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PRODUCTION OF ADVANCED BIOFUELS WITH BIOGASDONERIGHT®

A SUSTAINABLE APPROACH TO PRODUCE BIOMASS, FOOD AND FEED WITH HIGH SOIL USE EFFICIENCY AND LOW ENVIRONMENTAL IMPACT

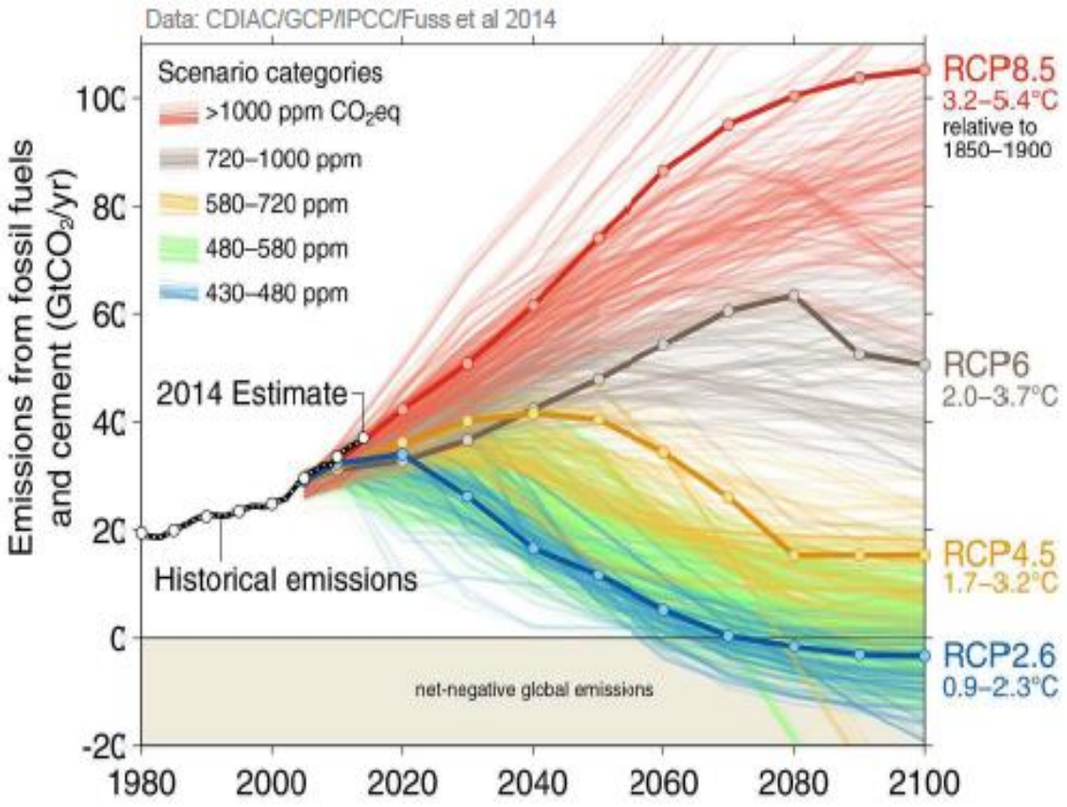
IEA Bioenergy Task 43 & FAO Workshop
Rome 11-12th October 2018

Global Warming and Emission Scenarios

GLOBAL CARBON PROJECT

Observed Emissions and Emissions Scenarios

Emissions are on track for 3.2–5.4°C "likely" increase in temperature above pre-industrial
Large and sustained mitigation is required to keep below 2°C



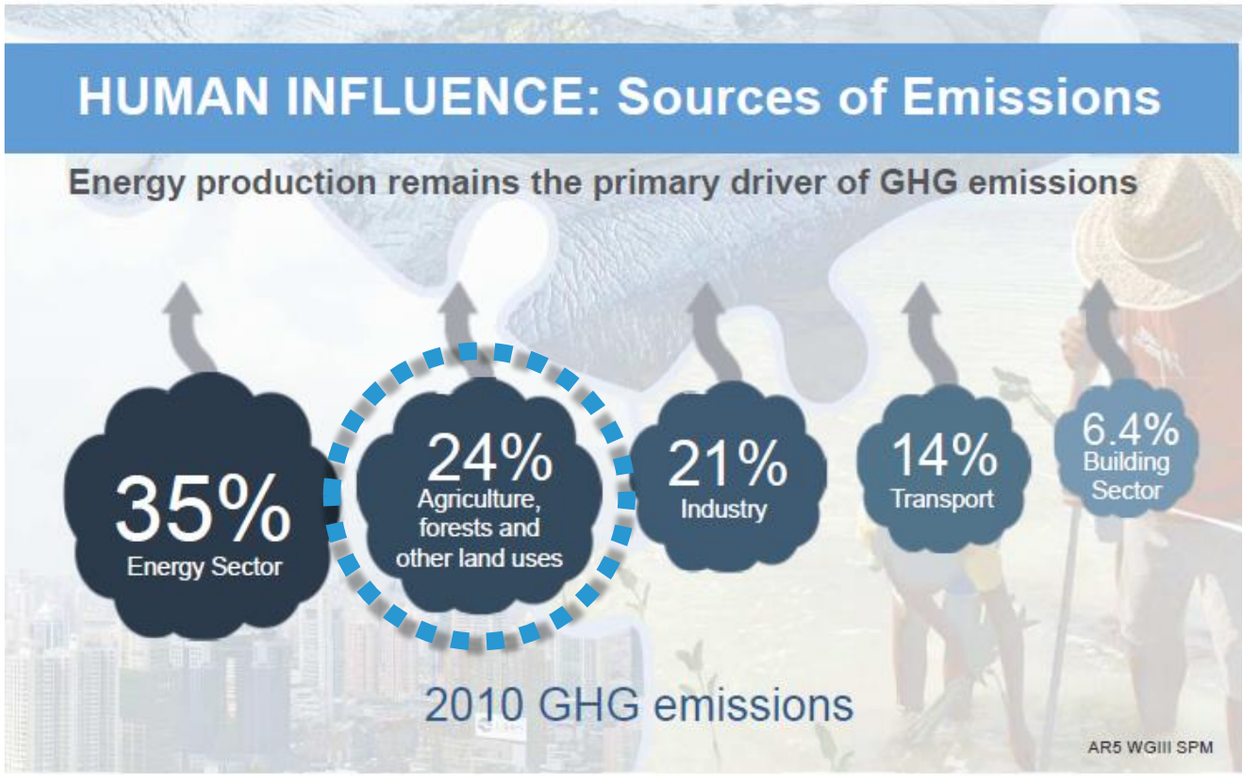
Over 1000 scenarios from the IPCC Fifth Assessment Report are shown
Source: Fuss et al 2014; CDIAC; Global Carbon Budget 2014

- Global emission rate from human activity continue to growth fast.
- Is needed a drastic change to avoid 2°C increase.
- The IPCC special report on Global Warming (2018) analyse some pathways to limit the global warming at 1,5°C to 2050.
- Reducing emissions from fossil fuel use and improve energy use efficiency is not enough.
- **Bioenergies can be a solution to reduce fossil fuel emissions** but they will be produced in sustainable way without land use change.

