Syngenta BioFuels

Bruce Link

Biomass Traits, SBI

Syngenta – a leading global agribusiness

- **Strong worldwide market presence**
  - A leader in crop protection
  - Third in high-value commercial seeds

- **2007 annual sales were $9.24 billion (USD)**
  - 80% in Crop Protection
  - 20% in Seeds

- More than 21,000 employees in over 90 countries

Global R&D capabilities

JEALOTT'S HILL, UK

Chemical Discovery
Weed Control
Formulation
Bioscience
Environmental Science

Other sites

- **Marker-assisted breeding support**
- **Global field station network**

GREENSBORO, NC

Formulation
Environmental Science

GOA, INDIA

Chemistry

RESEARCH TRIANGLE, NC

Biotechnology R&D

BASEL/STEIN, SWITZERLAND

Fungicides, Insecticides & Professional Products

BRISBANE, AUSTRALIA

Cane Research Collaboration

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Syngenta Biotechnology Inc. (SBI)

Biotech R&D Center

- Bioinformatics & Scientific Computing
- Enzymology and Protein design
- Plant Protein Expression
- Crop Transformation
- Plant Analysis & Immunology
- Patents and Licensing
- Regulatory Science
- Regulatory Affairs

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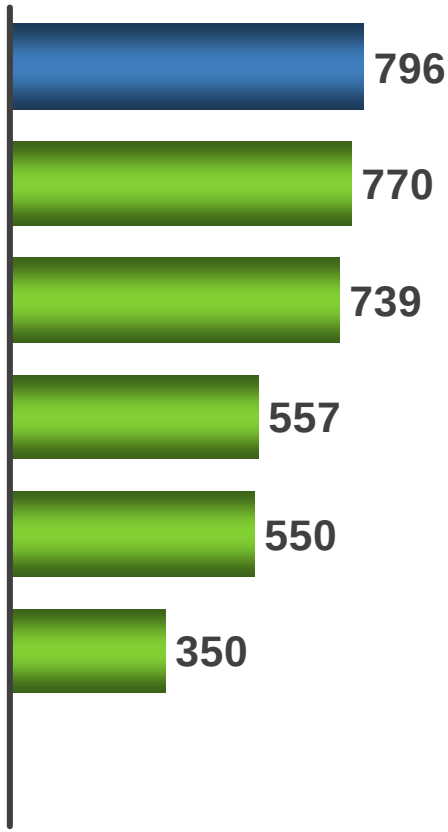
Syngenta is the industry leader in R&D

Rank	2006 R&D spend $ m	*As % of sales*
1 Syngenta	796	*10%*
2 Bayer	770	*11%*
3 Monsanto	739	*10%*
4 BASF	557	*14%*
5 DuPont	550	*11%*
6 Dow	350	*10%*

