MYTHS AND FACTS ABOUT BIOFUELS

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February 2010

U.S. BIOFUEL PRODUCTION (RENEWABLE FUELS ASSOCIATION)

Senate Energy Policy (2007) calls for 36 billion gallons by 2022, of which 15 billion gallons is from first generation biofuels.

Year	Fuel Ethanol (10^9 Gallons)
1980	0.3
1990	0.9
2000	1.7
2007	6.5
2008	9.1
2009	10.5
2015	15.0

ENERGY INDEPENDENCE AND SECURITY ACT OF 2007

Target of ethanol by 2022: 36 billion gallons

Cap on corn ethanol : 15 billion gallons

The Gap : 21 billion gallons

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SECOND GENERATION BIOFUELS

- Thus, the emphasis is on cellulosic ethanol
- The strategy is to produce hydrocarbons from lignocellulose with minimal land use change
- 1t of cellulosic biomass = 100 gallons of ethanol

$$\text{Net biomass required by 2022} = \frac{36 \times 10^9 \text{ gallons}}{10^2 \text{ gallons/ton}} = 360 \text{ Mt}$$

With 30% efficiency,
total biomass needed = **1 billion ton**

ESTIMATES OF CROP RESIDUES
(LAL, 1995; 2005)

Crop	Residue Production (10^6 Mg/yr)	
	USA	World
Cereals	367	2800
Legumes	82	305
Oil Crops	20	108
Sugar Crops	14	373
Tubers	5	170
Total	488	3758

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CROP RESIDUES RETENTION ON SOIL AND THE ECOSYSTEM SERVICES

1. Hydrological Cycle : Runoff, Evaporation, Soil Water Storage
2. Energy Balance : Soil Temperature (Albedo, Evaporation)
3. Nutrient Cycling : N, P, K, Ca, Mg, K, Zn, Cu, B, Mo, etc.
4. Food for Soil Biota : Microbes, Earthworms, Termites
5. Erosion Control : Preventing Rain Drop Impact
6. Water Quality : Non-Point Source Pollution Abatement
7. Hypoxia : Reducing risks of anoxia in coastal ecosystems
8. Eco-Efficiency : Enhancing use-efficiency of inputs
9. Agronomic Production: Advancing Global Food Security
10. Climate Change : Mitigation and Adaptation