Agriculture and Sustainability

Needs and Potential environmental role

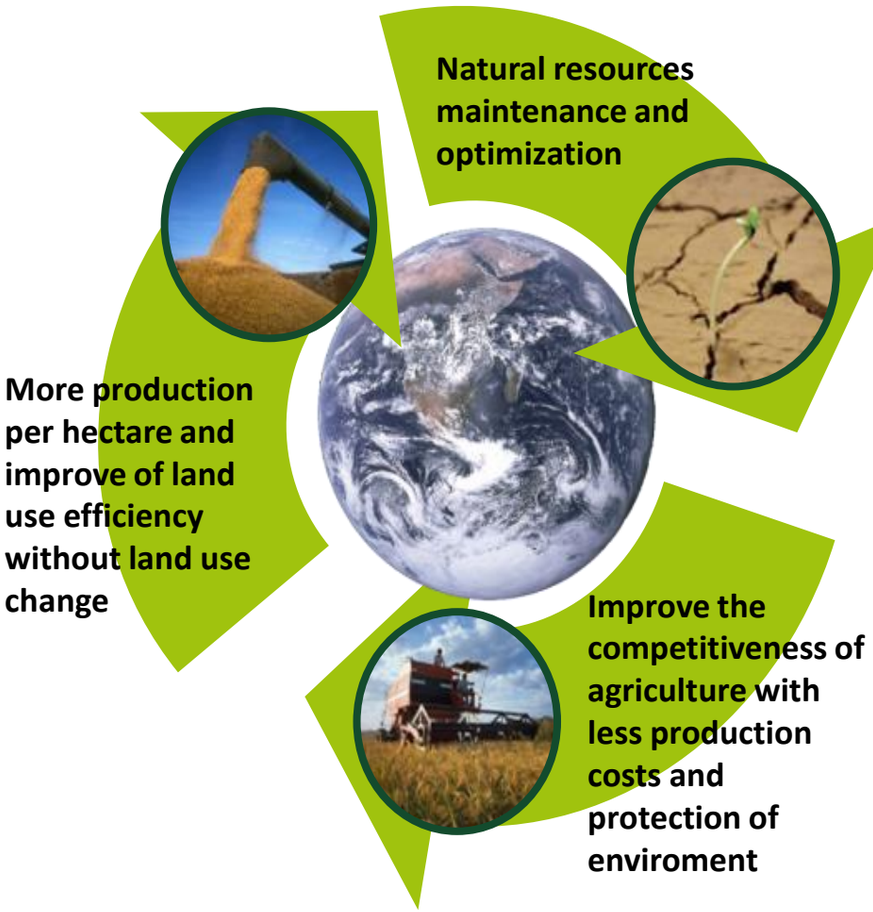
Today agriculture is responsible for 10-14% of the GHGs emission globally



IPCC AR5 Synthesis Report

ipcc INTERGOVERNMENTAL PANEL ON climate change WMO UNEP

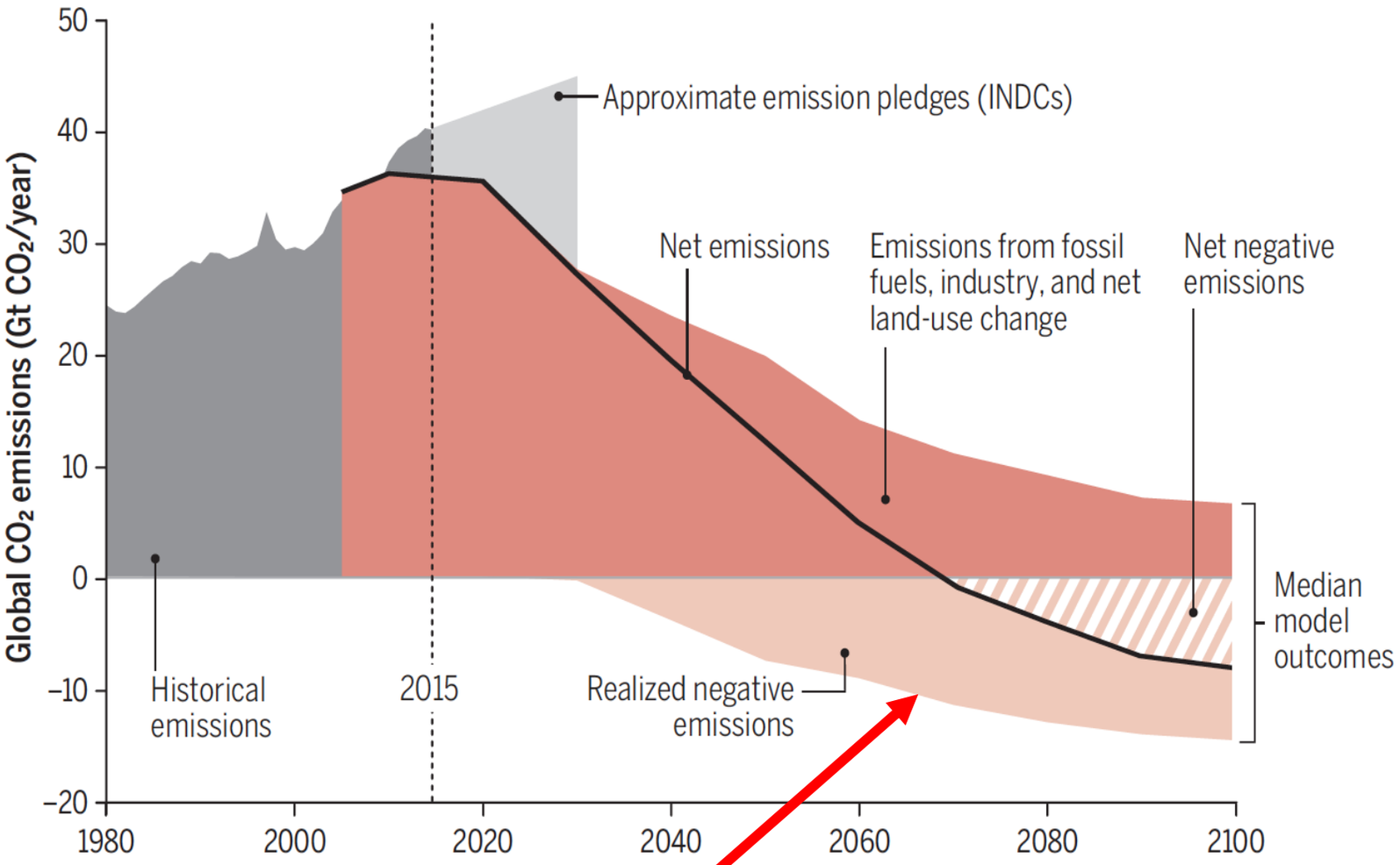
What we need for sustainable agriculture



AGRICULTURE CAN BECOME PART OF THE SOLUTION RATHER THAN BEING PART OF THE PROBLEM

Bioenergy and Environment

The role of BECCS to reduce Greenhouse gases



CARBON NEGATIVE SCENARIOS
ALL DEPEND ON BIOENERGY

Anderson and Peters. 2016

IPCC 1,5 ℃, 2018 Report

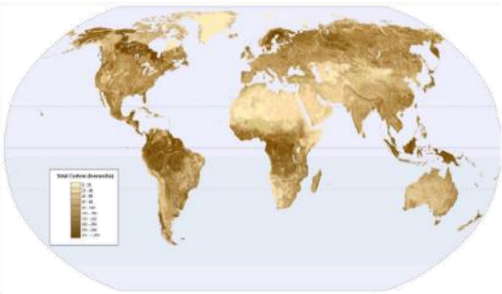
IPCC "Mitigation report"
April 2014 The BECCS

In order to prevent abrupt climate change scenarios the mere production of carbon neutral electrons will not be sufficient, and that technologies able to sequestrate CO_2 directly from the atmosphere as will be needed as afforestation and **Bioenergy and carbon capture and sequestration** (BECCS)

Agriculture, Bioenergy and Environment

Soil and Greenhouse gases

- Almost 30% of emitted carbon in last 2 centuries came from soils by the lost of organic matter.



