Assessing the effects of anaerobic digestion on farms

What makes on-farm anaerobic digestion environmentally friendly?

Guy Poppy, Laura Clements Andreas Muskolus, Donna Clark

WP9 – Assessment of potential environmental benefits and impacts of nutrient management through fertiliser substitution

WP10 Assessment of benefits to environmental protection (including GHG and ammonia emissions) and disease management on farms through introduction of AD

WP11 Development of methods to assess potential benefits to biodiversity in a wider context as a result of diversification into farm energy production through AD

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Environmental effects of AD

Direct effects	Indirect effects
•Using digestate as fertiliser •Effects from field transport	•Effects from emissions •Change of cropping scheme •Effects on pathogen spread •Effects on farm nutrient flows •Effects on soil and biodiversity

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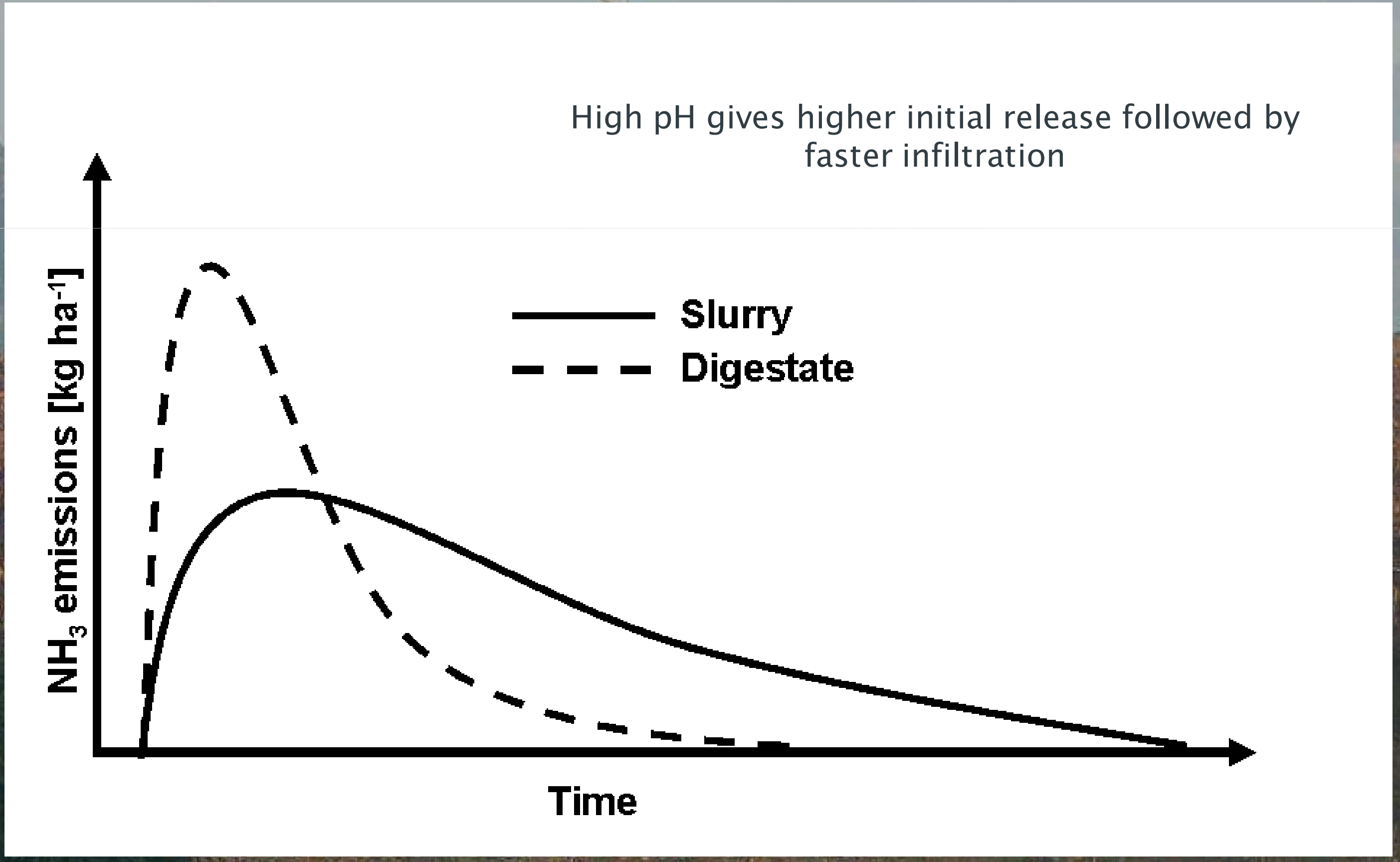
How does AD change input materials? What happens within the digester?

