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GREEN REFINED SOLUTIONS

Enhancing efficiency and sustainability of the food system

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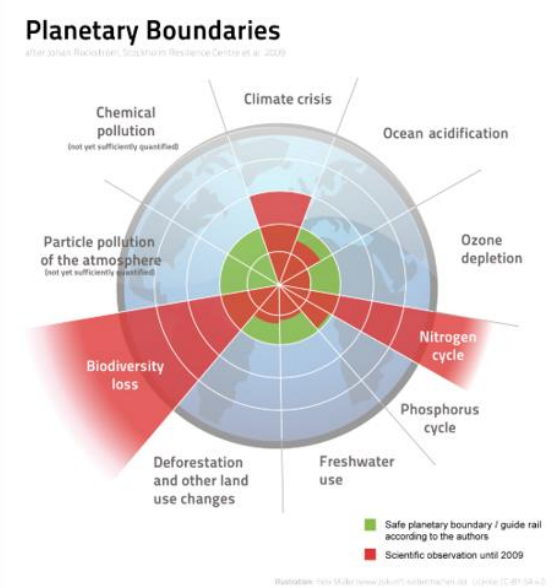
Too much Nitrogen and too little land..

2/3 of all agricultural land in the world is used for animal feed;

In 2050 we have to feed 10 billion people with at least 50 gr protein per day. With the current system, for each 1kg N on our plate we need 7kg N input through fertilizers. We need 3x more Nitrogen fertilizer than our world can cope with.

Protein supply will become scarce in the world. We need radical changes:

- Input of nitrogen in Agriculture should be reduced
- Higher production of protein/ha
- Protein and nitrogen efficiency needs to be increased
- Transport of raw materials and end products should be reduced
- Farmers income/ha should be increased



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Possible solutions

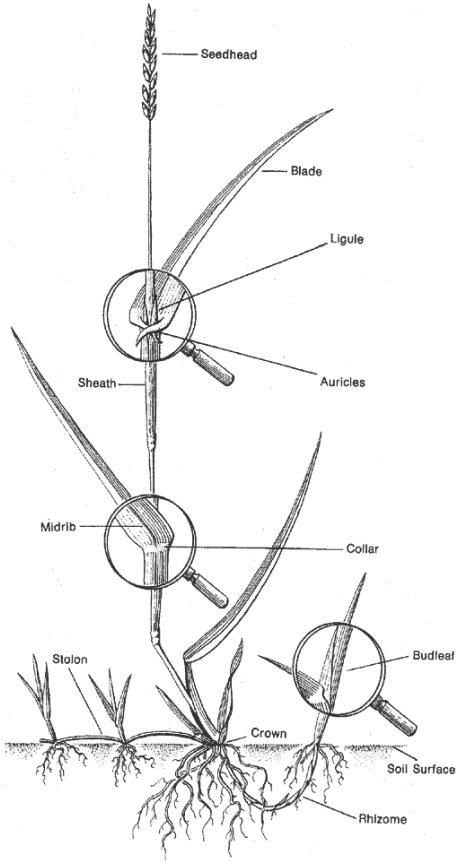
- Shifting towards a more plant-based protein in our food
- Growing animal **feed** crops on land which is unsuitable for growing **Food** crops
- Enhancing fertilization efficiency of crops by using legumes
- Recycle ammonia from manure digestates
- Using biorefinery to:
  - Enable a redistribution of proteins to the best suitable usage
  - Improve digestibility and feed conversion

A perfect crop to use is: READILY AVAILABLE

AND

RIGHT UNDER OUR FEET

GRASS
Lolium multiflorum/perenne



- Most common and easiest growing plant globally and in Ireland
- Unrivalled yield /ha and Protein/Lysine/Methionine content compared to other protein crops

Crop	Yield (ton DM/ha)	Protein (kg/ha)	Lysine (kg/ha)	Methionine (kg/ha)
grass-clover mixture	13	2600	200	90
alfalfa	12	2600	200	90
peas	6	1300	92	13
field bean	6	1500	92	11
soy bean (US)	3	1050	65	14