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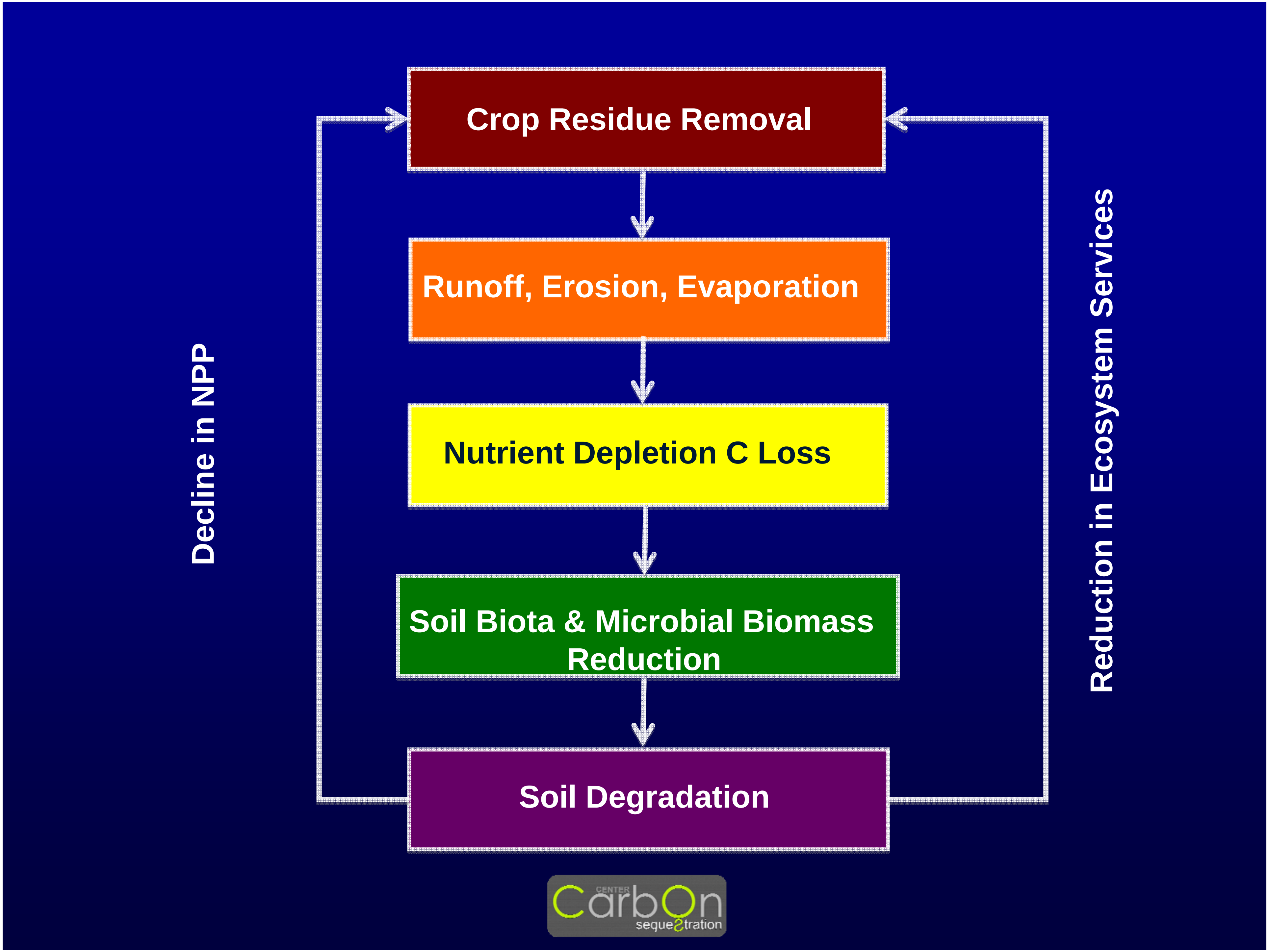
Crop Residue Removal
Runoff, Erosion, Evaporation
Nutrient Depletion C Loss
Soil Biota & Microbial Biomass Reduction
Soil Degradation
Decline in NPP
Reduction in Ecosystem Services
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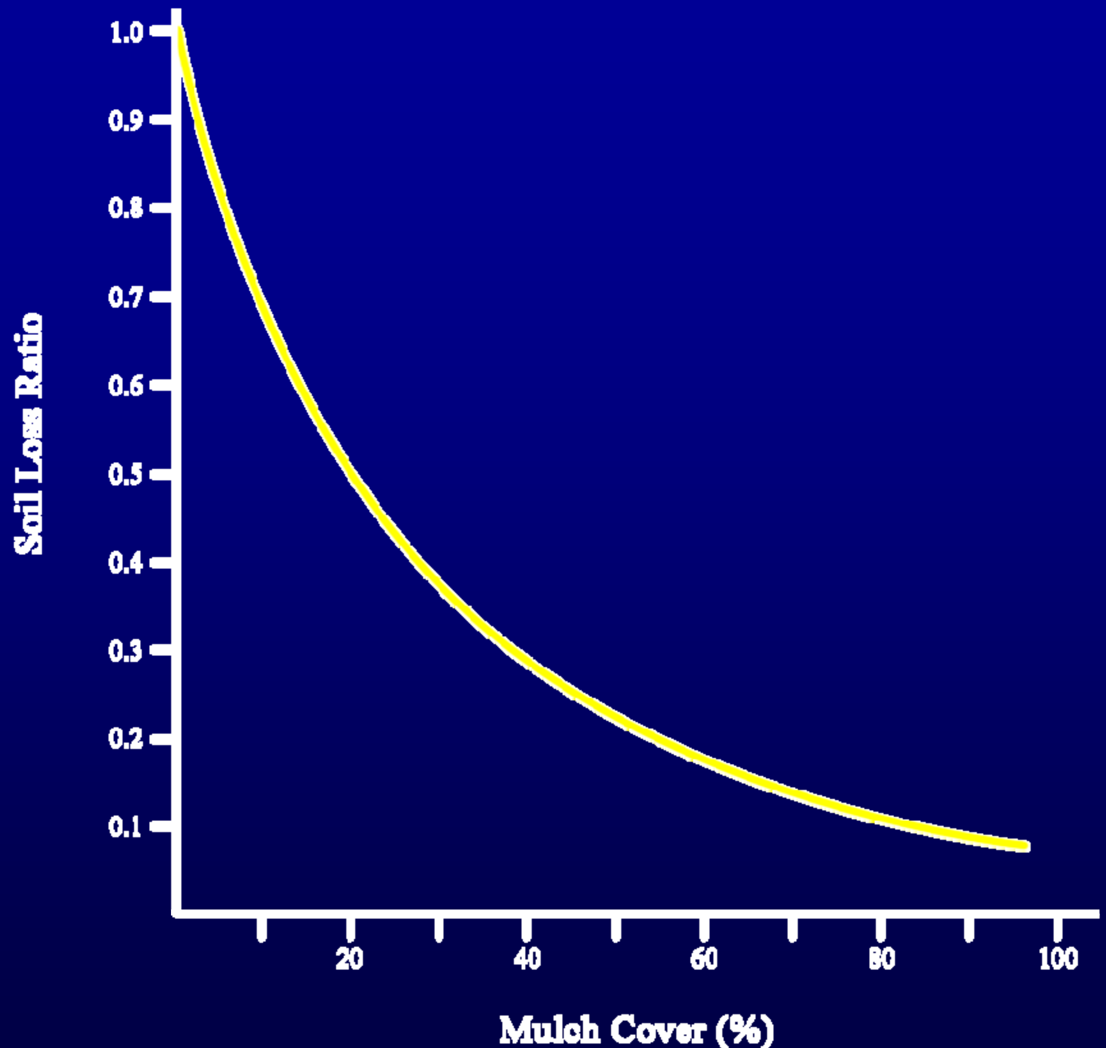
MULCH EFFECT ON RUN OFF AND SOIL EROSION REDUCTION



