).



ARE WE SURE THAT THE 'CIRCULAR ECONOMY' ALWAYS USES LESS RESOURCES, OR IS IT JUST DIFFERENT ONES?

- does it create more jobs and financial flows within the economy, or just displace established ones, perhaps with less?
- are businesses founded on 'circularising' agricultural waste long-term secure **if the source of that waste is from an inefficient system and will eventually have to be reduced?**



SYSTEM EFFICIENCY IS IMPORTANT ...

- The 'circular economy' will benefit by acknowledging that system efficiency is important – **cannot assume that if a waste is 'used' then the system is in some way more sustainable**
- A '**circular efficiency**' approach is needed, whereby upstream inputs are minimised (e.g. using precision agriculture) and downstream residues/by-products (manures/crop residues) are 'circulated', where possible via technological pathways to maximise use of hard-won protein, nutrients and water.



IS THE 'CIRCULAR ECONOMY' ALWAYS BENEFICIAL?

- It is generally assumed that the 'circular economy' transition for agricultural materials offers clear benefits to EU industries from an economic, social and environmental perspective.
- This assumption needs careful thought because it is quite possible that 'circularisation' could cause economic and social stress unless properly analysed before implementation.





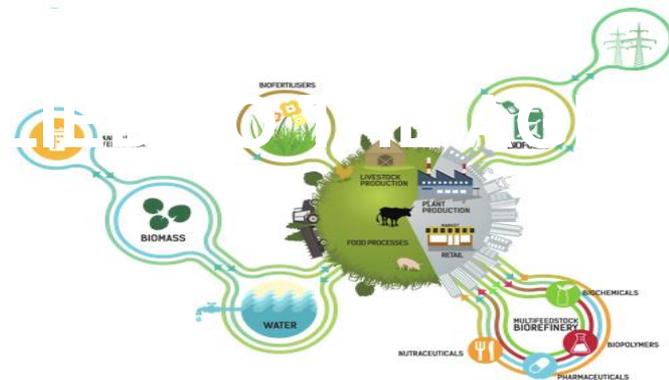
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