- Reduction of carbon
- Reduction of dry matter
- Conversion of organically fixed nitrogen to ammonium
- Raise of pH value
- Reduction of organic acids
- Reduction of odour
- Reduction of germs and pathogens

Assessing environmental effects of AD

NH_3 emissions after digestate spreading



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Example: Maize as feedstock

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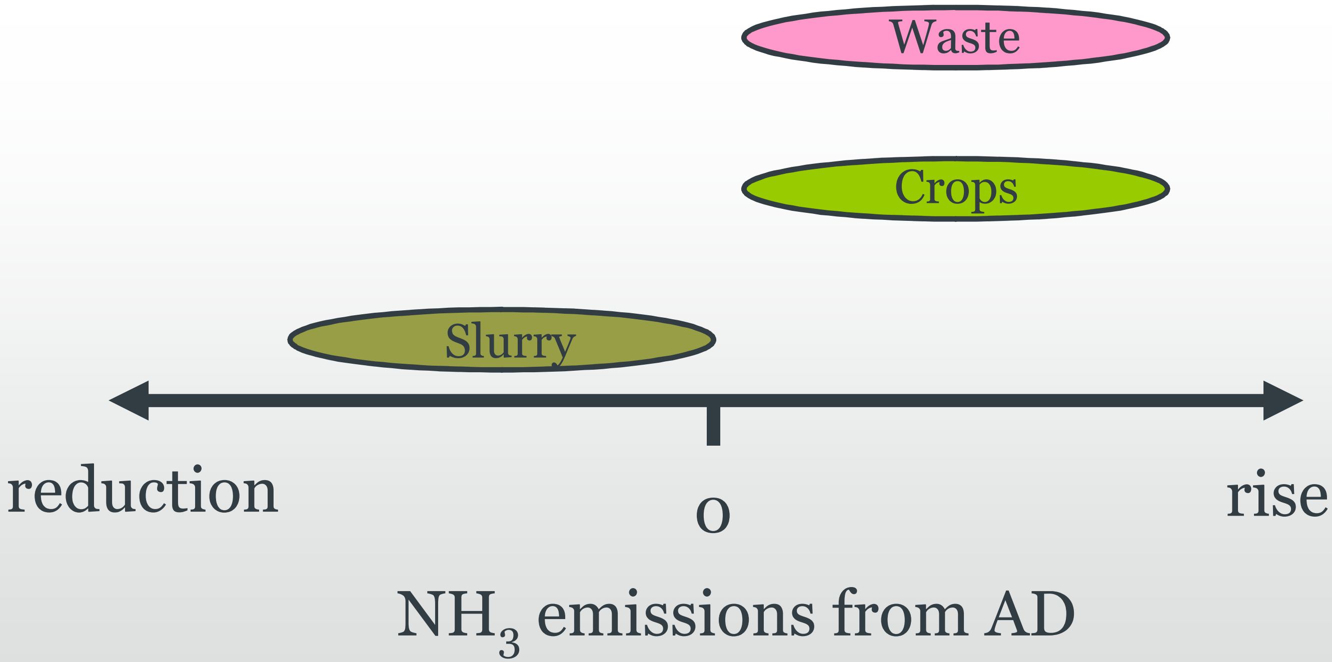
The source of digester feedstock determines the impact of AD on total emissions of NH_3

On the whole use of AD will lead to increase in NH_3 emissions



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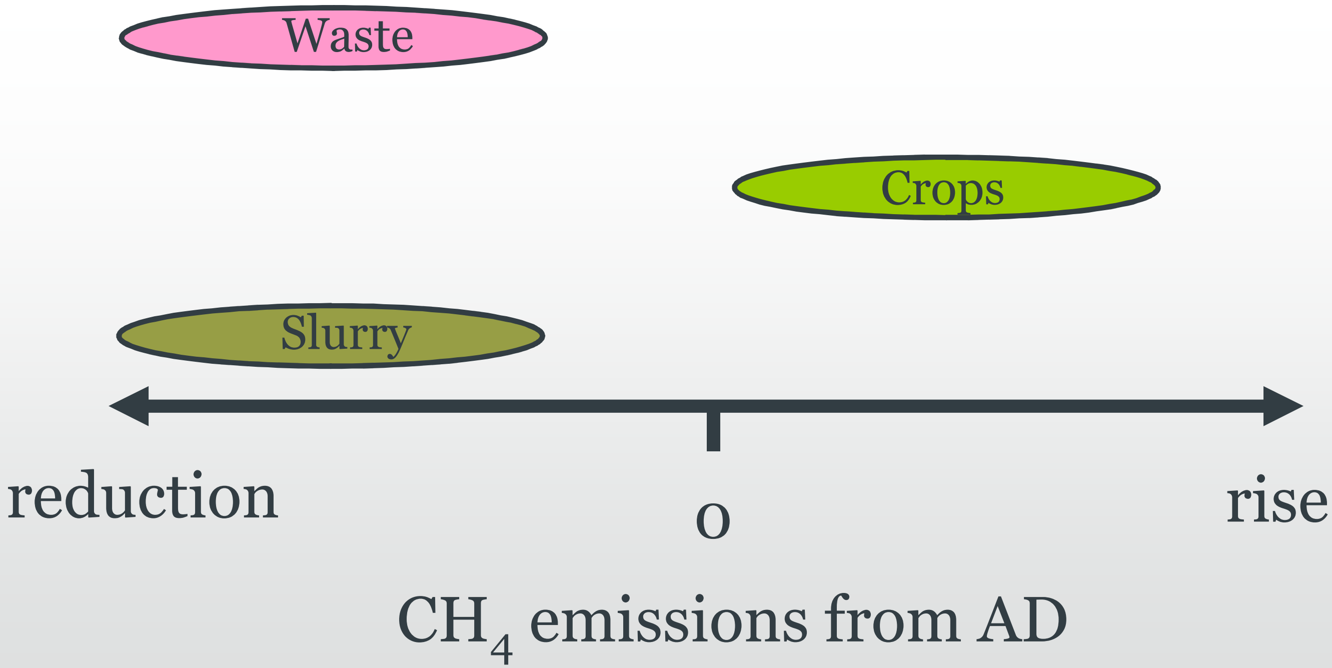
The source of digester feedstock determines the impact of AD on total emissions
Waste based on removal of emissions from landfill