- **Close to half of the agricultural world soils** are estimated to be degraded with significant production losses (FAO, 2006).

- **89% of mitigation potential** in the agriculture sector concerns soil carbon sequestration (IPCC, 2013).

- Soil is the **2nd ecosystem for its carbon content** after oceans and carbon in soil is useful (**2-3 times more carbon** in soil organic matter than atmospheric CO_2)

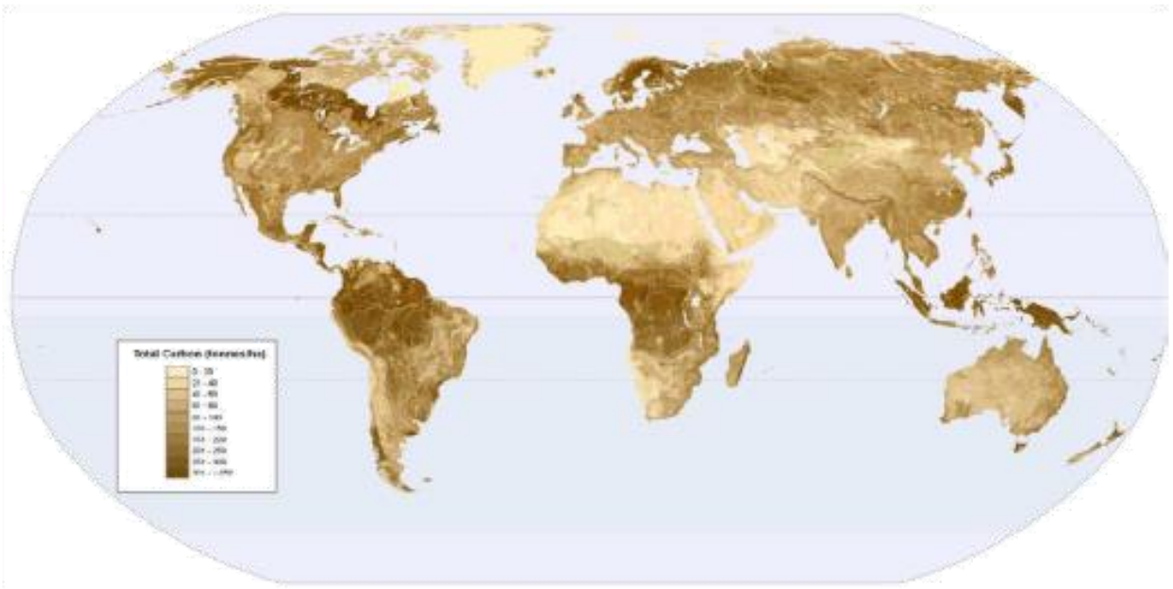
- The adoption of best agronomic practices allows a significant carbon sequestration rate (4pour1000 program).

- **1,2 billion metric tons carbon** could be stored annual in arable land and grassland soils, equivalent a storage rate of 4 per thousand in top soils (IPCC, 2013; Smith et al., 2008)

- **20-40 million metric tons additional grains** could be produced in developing countries by additional storing 1t of C in soil organic matter (Lal, 2006)

Agriculture, Bioenergy and Environment

Soil and Greenhouse gases



CARBON SEQUESTRATION IN SOIL MEANS POSITIVE IMPACTS WITH A SUSTAINABLE INCREASE OF PRODUCTION IN AGRICULTURE OF FOOD, FEED AND BIOENERGY/BIOFUELS

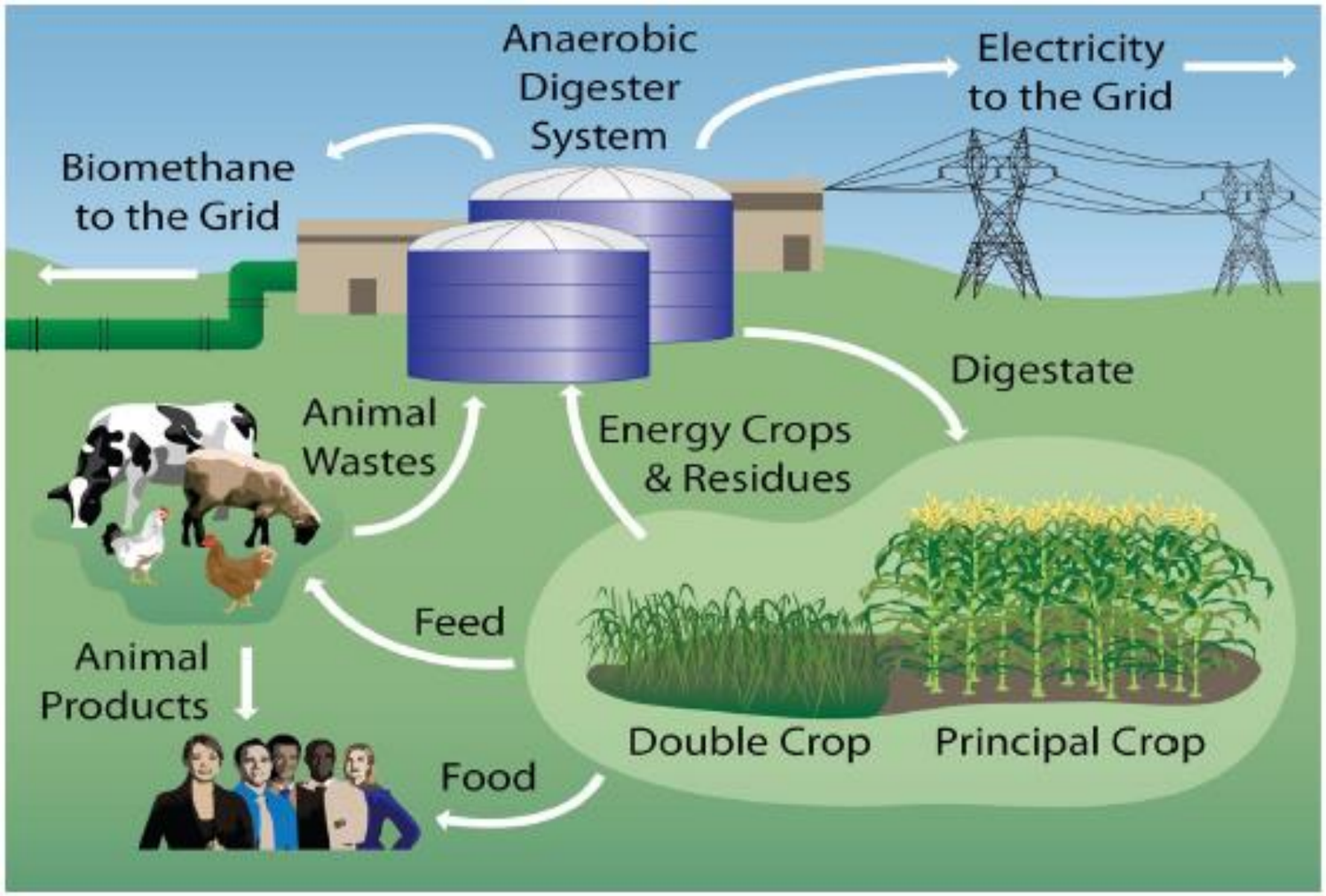
(UNEP, FAO, JRC 2010)