ESTIMATES OF NUTRIENTS CONTAINED IN CROP RESIDUES (USDA, 2008)

Crop	Nutrient Concentration (%)		
	N	P	K
Corn	0.97	0.10	1.52
Wheat	0.61	0.06	1.17
Sorghum	0.77	0.115	1.01
Rice	0.70	0.09	1.48

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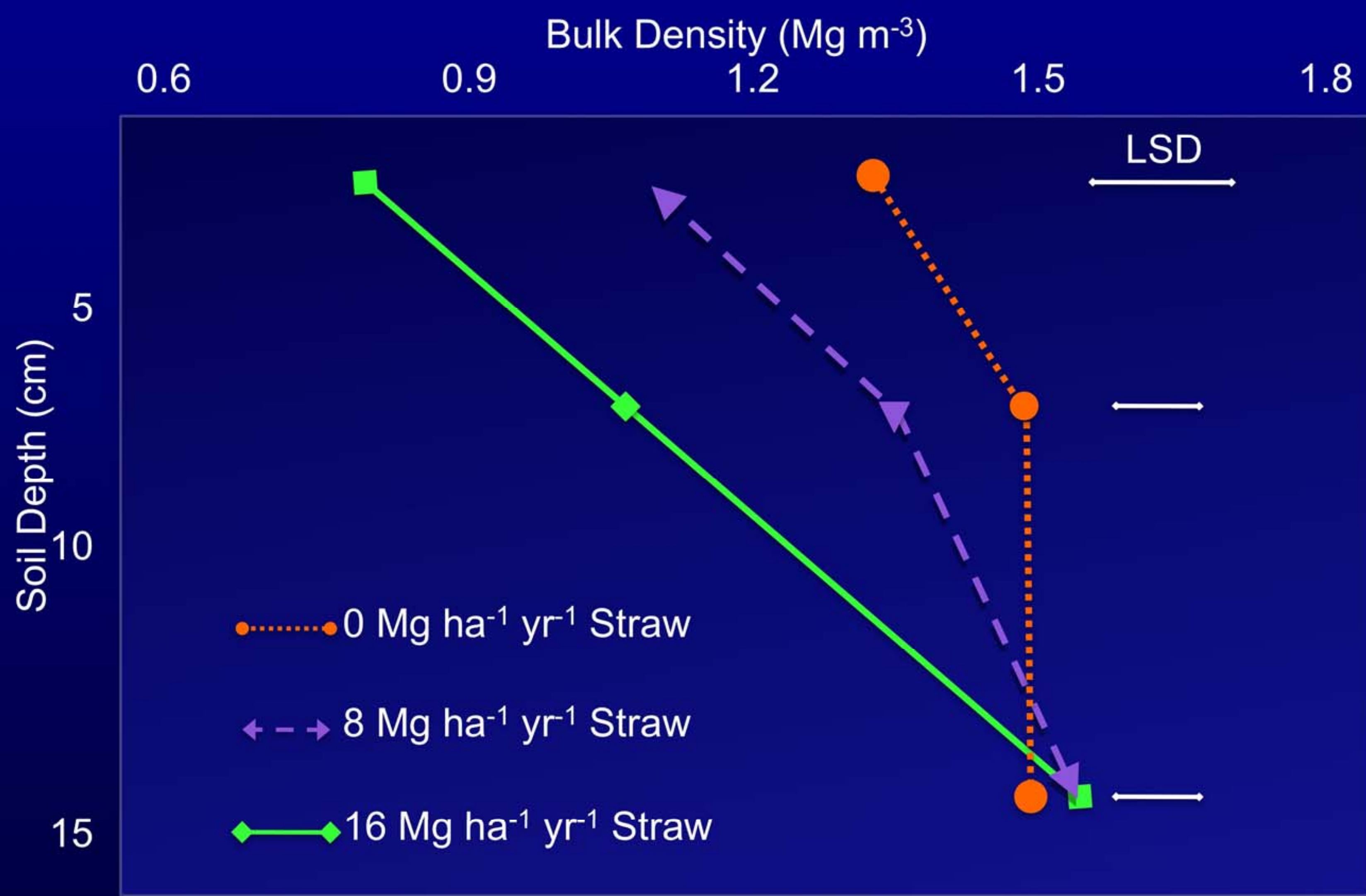
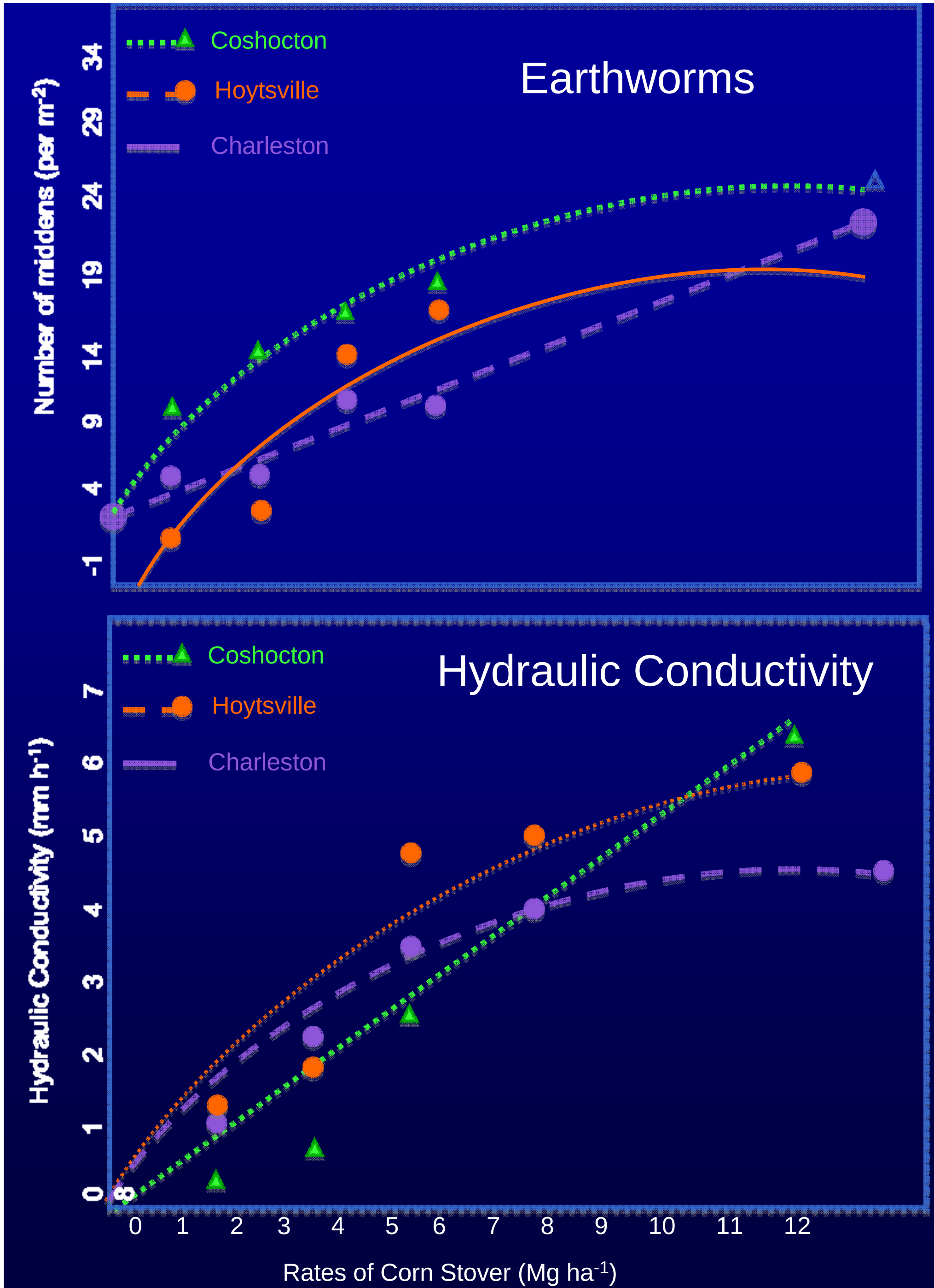
MULCH EFFECT ON SOIL BULK DENSITY OF A MIAMIAN SOIL (BLANCO-CANQUI & LAL, 2007)