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The impact of AD on nutrient management

In animal husbandry: AD increases N availability in slurry

In crop farming: Substitution of mineral fertiliser with digestate

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Managing/Mitigating Emissions

- Cover digestate tank and/or trap emissions before applying to fields.
- Move from broad spread to injected application – reduces emissions but does require additional energy input

Crop Requirements and Nutrient Compositions vary considerably which means a need to manage which digestate is best for which crop

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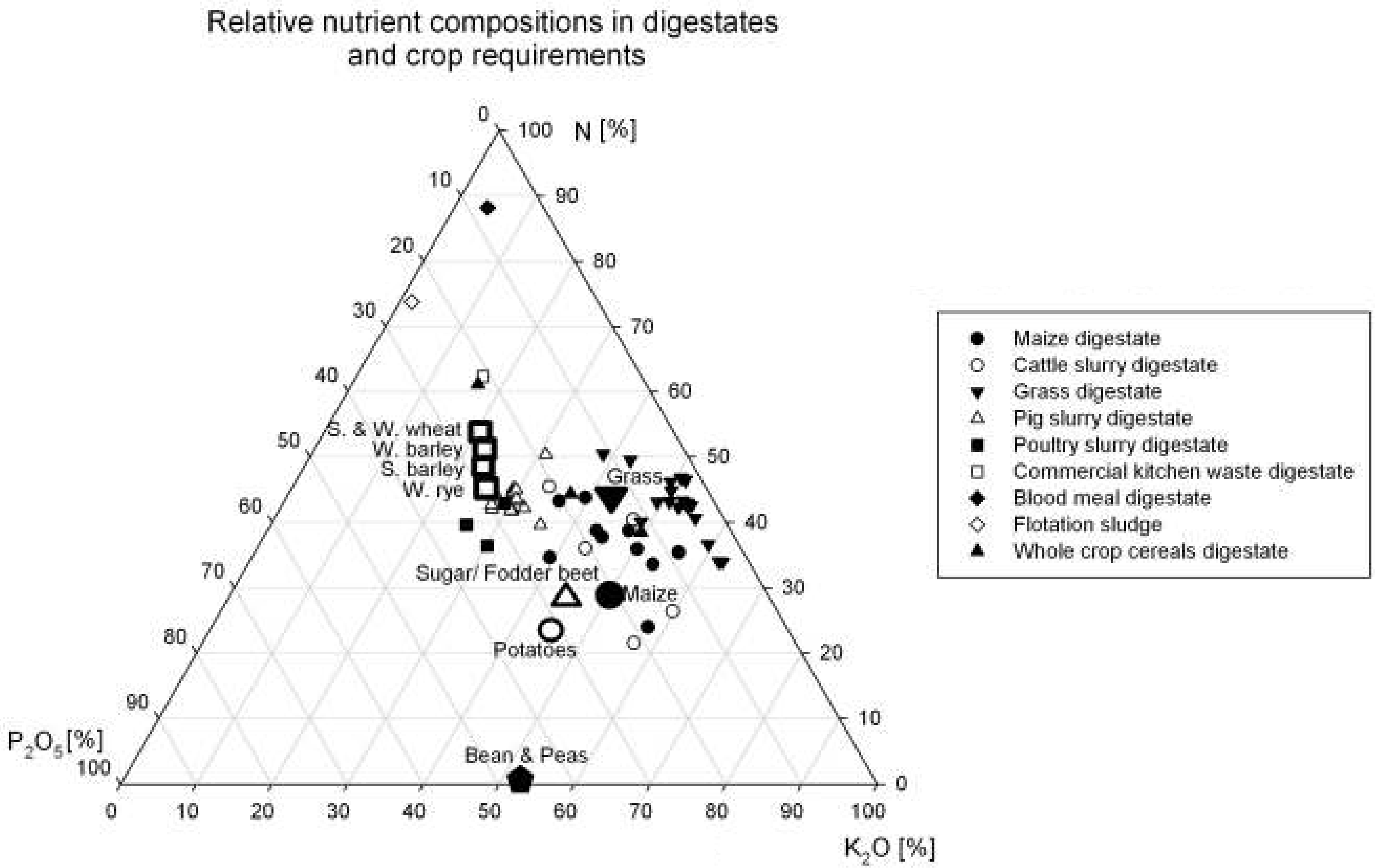

Example:

Digested maize applied on grassland.