AGRICULTURE IS A KEY SECTOR FOR SUSTAINABLE PRODUCTION OF BIOENERGIES WHEN THE USE OF NATURAL RESOURCES IS EFFICIENT

BIOGASDONERIGHT® IS A WAY TO PROMOTE CARBON SEQUESTRATION, DECARBONISATION AND EFFICIENCY IN AGRICULTURE…BECCS?

BiogasDoneRight®

Food, Feed and Biomass with Sequencial Cropping
More than bioenergy



Source: Michigan State University

- **Sequential cropping**: *harvesting two crops instead of one on the same field in a single year*. More vegetable production, more C fixed than classic agriculture and soil covered year-long.
- **Nutrients being recycled** back to the field through **digestate.**
- Conservative agriculture systems are applied in order to **promote carbon sequestration in soil** and store part of C fixed in additional biomass produced.

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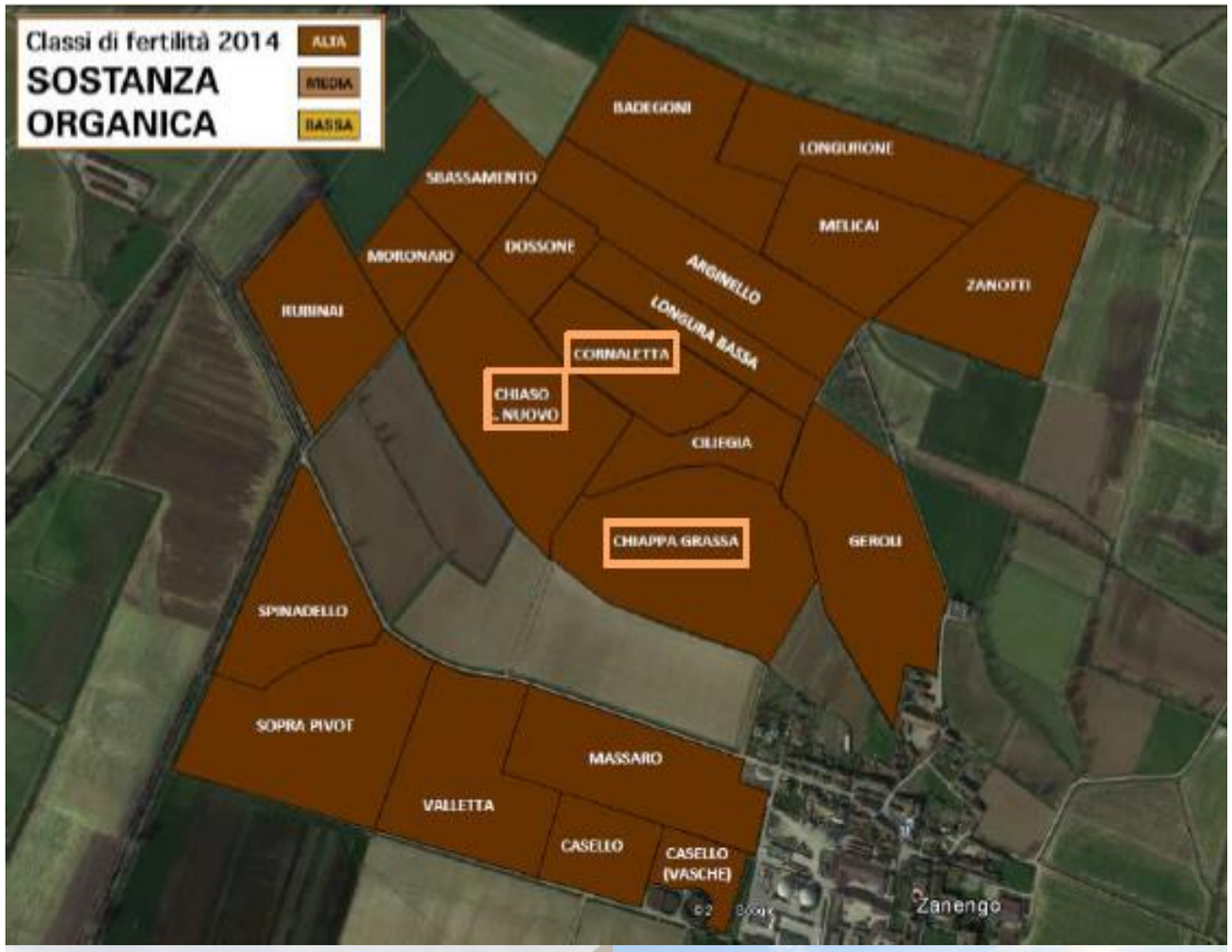
Study Case focused on Po Valley Farm



- Bottom-up approach based on hystorical and real data collected from Palazzetto farm
- Cultivated Area: 255ha
- Rotation: feed and biogas annual crops
- Dairy cows: 650 (300 milking)
- Biogas Plant: 1MWe
- 3 study fields representative of farm structure.
- Soil texture: Loam / Sandy-Loam