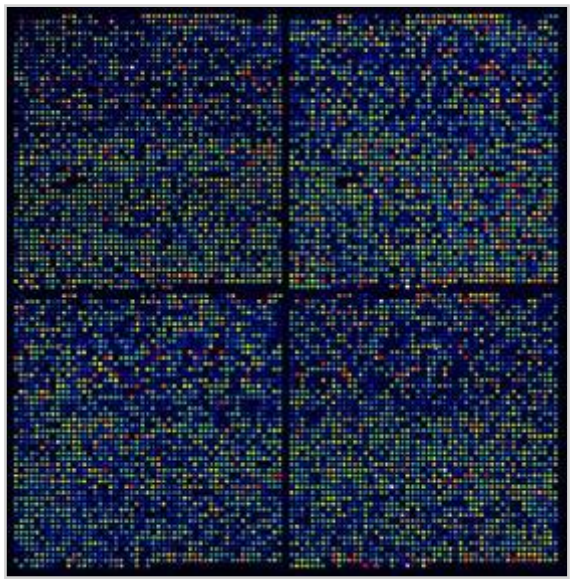


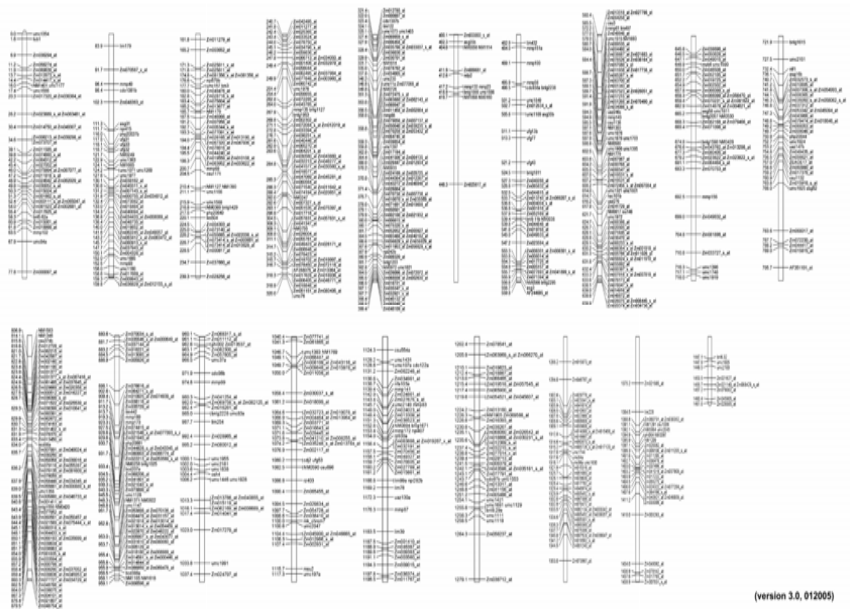
Source: Phillips McDougall, Syngenta

Syngenta research leadership in precision breeding

Gene discovery through genomic analysis

- Powerful tools to examine whole crop genomes
- Published rice genome
- Working on Corn >11,200 genes mapped
- Applications for marker assisted breeding and native traits discovery





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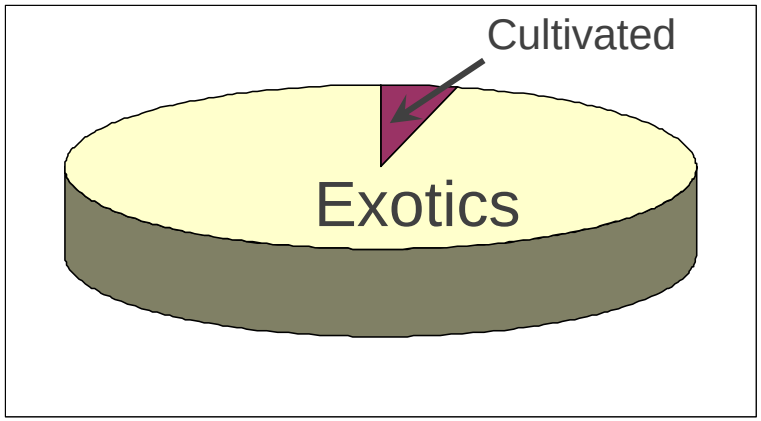
Tapping genetic diversity for novel traits



- Genetic diversity is essentially an untapped resource
- Syngenta's integrated approach effectively leverages genetic diversity into elite products

Second generation input traits: Drought tolerance – combining GM and non-GM technology

Unstressed **Stressed**

- Drought during pollination leads to poor kernel set
- New technology would protect during drought conditions
- Multiple complementary approaches: native trait and functional genomics, transgenics
- Multiple new trait constructs are currently under evaluation in field trials

Agricultural biotech and renewable fuels

- 1st Generation renewable Fuel
  - Sugar and Starch to Ethanol
  - Limited volume - Food vs Fuel?
  - Immediate solution to MTBE replacement
- Maximising yield is key
  - Genetics
  - Crop Protection
  - Biotechnology
- 2nd Generation renewable fuel
  - Agricultural, forestry and municipal waste
  - Sustainable at high volume
  - Does not compete with Food and Feed

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For Syngenta, the path to efficient and sustainable renewable fuels will encompass three horizons

Today

Maximizing yield and decreasing pressure on key feedstocks

- Best genetics
- Optimized starch
- Protecting yield
- Facilitate crop production / availability

3- 5 years

Innovating within the existing industry to maximize efficiency

- Tailored crops
- Tropical Sugar Beet
- Corn Amylase
- Processing changes

5+ years

Help make sustainable cellulosic conversion a reality

- Plant-expressed enzymes
  - Self-processing biomass crops
  - Plant made additive enzymes
- Improved feedstocks
- Biomass conversion process around key feedstocks