	N	P_2O_5	K_2O
Nutrient requirements of grassland [%]	56	17	27
Nutrient composition of maize digestate [%]	34	18	48
Nutrients applied if N=100% [%]	100	175	285
Nutrients applied if K_2O=100% [%]	34	57	100

Farm nutrient management

Appropriate fertilising schemes can make AD environmentally friendly but need to know which digestate is best for which crop!

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WP11 Development of methods to assess potential benefits to biodiversity in a wider context as a result of diversification into farm energy production through AD

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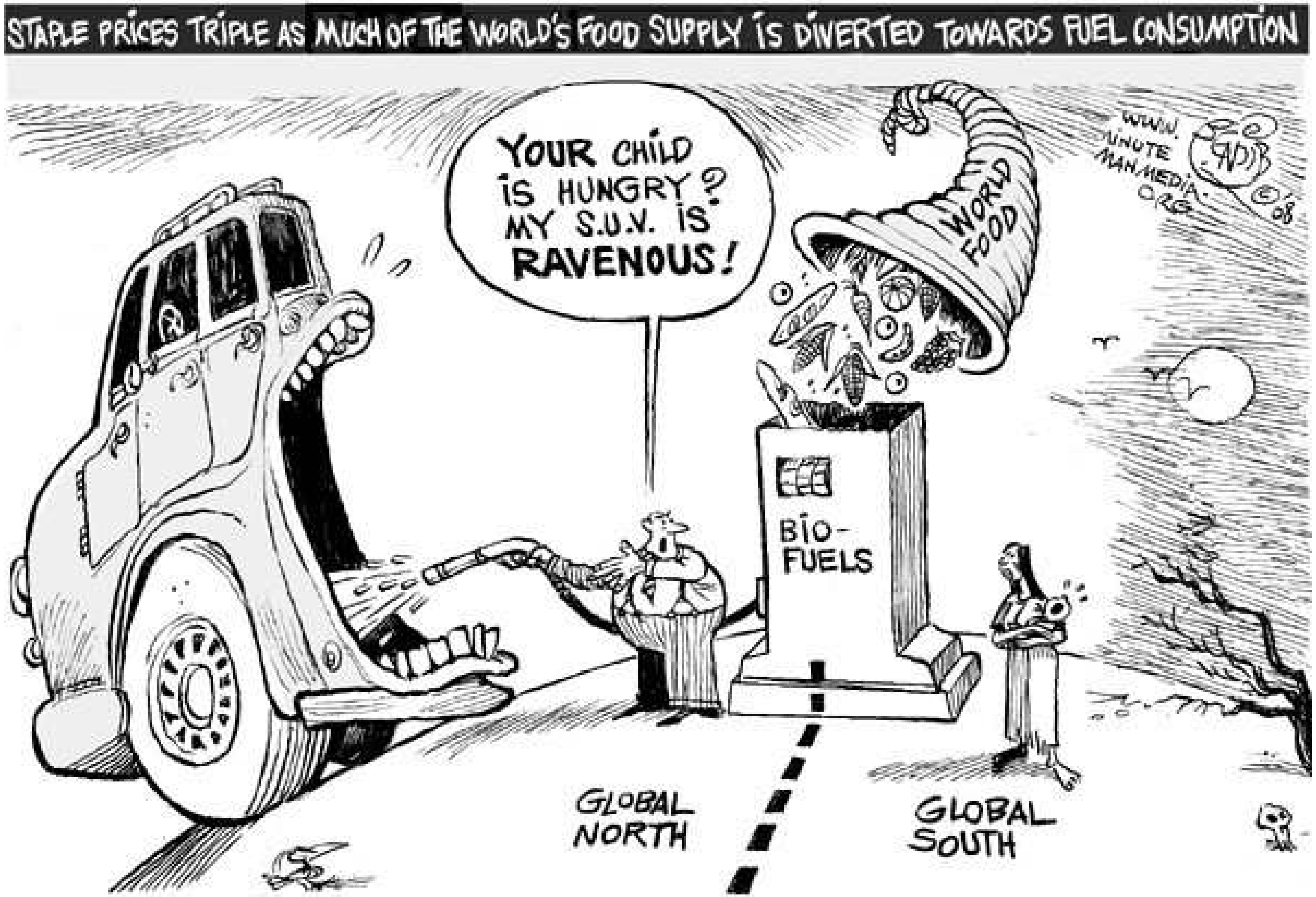
Increasing productivity and conserving biodiversity – a difficult balancing act

Food and Energy Security – must not oppose each other



For a full assessment of the implementation of AD on a farm we need to examine all three aspects:

- Economics
- Environmental impact
- Energy balance

3 concepts for analysis

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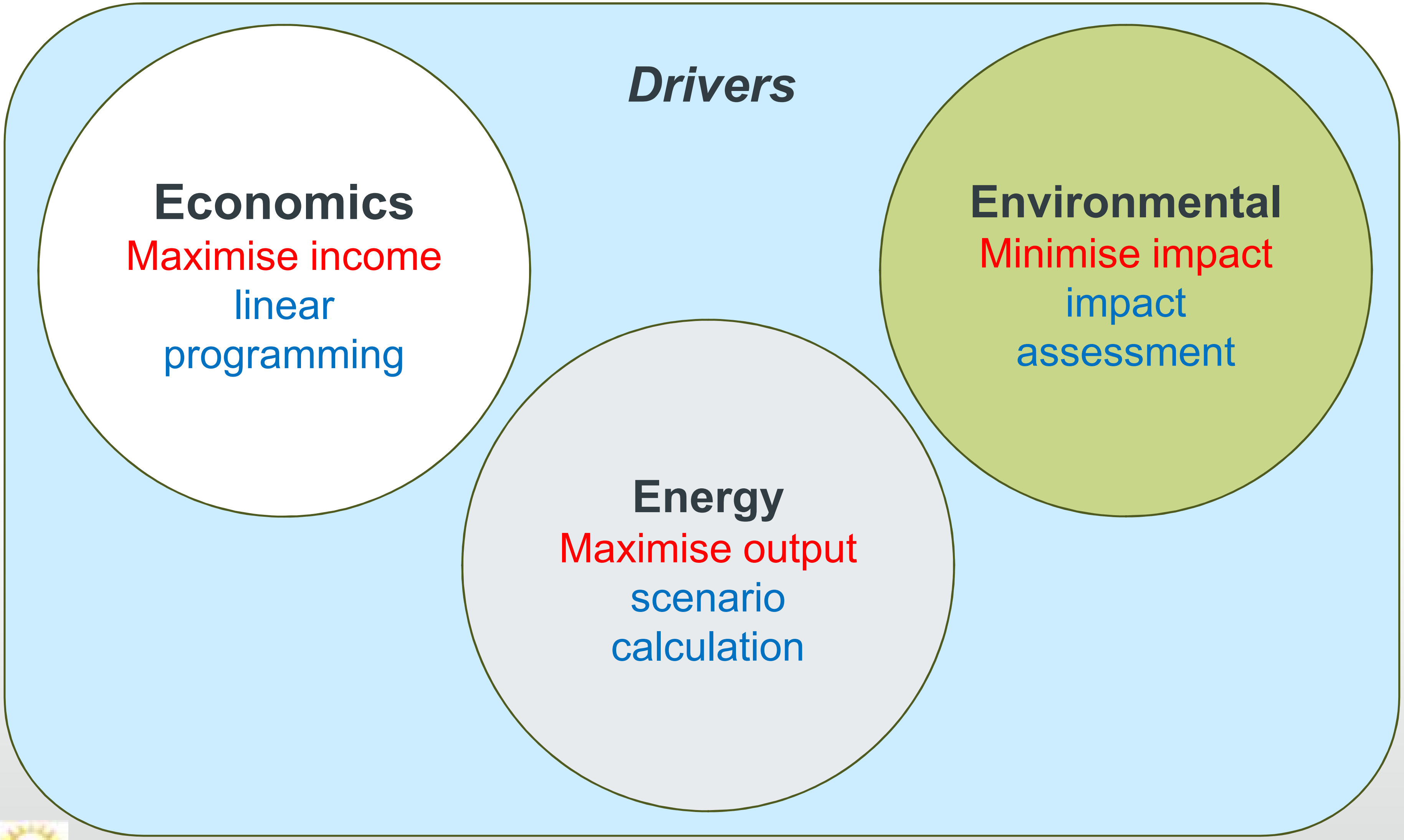