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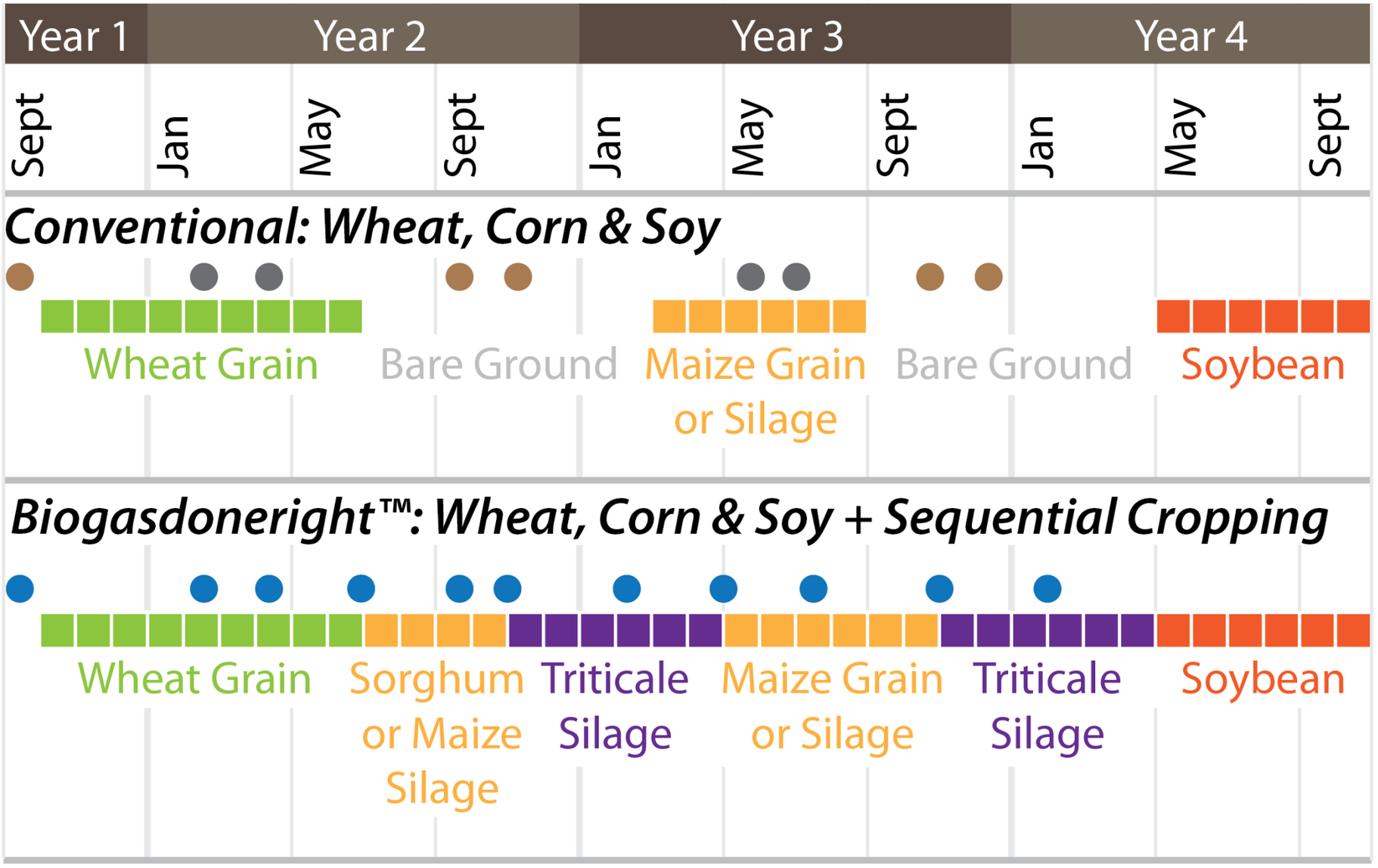
Sequential cropping Triticale/Maize



MICHIGAN STATE UNIVERSITY

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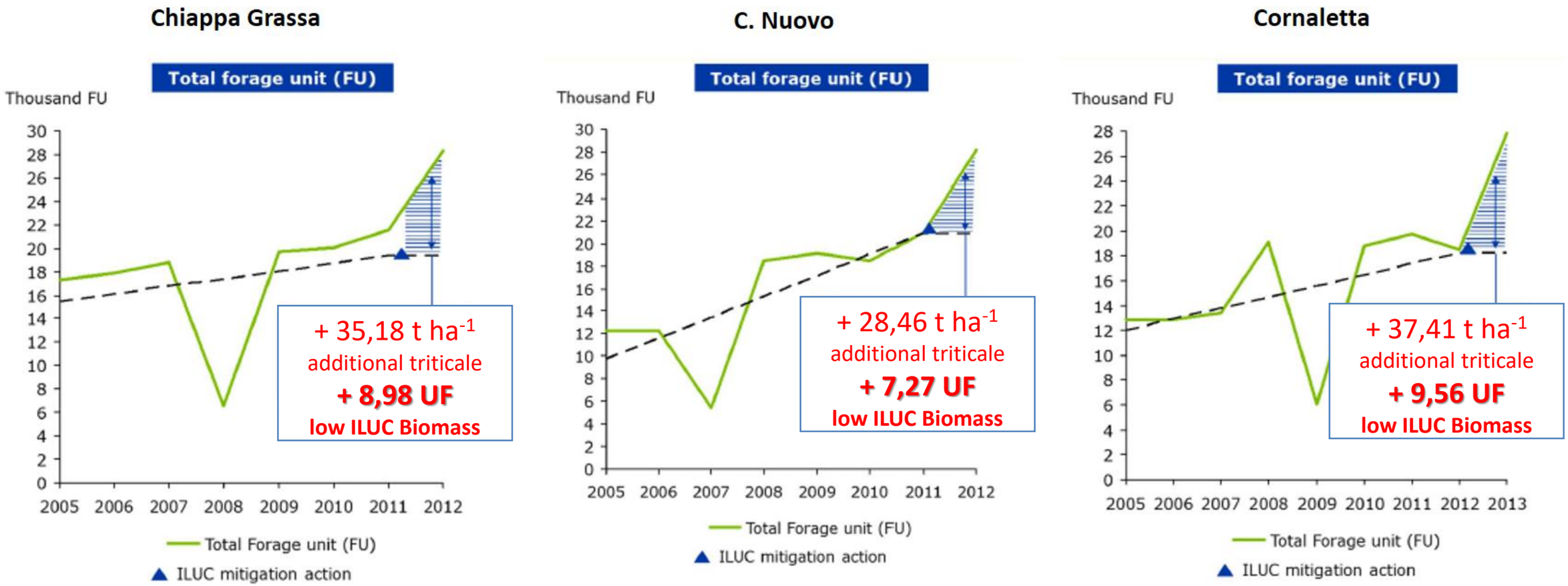
More photosynthesis, More Forage Unit and Additional low ILUC risk biomass



Source: Peters D. et al., 2016

- Comparison of historical productions of biomass from single crop with new sequential cropping system yields.
- ***"Forage Unit"*** *is a new way to calculate ILUC risk of biomasses recognized by UE from ECOFYS study*
- *Applying* ***"Forage Unit"*** *to compare different biomasses to feed biogas.* ***Large amount of additional low ILUC risk biomasses are produced with sequential cropping***

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Additional low ILUC risk biomass

CROP	BIOMASS PRODUCTION		
	T.q. (t ha^{-1})	s.s. (%)	s.s. (t ha^{-1})
Triticale	46,2	30,5	14,1
Mais 2nd harvest	53,0	33,3	17,6
Tot. Sequencial crop.	**99,2**	**32,0**	**31,7**
Mais (Conventional)	**62,0**	**35,0**	**21,7**
Δ (Seq. Crop/ Conventional)	***37,2***		***10,0***

- Average data from Palazzetto Farm confirm how sequencial cropping is more productive than Conventional Crop in term of biomass, FU and Biomethane (from 30 to 60%).
- Conventional mais is more productive than 2nd harvest mais but sequencial cropping with winter crop can give a real and convenient increase of soil use efficiency.