- Perennial, full year around cover of the soil, C02 binding, no erosion, limited costs
- For arable farmers a perfect rotation crop

Opening the full potential of Grass

Extruder Opened Grass

With **increased protein resistancy**, it is perfectly suitable as roughage for ruminants or horses

Protein Concentrate

55% of dry matter is protein with **a higher essential amino acid composition** than soy protein offers an appropriate alternative for environmentally and socially harmful soy meal in chicken, pigs and fish feeds.

Sugar / FOS

A **prebiotic** that improves digestion, stimulates the immune system, as well as lowering the need for antibiotics.

Mineral C

A plant based, soluble, organic alternative for chemical or animal-derived fertilizers.

LCA: Biorefining of grass vs soymeal

- Less land use: **33%**
- Less ammonia and phosphate emission: **30% and 50%**
- Less GHG emissions **75%**

- No longer imports are required of 20 M ton soy protein in EU and no import of minerals
- Biorefining 25 Mha EU grassland (35%) compensates for all soy import
- Non-GMO
- Increases rural employability with 100 000fte per 1M ha of grassland
- Production on marginal land can substitute good agricultural land for protein production and no deforestation.
- Ireland can become a net exporter of protein products and prebiotics

Outlook: increase of NUE by grass biorefinery combined with mixed species swards and NH_3 stripping by Byosis technology

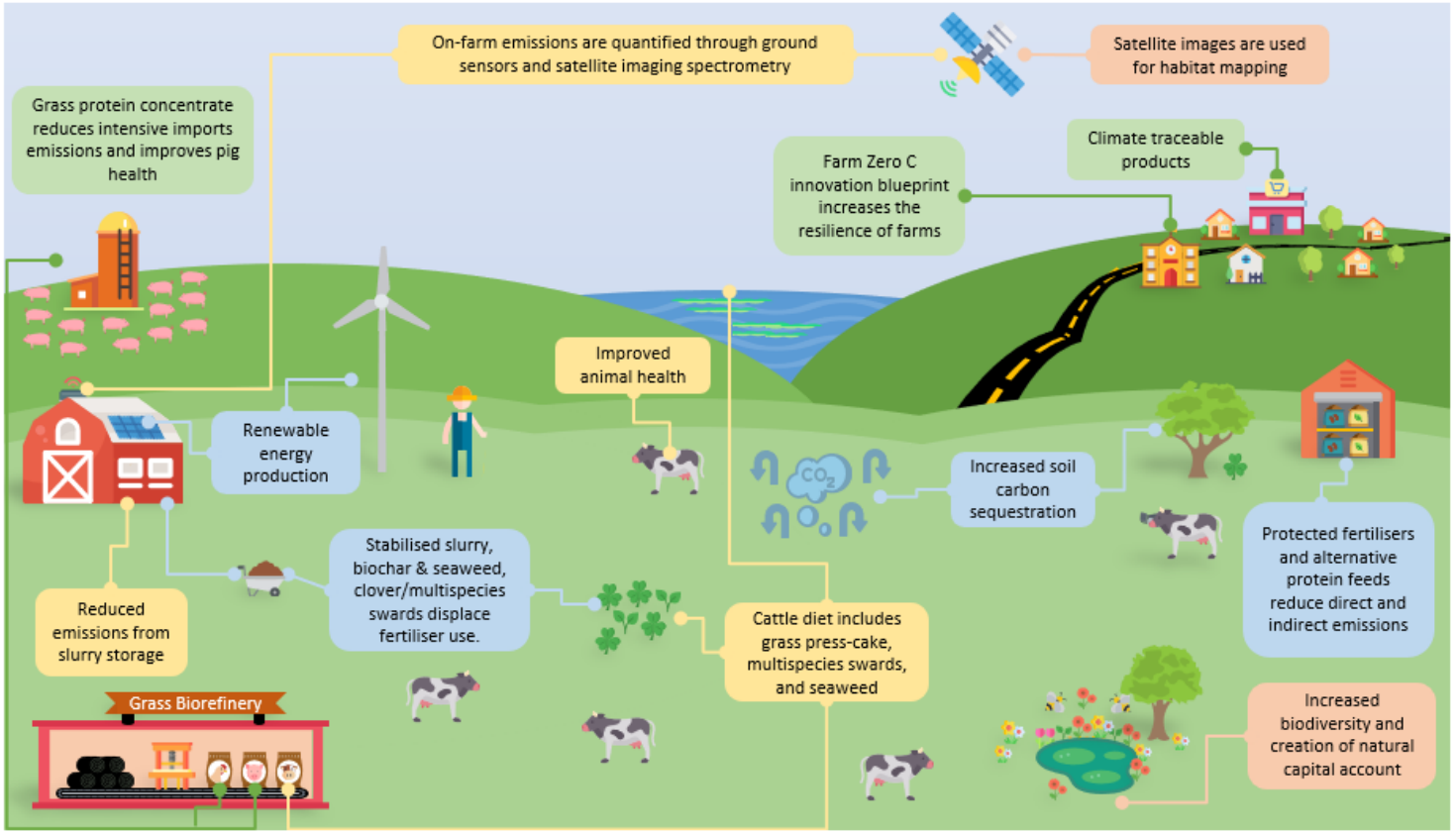
- Legumes in swards containing 6-9 different plant species do **require little N fertilizers** because these plants can fixate N from the air at even higher protein yields per ha