Circular model

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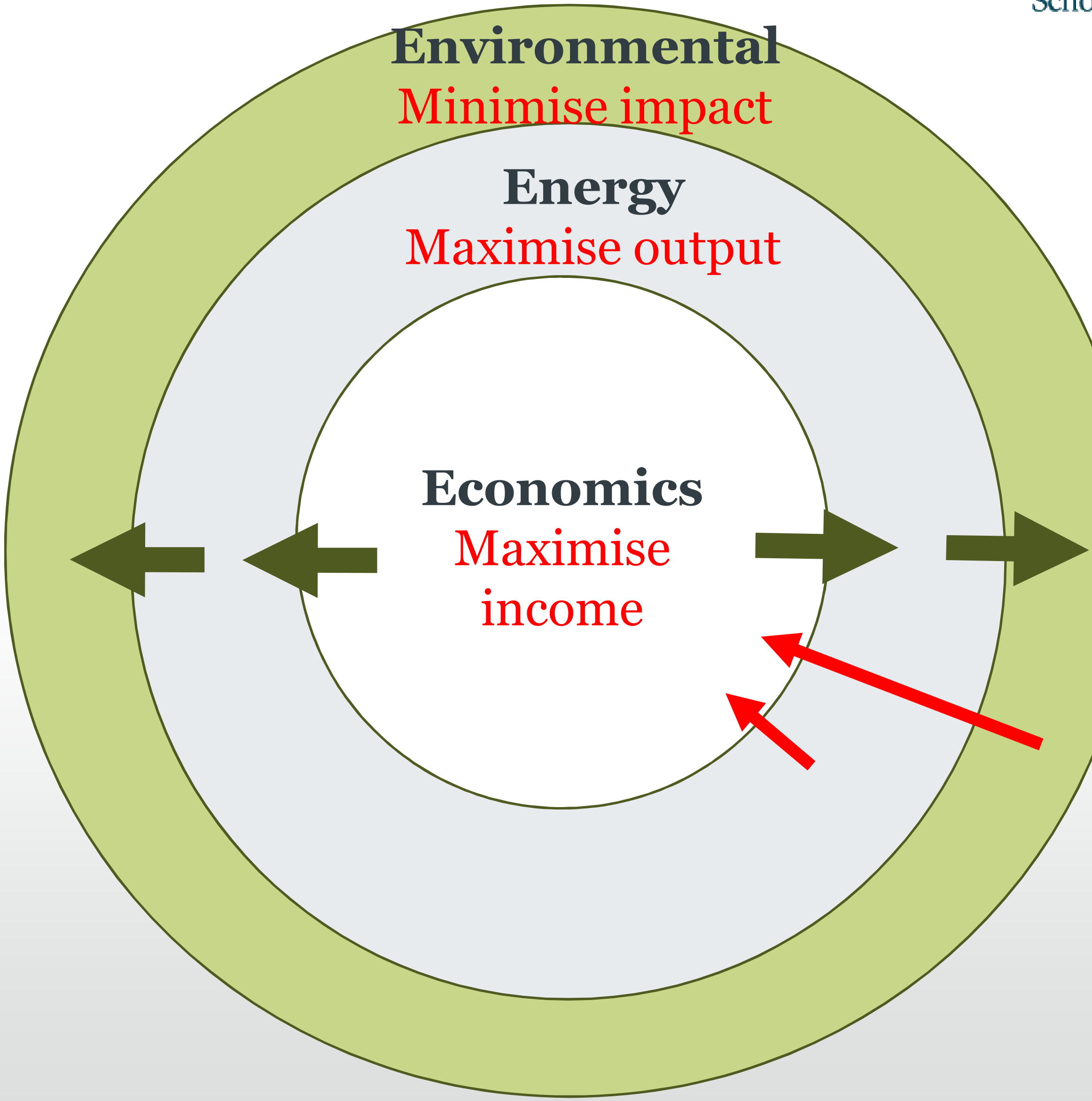
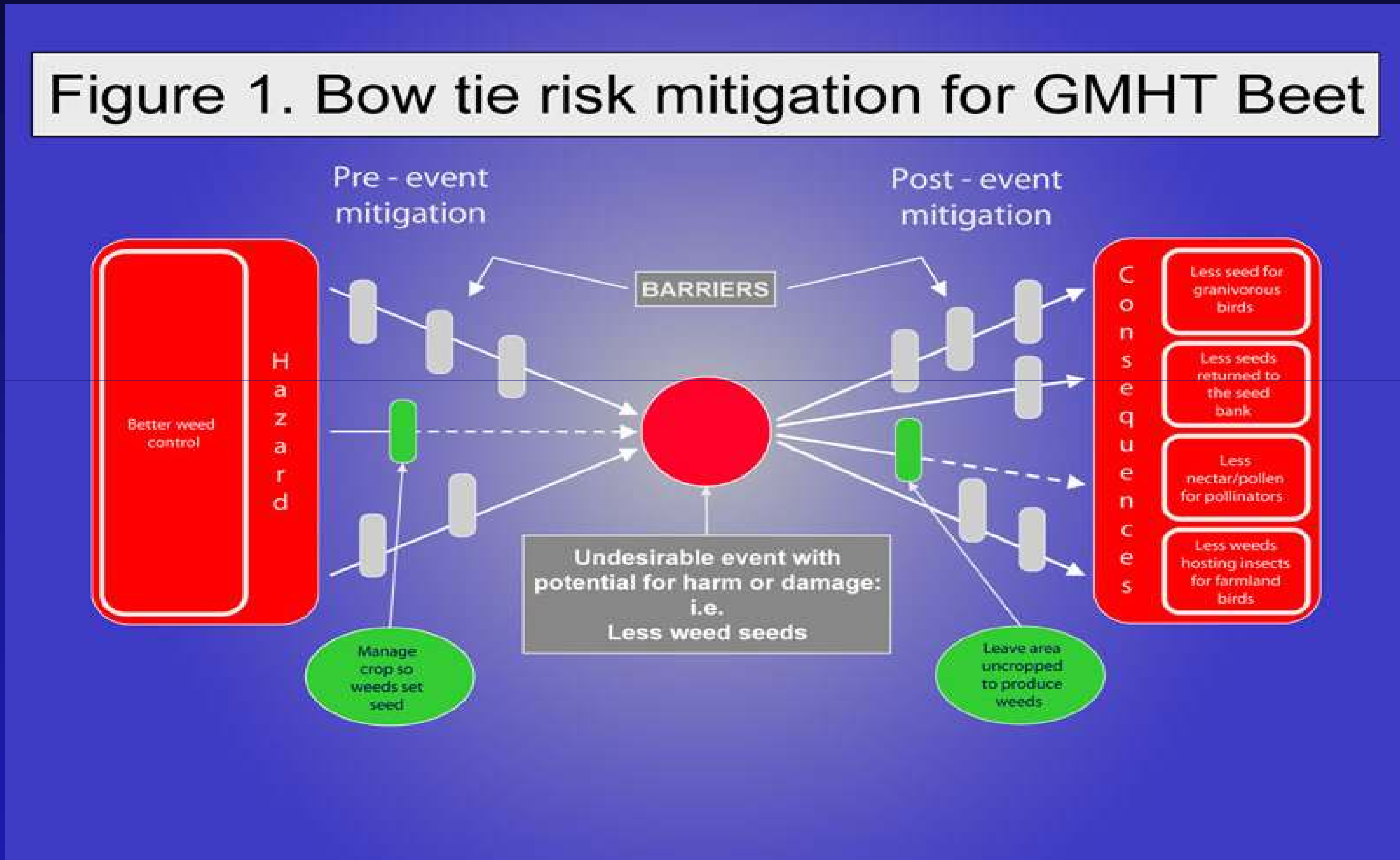