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High efficiency in digestate use and conservative agriculture to close the C cycle

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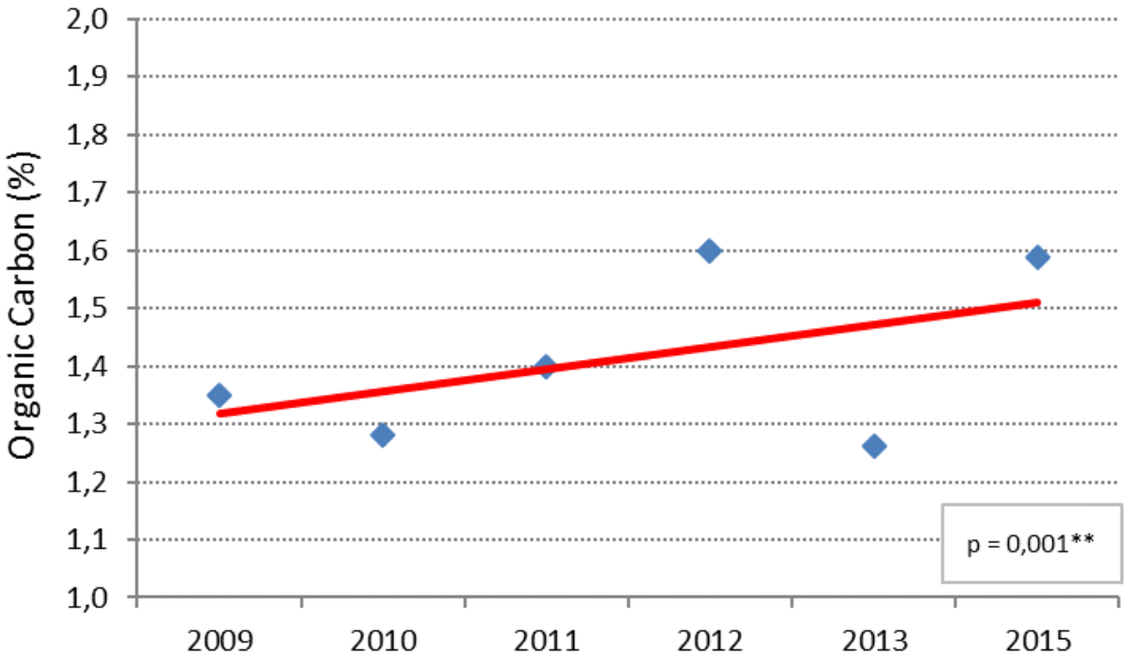
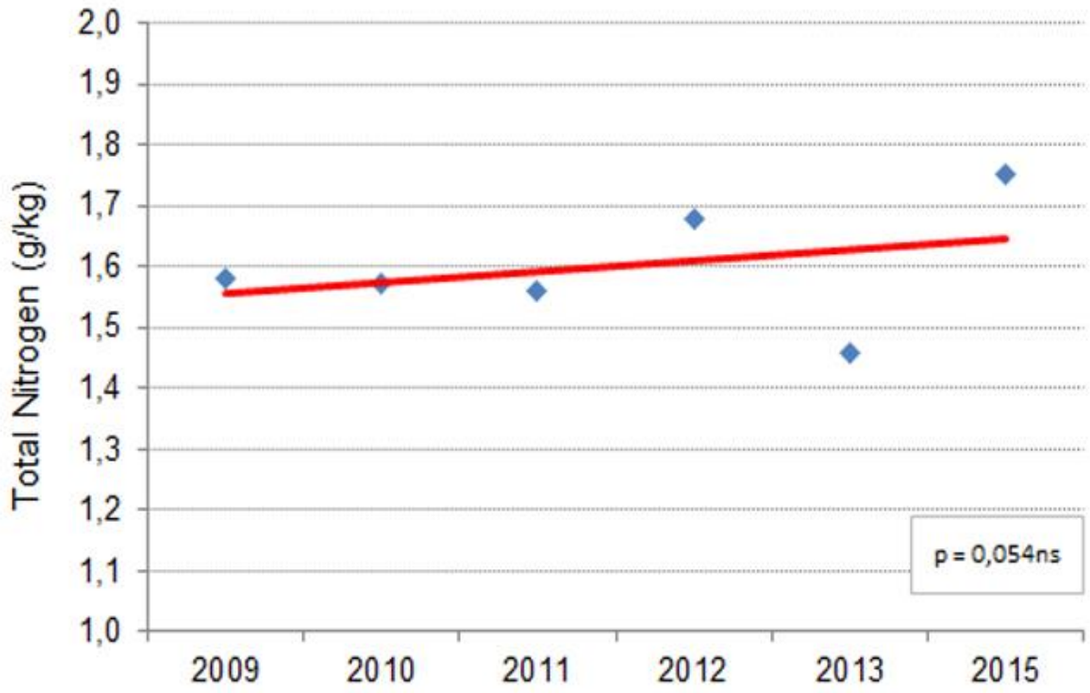
Positive impacts on soil quality





- Substantial increase in soil organic carbon (*Bezzi et. Al., 2016*)
- *estimated with mass balance approach an increase of SOC 0,5-1 t C/ha/y in first 10 years BDR – Valli and Mantovi, 2018)*

- Land is covered all-year round, which reduces soil erosion risks
- Nitrogen concentration is maintained and leaching risks are reduced
- The use of fertilizer herbicides and pesticides is significantly reduced

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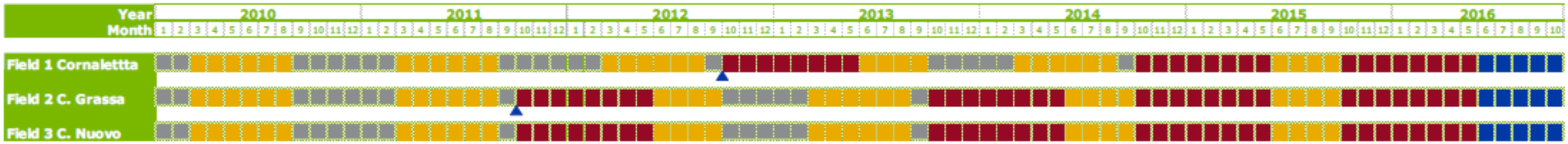
Positive impact on on-farm biodiversity and landscape

Harvesting (under sequential cropping starting 2012 and 2013, which means the first winter crop was seeded in October 2011 and 2012)

Triticale Silage	End of May
Soybean	End of October
Maize Sillage	End of September
Fallow	