MULCH EFFECT ON (A) EARTHWORMS AND (B) HYDRAULIC CONDUCTIVITY (BLANCO-CANQUI AND LAL, 2007)

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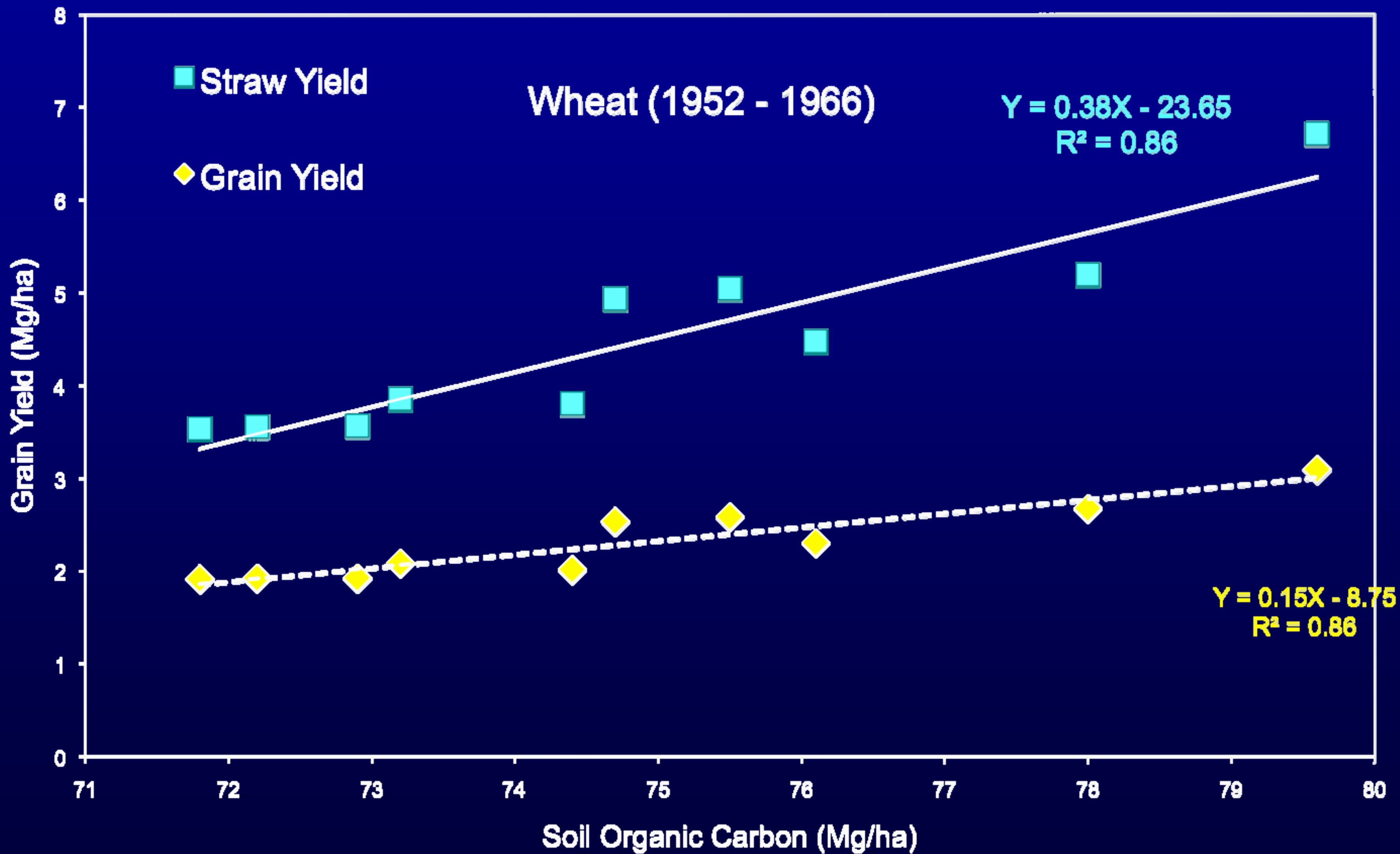
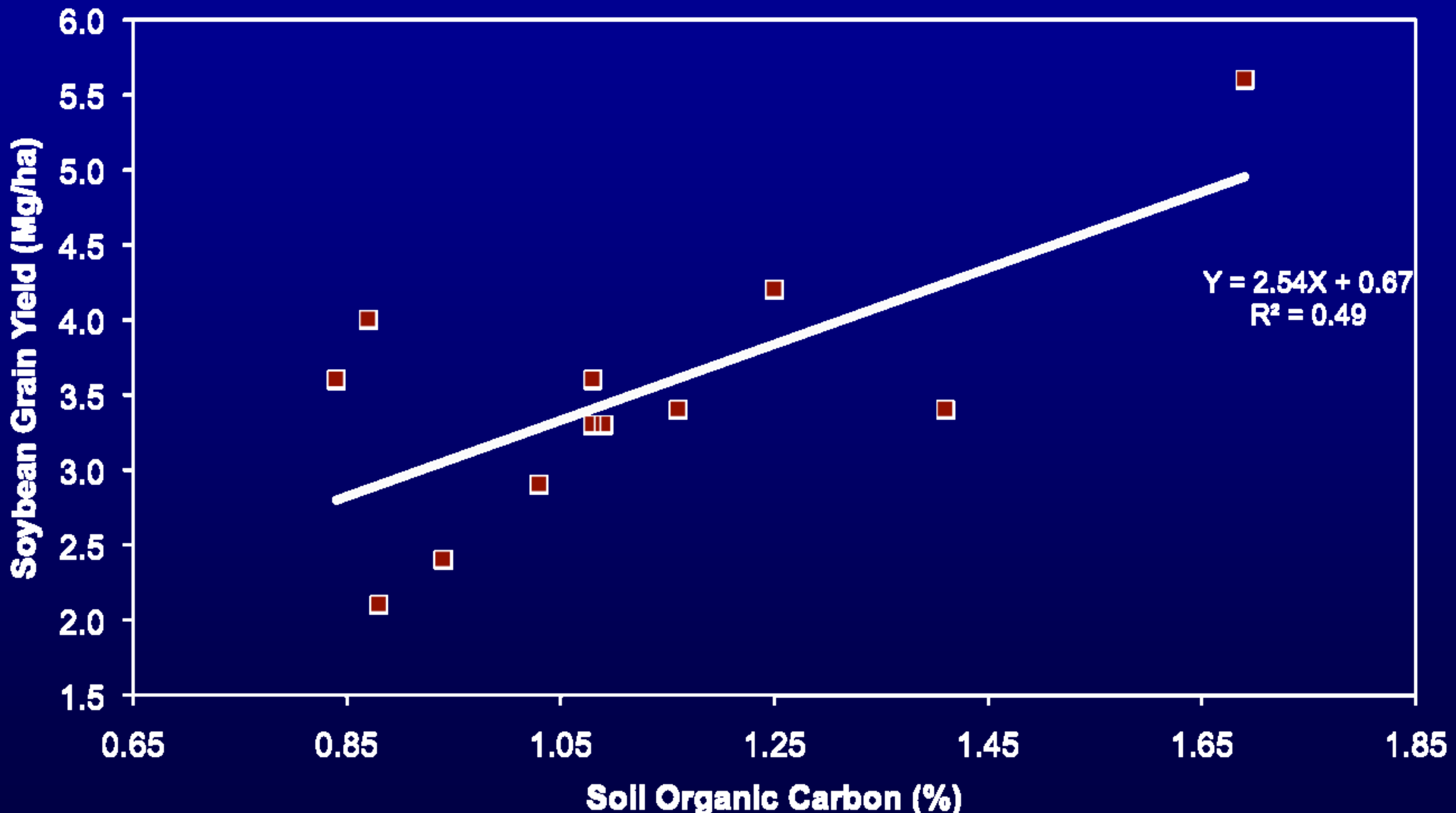
ECONOMICS OF RESIDUE REMOVAL FOR BIOFUEL