Pidgeon JD, May MJ, Perry JN, **Poppy GM** 2007. Mitigation of indirect environmental effects of GM crops. Proceedings of the Royal Society B-Biological Sciences 274: 1475-1479.



Once we know the risk we can manage it – don't have to stop the technology

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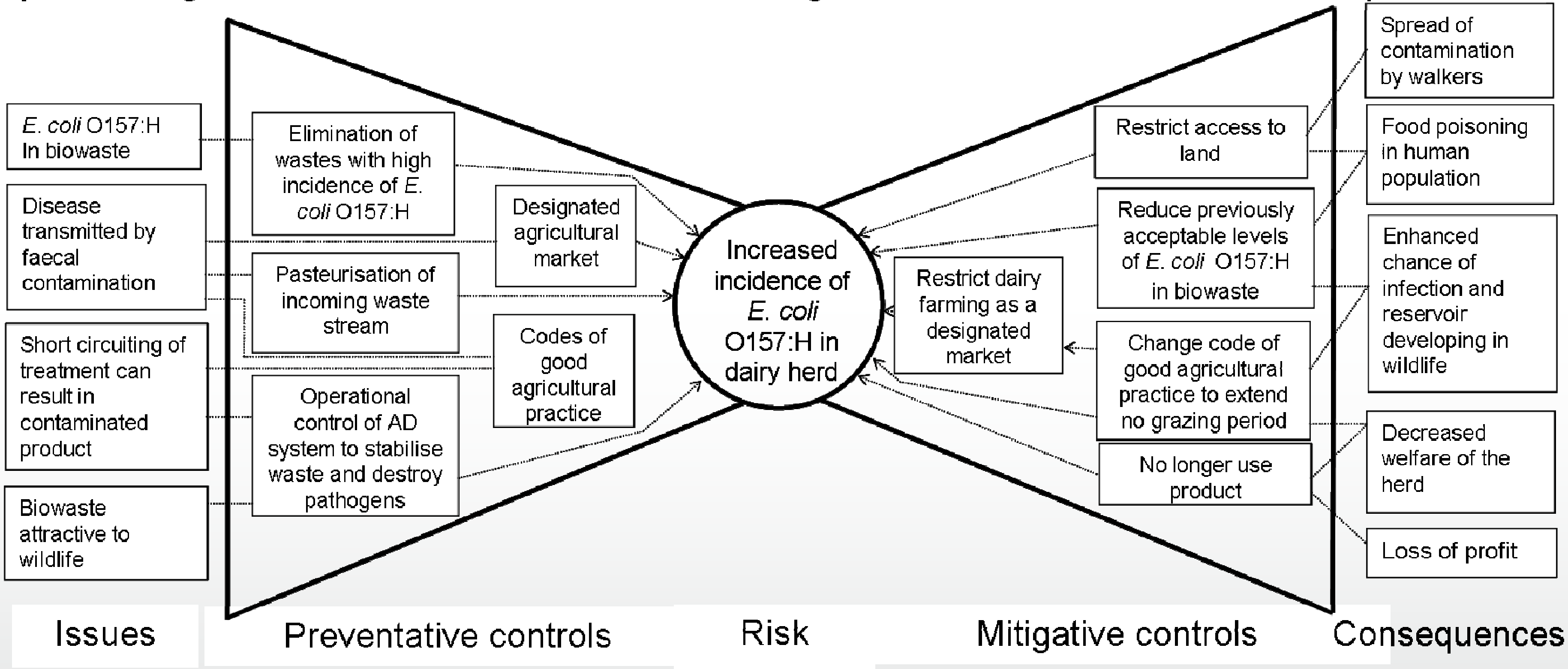
Key issue identification - Prevalence of *E. coli* O157:H in dairy cows increasing presenting increase risk of transmission through the food chain to human receptors



- **Figure 3. Simplified example showing some key features of a bow-tie analysis**