Plot	2015			2016			2017		
	Winter Crop	Summer Crop	Area (ha)	Winter Crop	Summer Crop	Area (ha)	Winter Crop	Summer Crop	Area (ha)
Plot 1	-	Mais I	20	-	Mais	25	-	Mais I	10
Plot 2	Ryegrass	Mais II	30	Ryegrass	Mais II	30	Ryegrass	Mais II	30
Plot 3	Triticale	Mais II	20	Triticale	Mais II	5	-	-	0
Plot 4	-	-	0	Triticale + Legum.	Mais II	15	Triticale + Legum.	Mais II	60
Plot 5	Medica	Medica	15	Medica	Medica	15	Medica	Medica	15
Plot 6	-	-	0	-	Mais I	30	-	Mais I	30
Plot 7	-	Mais I	65	-	Mais I	20	-	Mais I	10
Plot 8	Triticale	Mais II	50	Triticale	Mais II	60	Triticale	Mais II	60
Plot 9	-	Mais I	55	Triticale	Mais II	10	Triticale	Mais II	10
Plot 10	-	-	0	-	Mais I	45	-	Mais I	30
		Total Area	***255***		***Total Area***	***255***		***Total Area***	***255***
		Sequencial Cropping Area	*115*		*Sequencial Cropping Area*	*135*		*Sequencial Cropping Area*	*175*
		% Seq. Cropping	***45,1%***		***% Seq. Cropping***	***52,9%***		***% Seq. Cropping***	***68,6%***

Destination	
	FEED
	BIOGAS

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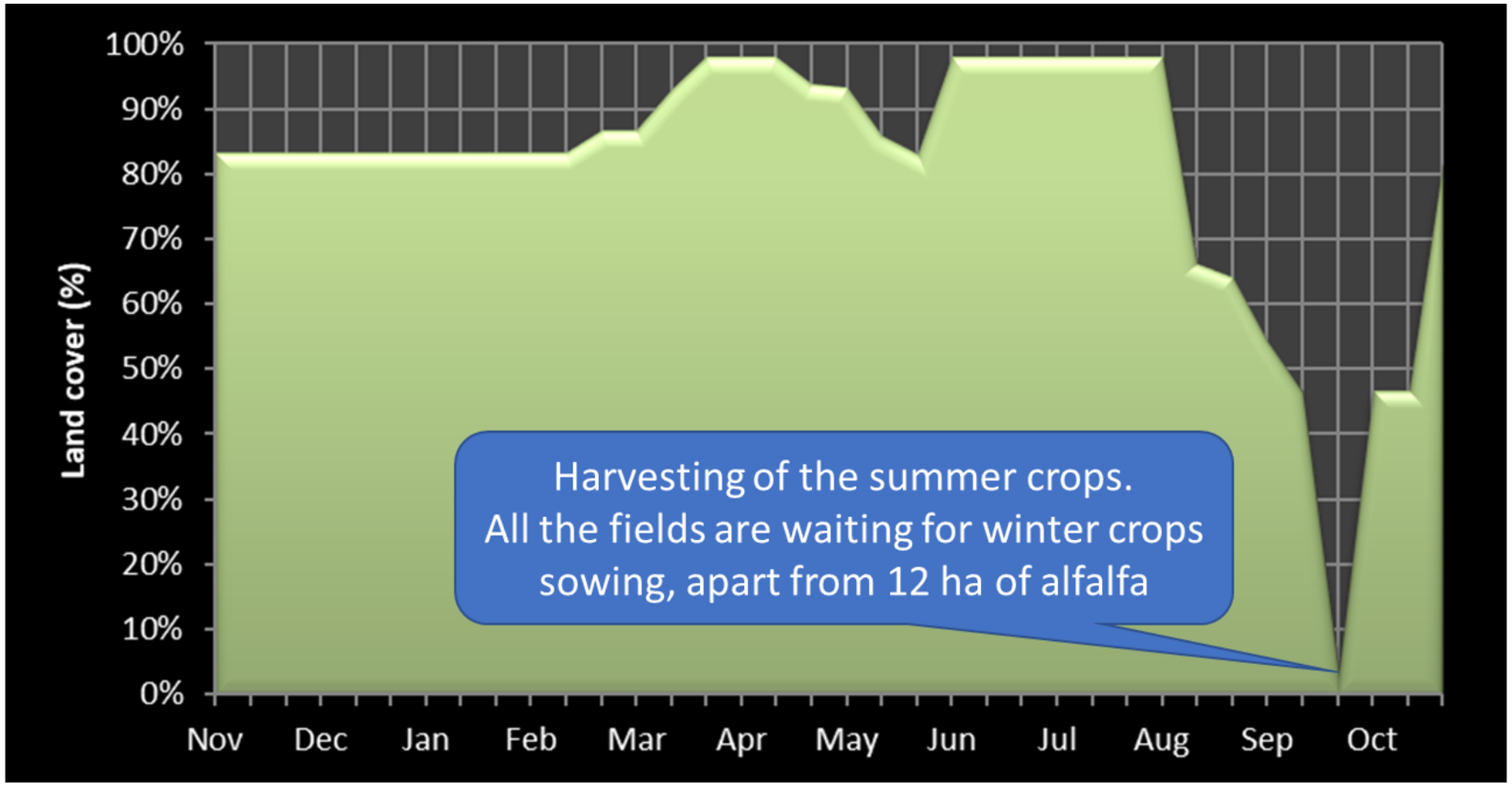
Positive impact on on-farm biodiversity and landscape



- Positive on-farm biodiversity impacts are expected after replacing monocropping with sequential cropping combined with nutrient recovery via biogas digestate
- Positive impacts of the sequential cropping in terms of crop density and higher soil use efficiency. Palazzetto farm are significantly increasing soil covered for whole year (59%) thanks to the increase of surface involved at sequential cropping.
- Positive impact on weed control efficiency and lower herbicides use.

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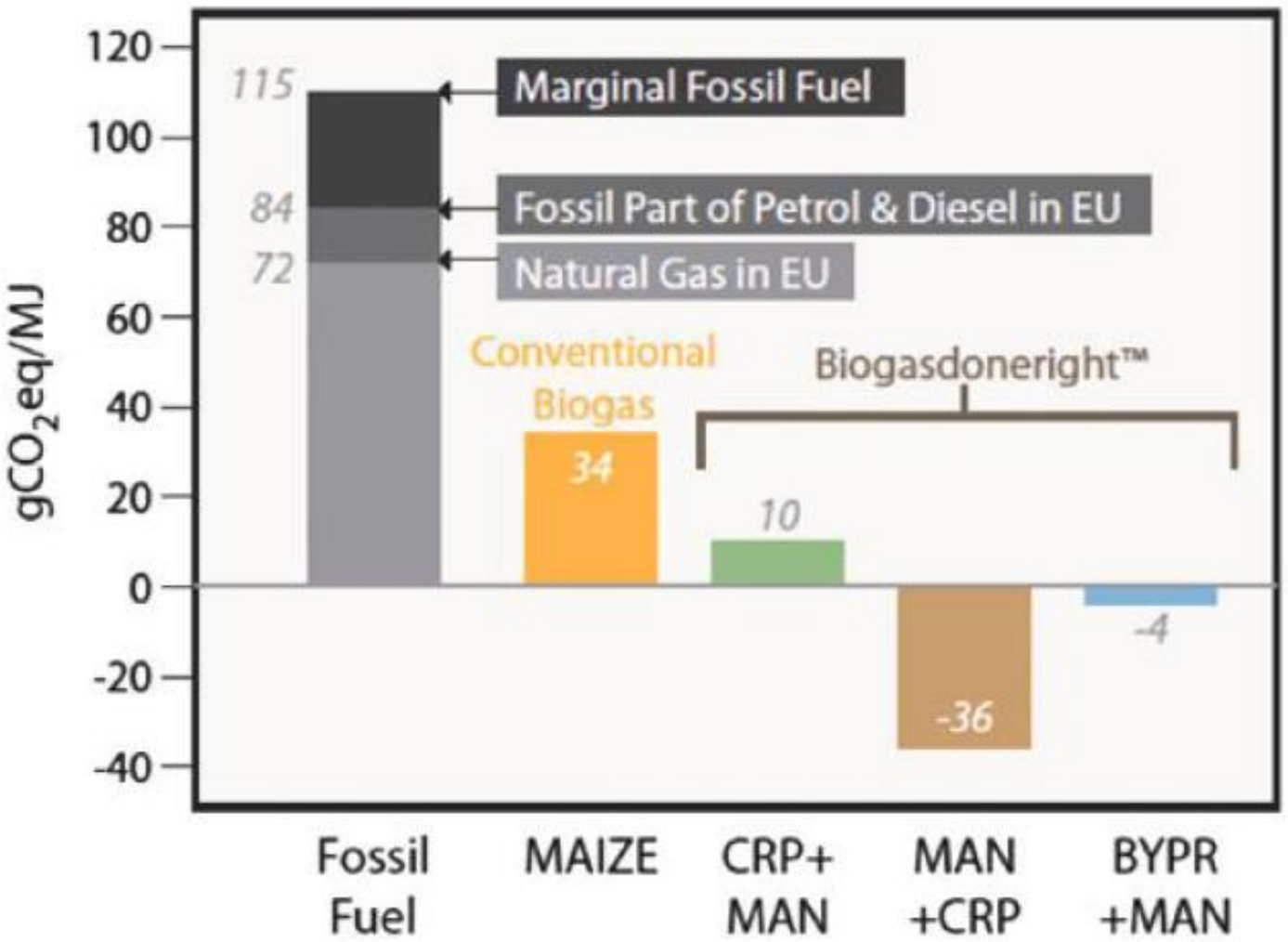
Positive impact on GHG saving of biomethane