SOC CONCENTRATION AND WHEAT GRAIN YIELD IN OREGON

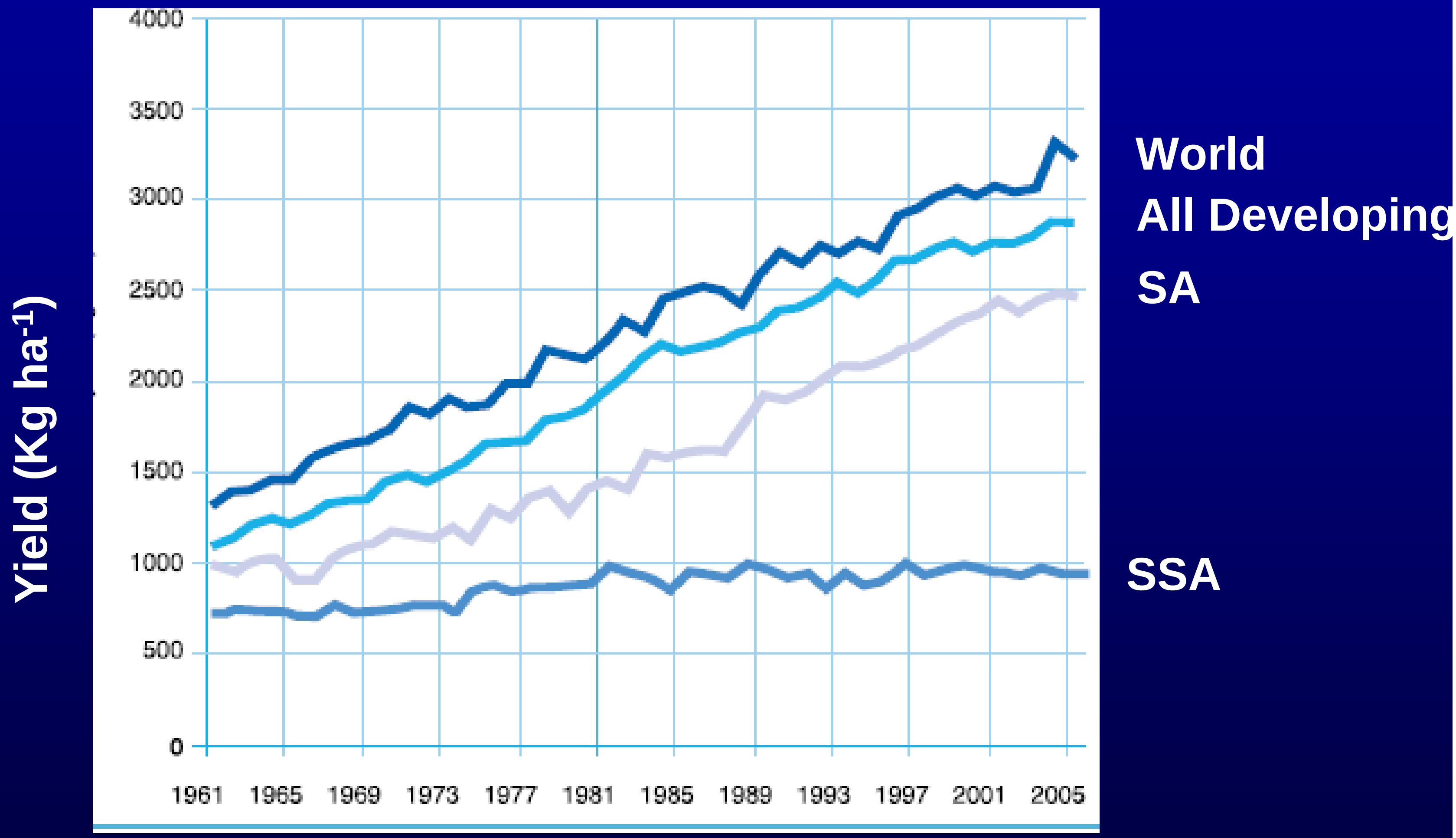
(Rasmussen et al., 1994)