Syngenta Technology Development

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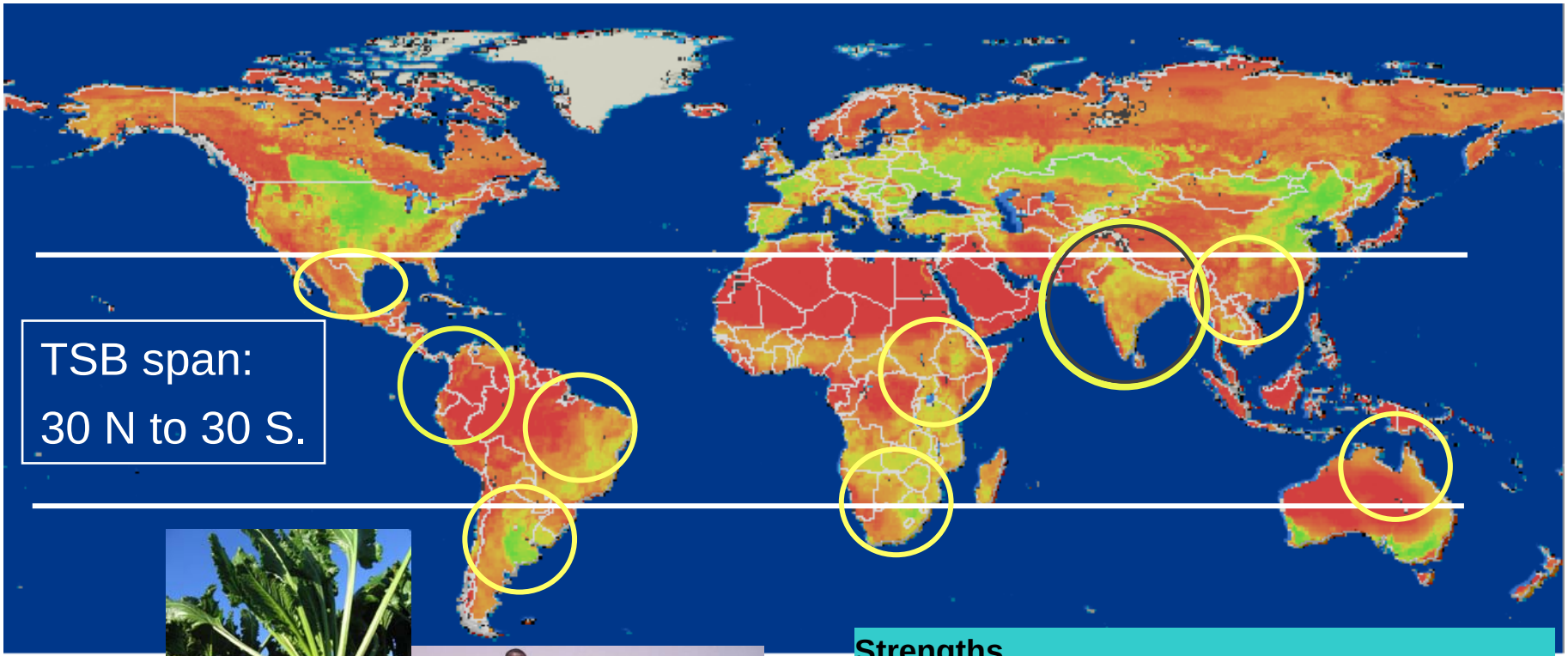
Tropical Sugar Beet – a global opportunity



Strengths

- **Uses 33% - 50% less water than sugar cane**
- **Fit for saline/alkaline soils**
- **Cost competitive with sugarcane**
- **Increased farmer income**
- **Provides an additional cash crop**

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Expression of the amylase enzyme in corn

Potential benefits:

- Processing flexibility
- Reduced chemical usage
- Reduced energy and water use

Potentially greater ethanol output per acre or per mill

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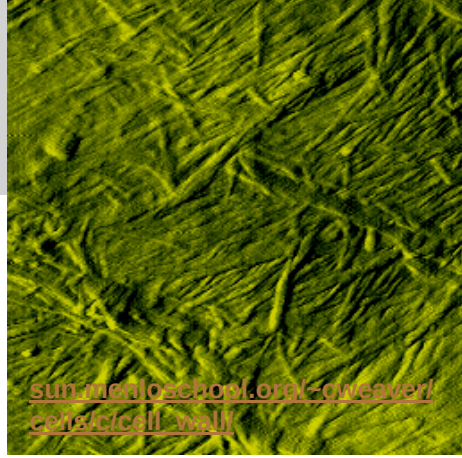
Syngenta Biomass Program

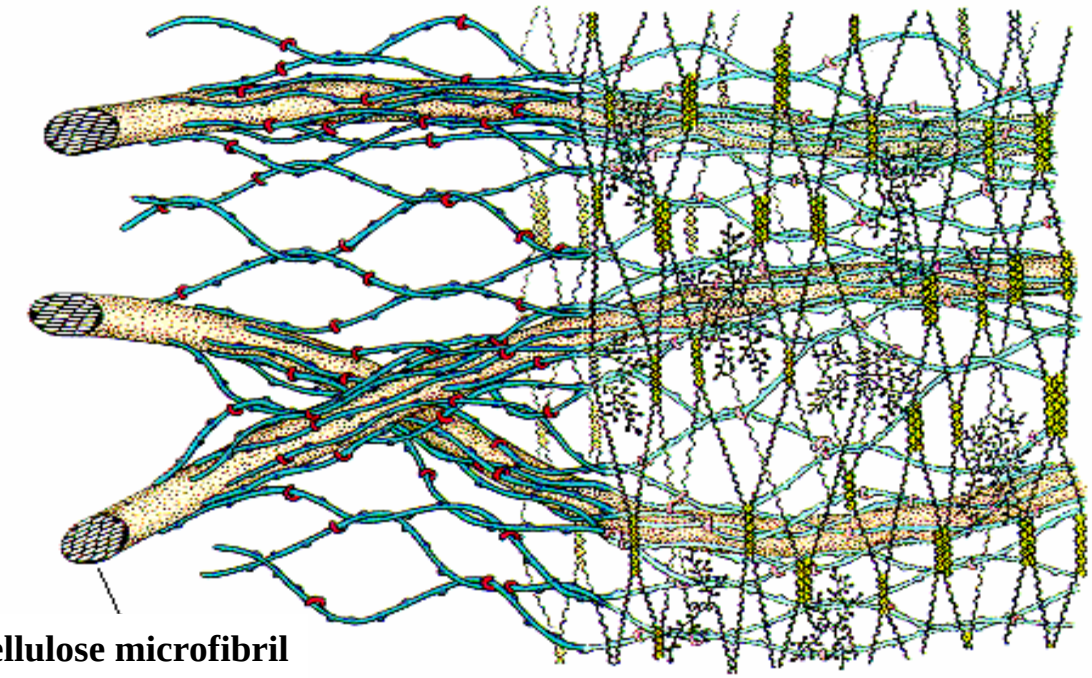
Cellulosic Ethanol

Why is Cellulosic Ethanol Hard to Achieve?



Highly Complex cell wall

- Hemicelluloses rich in xylose and arabinose
- Cross links
- Lignin
- Crystaline substrate
- Slow Enzymes
- Expensive Enzymes