Banks and Poppy Phil Trans Royal Society in press

Focus: Consequences of Ecosystem Change for Human Well-being

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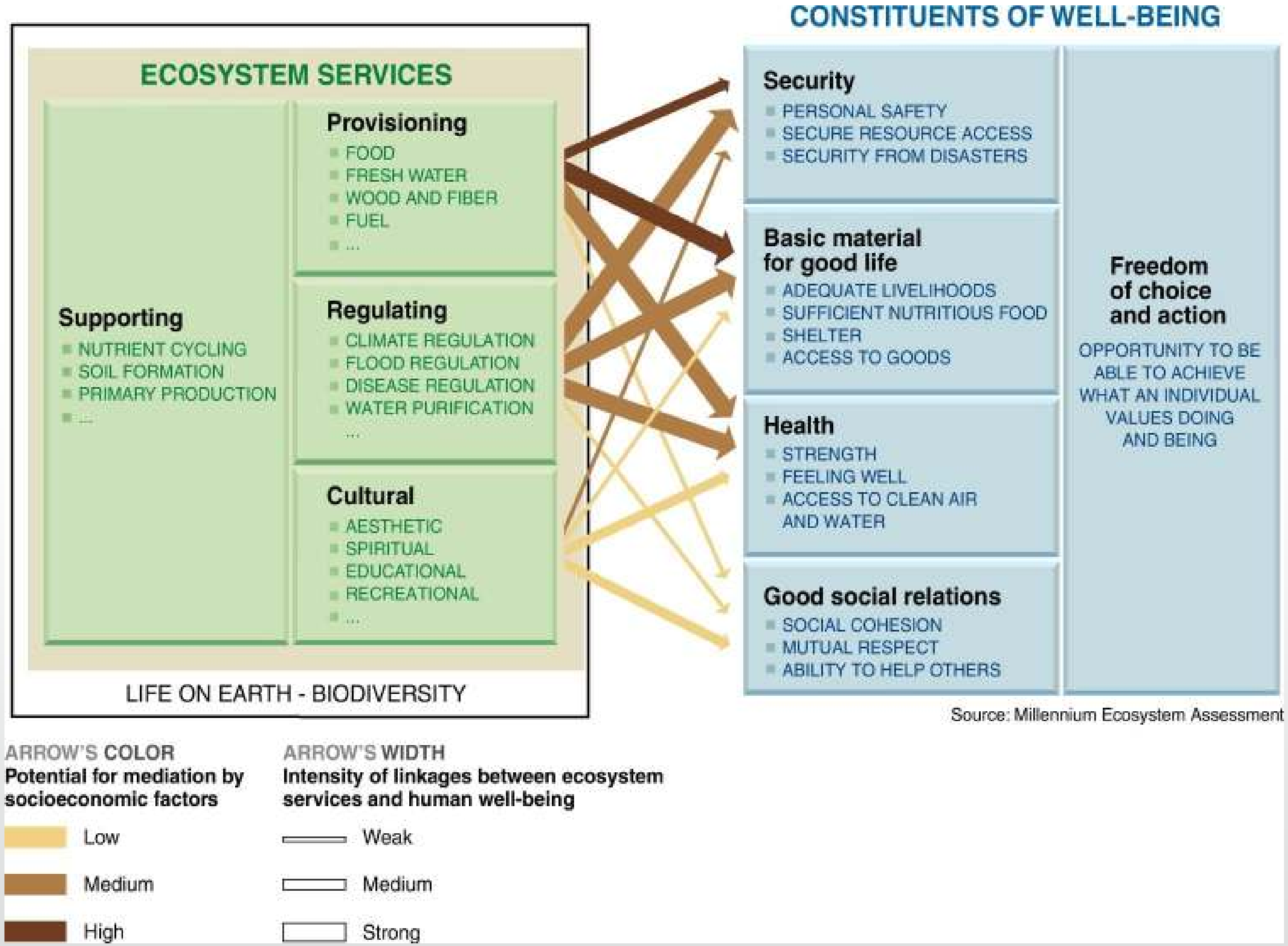

Source: Millennium Ecosystem Assessment

Assessing indirect effects of AD

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Effects of AD on biodiversity - the example maize

- The percentage on maize in a rotation
- Individual field sizes
- Catch crops
- Hedges and field boundaries
- Habitat connecting corridors
- Reduced pesticide application
- Harvest times in relation to breeding requirements

Great impact

No impact

Evaluation of a specific farming situation
3
5
1
3
3
2
1

Ecosystem Services: Linking Energy, Economics and Biodiversity

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RISK SCORED ON			Yield	GHG Emissions	Run-off & leaching	Potential impact on invertebrates & weeds			Cost
			Provisioning	Regulating			Supporting		Economic
Management Practice			Food /Fuel	Climate	Water	Pollination	Soil Formation	Nutrient Cycling	£ /ha
Cultivation									
Tillage	Inversion ploughing (15cm)		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Minimal tillage / Direct Drilling		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Harrowing (5cm)		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Discing (dragged through)		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Culitvation Score								
Crop Production									
Nutrient input	Mineral fertilizer		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Slurry / organic		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Digestate		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Production Score								
Crop Protection									
Weed control	Mechanical		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Herbicides		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
Pest control	Pesticides		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Biological		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Natural products		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Protection Score								
Pre/Post Cropping									
	Stubble retained		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Stubble removed		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Incorporation		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Spring sowing		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Winter sowing		+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	+3/-3	££
	Pre/Post Cropping Score								
	OVERALL RISK SCORE								

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Funded under the RELU project:
Integrated systems for farm diversification into energy production by anaerobic digestion: implications for rural development, land use & the environment

More information can be found at:
http://www.AD4RD.soton.ac.uk

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