SOC CONCENTRATION AND SOYBEAN YIELD OHIO
(Redrawn from Fahnestock et al., 1995)



REGIONAL TRENDS IN CEREAL YIELDS



Source: Hazel and Wood, 2008 (adapted from FOASTAT 2006)

EMISSION OF CO_2 EQUIVALENT FROM 1 Mg OF CORN RESIDUES HARVEST

Processes	CO_2 Emission (Eq) %	CO_2 Emission (Eq) kg	Source
Combustion	32	32.6	Tiffany (2009)
Nutrient Replacement	29	29.6	
Grinding, Press, etc.	19	19.4	
Collection/Transport/Local Storage	13	13.3	
Truck transportation	5	5.1	
	2	2.0	
	100	102.0	
Loss of Soil C		282.0 (77 kg/C)	
Soil Erosion Loss (5 Mg/ha@2%SOC)		366.0 (100 kg/C)	
Total		750.00	

BIOFUELS VS HUMUS

"I am arguing against indiscriminate conversion of biomass and organic wastes to fuels. The humus capital, which is substantial, deserves being maintained because good soils are a national asset."

………………. Hans Jenny (1980)

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POTENTIAL OF BIOENERGY PRODUCTION OF MARGINAL SOILS

Some have suggested that cellulosic ethanol can be produced with low inputs on marginal soils.

"This is a myth at best, and a lie at worst."

…Bobby Stewart, 2009

ADVANCED WOOD COMBUSTION (AWC) FACILITIES

- Wood supplied more energy than fossil fuel in the U.S. until 1880s

- Total energy use in the U.S. = 100 Quads/y
- Present Wood Supply = 2 Quads/y

- Sustainable Wood Production in the U.S. = 368 million dry tons of wood/y (5 Quads/y)

LAND AREA NEEDED FOR BIOFUEL PRODUCTION

A 10% substitution of petrol and diesel fuel is estimated to require:

- **43% of the current cropland are (USA)**
- **38% of the current cropland are (EU)**

Which means forests and grasslands would need to be cleared to enable production of energy crops.

ADDITIONAL LAND AREA NEEDED GLOBALLY BY 2050

Biofuel Production	=	440 Mha (850 Mha)
Food Production	=	200 Mha
Infrastructure	=	100 Mha

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PAYMENT FOR ECOSYSTEM SERVICES

Carbon content 1 t of corn residue at 15% moisture	:	348 kg
Humification Efficiency (10%)	:	35 kg
Cost of CCS @ $3.67 /kg	:	$128
Cost of Stover	:	$77/t

Cost of Stover = 77/128 x 100 = 60%

SUGGESTIONS FOR POLICY MAKERS (SHORT-TERM 30 YRS)

If the objective is to mitigate CO_2 and global warming, policy makers may be better advised to focus on the following:

- **Increase the efficiency of fossil fuel use,**
- **Conserve the existing forest and savannahs,**
- **Restore natural forests and grasslands or croplands that are not needed,**
- **Sequester C in soils and biota, with SOC sequestration potential of 300 Mt/yr in the U.S.**

SUGGESTIONS FOR POLICY MAKERS (LONG-TERM >50 YRS)

INVEST IN

Non-C Fuel Technology

(H_2)

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FOUR LAWS OF ECOLOGY

1. Everything is connected to everything else.
2. Everything must go somewhere.
3. Nature knows best.
4. There is no such thing as a free lunch.

…….. **Barry Commoner (1971)**

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THERE IS NO SUCH THING AS A

FREE BIOFUEL

FROM

CROP RESIDUES

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