Source: Valli et al., 2017

- Related to fossil fuel comparator, GHG emissions savings are higher after the introduction of sequential cropping (CRP) compared to Conventional Biogas.
- When biogas is produced by sequential cropping (CRP), manure (MAN) and by-products (BYPR) the system can become Carbon Negative.
- Dynamic carbon sequestration in soils have a significant effect on GHG saving.

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Scalability

- **BDR is adaptable and can be applied both in small scale for development regions and medium/large scale in developed countries.**

- **ITALIAN** BIOMETHANE ROADMAP WITH BDR

2015 – **2,4 billion m³/y** – 288.000ha (4,8% of Arable Land)

2030 – **8 billion m³/y** – 4000.000ha (6,7% of Arable Land)

- ESTIMATED POTENTIAL OF **ARGENTINA** WITH BDR

(J. Hilbert, INRA – Unpublished data)

Argentina could replace all of its natural gas imports with biogas produced using BDR.

Today gas is 54% of the total energy consumed in Argentina

- ESTIMATED POTENTIAL OF **USA** WITH BDR

(T. Richard, Penn State University – Unpublished data)

Biogas potential in the US exceeds 20% of fossil natural gas.

Double cropping can also provide water quality benefits

- ESTIMATED POTENTIAL OF **UK** and **FRANCE** WITH BDR

Work in progress....

BiogasDoneRight®

Main challenges

Food vs. fuel dilemma

- *Historically biogas is often produced from maize silage cultivated as main crop*
- *This has become increasingly problematic due to the biofuel vs food security*

- *Biogasdoneright was started by Italian dairy farmers producing traditional Italian cheeses, who were not interested in focusing on biogas only*
- *The concept was invented to **smartly combine food with energy production**, **sustainable biogas is being produced without any competition with food***

Sustainability risks

- *Overly intense farming can lead to depletion of soil nutrients*
- *This risk is recognized by Biogasdoneright farmers*

- ***Agricultural soils have become more healthy** due to the fact that the soil nutrients are captured in the biogas production and are channeled back to the soil*
- *Leaving agricultural residues on the field **increases soil organic content** which leads to more healthy soil*
- *Biogasdoneright also reduces GHG emissions of agricultural activities*

High production costs

- *The production costs of biomethane are high*

- **Reduced production costs of biomethane of about 25%** compared to monocrop biogas production costs**, from €75 per MWh th to €60**, mainly from chemical fertilizers saving, fuels savings, better land and fixed cost use)

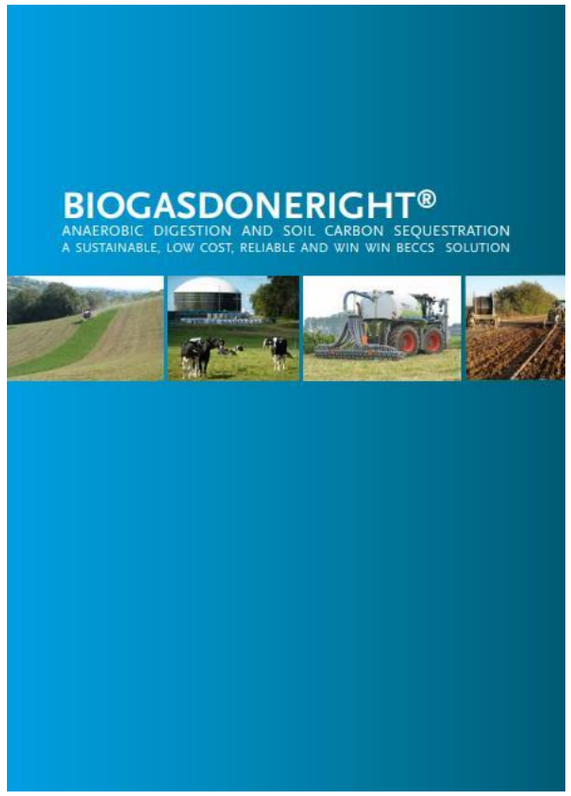
BIOGASDONERIGHT IS A BECCS FOR SUSTAINABLE BIOENERGY PRODUCTION

Conclusions

Special Requirements

1. *Biogasdoneright* farmers already succeed today to **increase farmers' incomes** and create **rural employment**, while **reducing** dependency on **chemical fertilisers** and **increasing soil carbon** levels.
2. To ensure the credibility of soil organic carbon accumulation through *Biogasdoneright*, soil carbon **monitoring systems must be implemented.**
3. The biogas sector should do more to **reduce biogas and biomethane production costs** so it can play an important role in a **cost-effective energy transition.**
4. The distinction in EU renewables legislation (RED II) between food and no-food crops does not make practical and logical sense: what matters is that **more biomass is created on existing farmland without harming current food and feed production**.
5. *Biogasdoneright* can stimulate innovation and market by involving different productive chains: agricultural machinery, digestate treatment and nutrient recovery, data analysis and precision farming, genetics, technical consultancy etc.
6. *Biogasdoneright* is currently implemented in Italy, should be expanded in other parts of Europe and World as well. Scalability study of the model are fundamental.
7. The public participation for social acceptance is also important for the better understanding of the characteristics of Biogasdoneright® and how it can contribute from social, environmental and economic point of view.

Thanks for your attention



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