Carpita and Gibeaut Plant J. 1993 Jan;3(1):1-30

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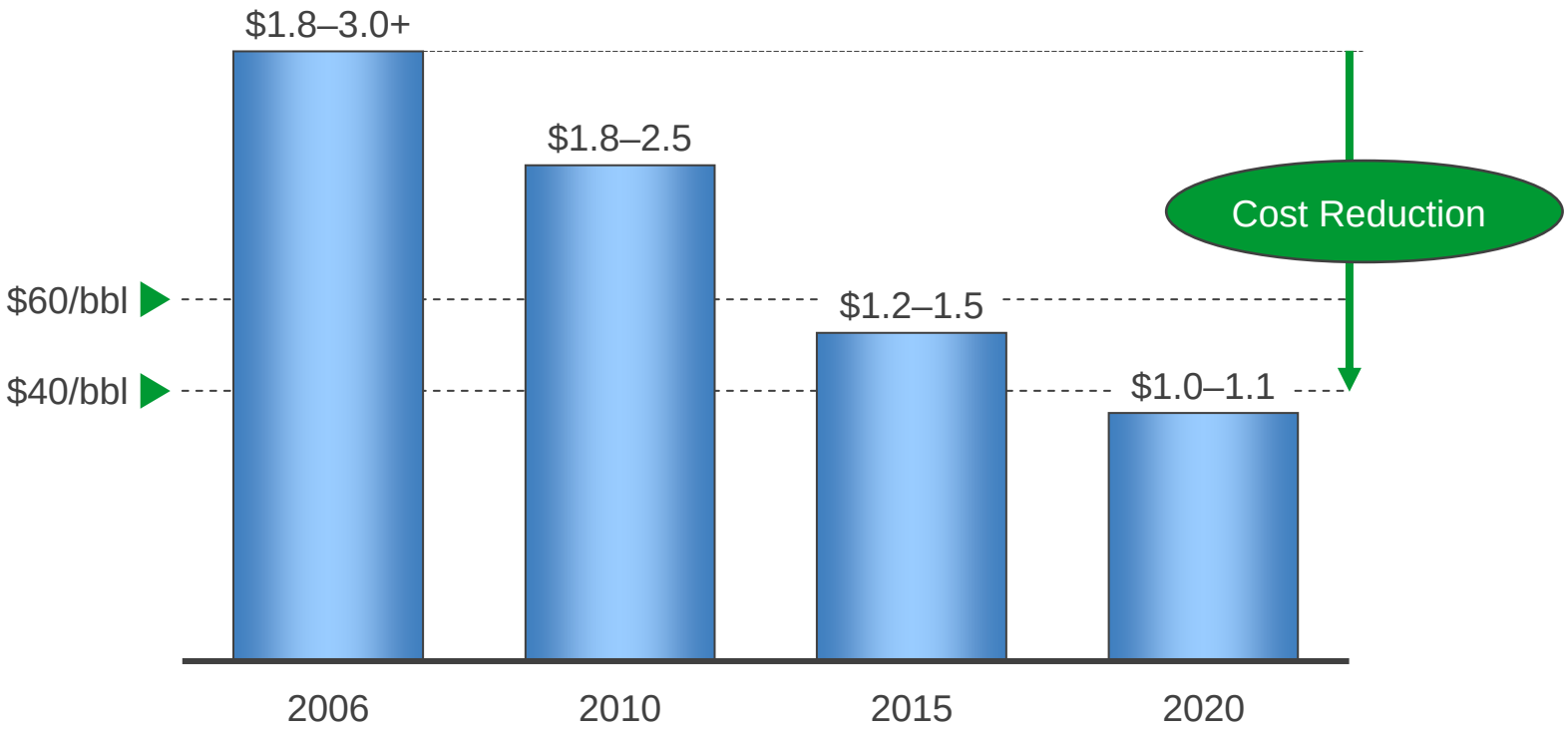
Significant improvement required to make cellulosic ethanol cost competitive

Full production cost of cellulosic ethanol*
USD per gallon



* Including depreciation and margin for capital recovery, based on estimate US cost for biomass; not adjusted for different energy content

Source: NREL, SRI, USDA, Oil World, expert interviews, McKinsey analysis

Addressing key challenges to reduce cellulosic ethanol cost

	Source optimum feedstock	Pretreatment (break up fiber)	Hydrolysis (Make sugars)	Fermentation (Sugars to fuel)
Costs (USD/Gal.)*	$0.15–1.15**	$0.35 – 0.60	$0.75–1.00	$0.40–0.75
	Total: $1.8 – $3.0+			
Key Challenges	• High cost of management and logistics	• High cost of capital equipment	• Low enzyme activity and expression	• Non-robust C5 sugar fermenting micro-organisms
Syngenta Focus	• **Feedstock productivity and management**		• **Unique, evolved enzymes with low loading requirements** • **Plant expressed enzymes**	

Collaborations to integrate process and reduce to practice

Focused improvements will enable $1.25 - $1.50 USD/Gal. cellulosic ethanol

Source: Syngenta analysis

*Estimated costs in 2007, ** High variability due to management and logistics for certain feedstocks