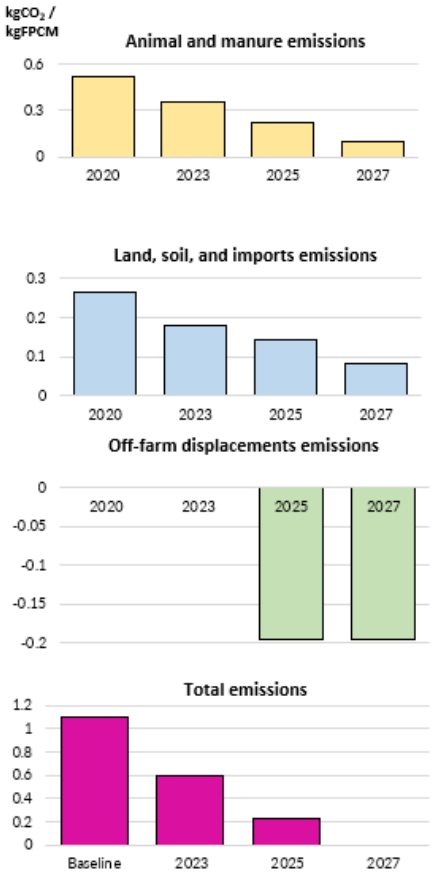
- Biorefining of these leaves **increases the protein efficiency** for cows so that some 40% of the protein can be fed to pigs at **equal milk yields** per hectare

- >50% of the nitrogen in the cow and pig manure can be recovered by **stripping of ammonia**; the other 50% goes back to the swards. **Instead of buying N fertilizer, the farmer can sell N fertilizer to crop farms and protein to pig farms and produce the same amount of milk**

Nitrogen Use Efficiency	Traditional grazing	Traditional grazing Including pig feed	Grass biorefinery	Biorefinery and Mixed species swards
No stripping	0,16	0,18	0,29	0,39
NH_3 stripping		0,23	0,33	0,45

Farm Zero C project: Our holistic approach





Conclusions

- Biorefining of grass will increase animal protein production per ha by 50%;
- Biorefinery of leaves can substitute all soy imported in the EU and can make Ireland a net protein exporter
- Biorefinery will lead to increased rural employability and increased agricultural incomes

- **Thank you for your attention**

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