Syngenta – Reducing the Concepts to Practice

- We have expressed multiple cellulases in plants
  - Exocellulases, Endoglucanases, Betaglucosidases and Hemicellulases
- Progress towards commercially relevant expression levels
- Early technology – but will provide the lowest cost performance enzyme for cellulosic biomass conversion

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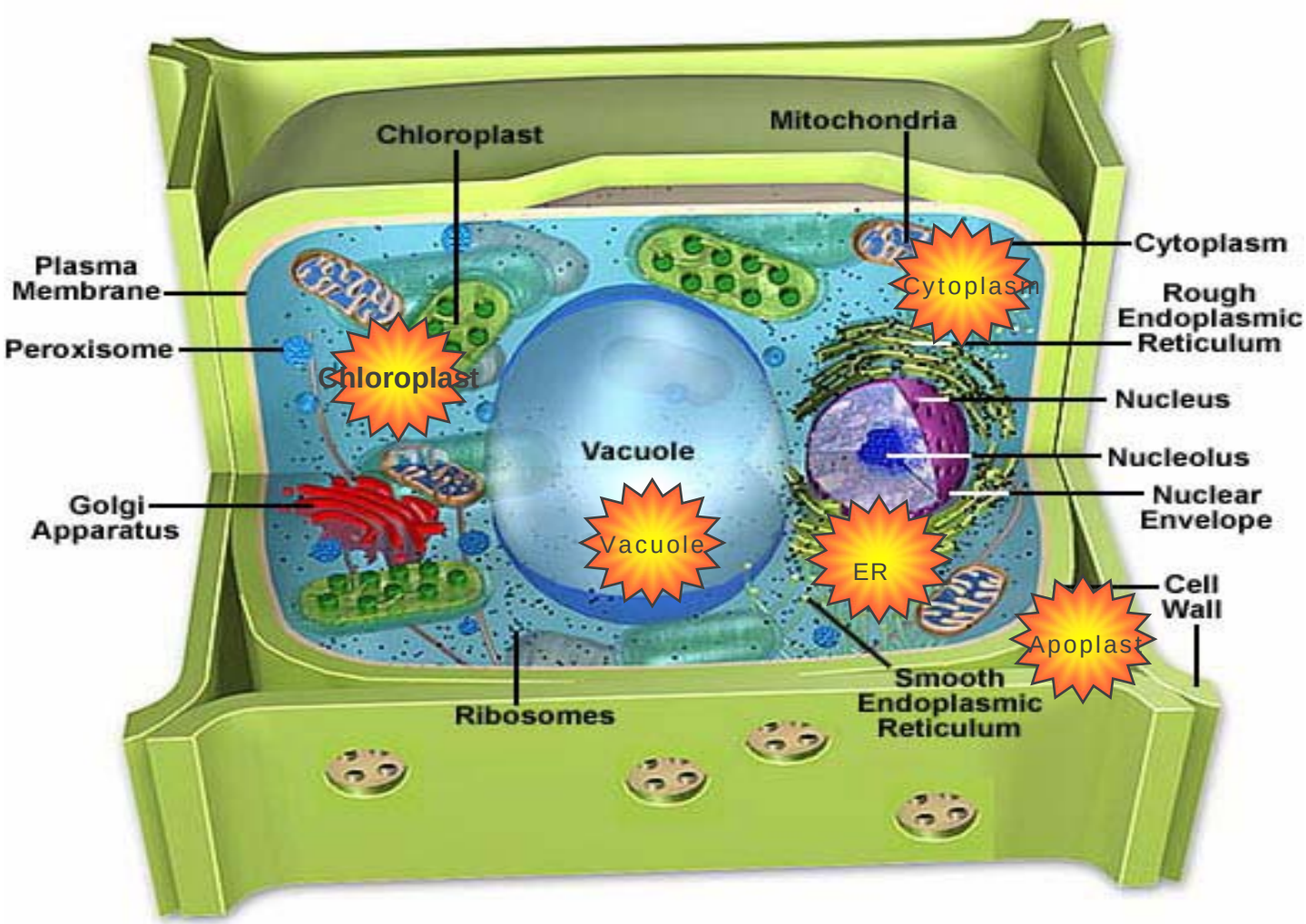
Delivering the plant enzyme expression concepts

- Subcellular targeting – important for cellulase expression



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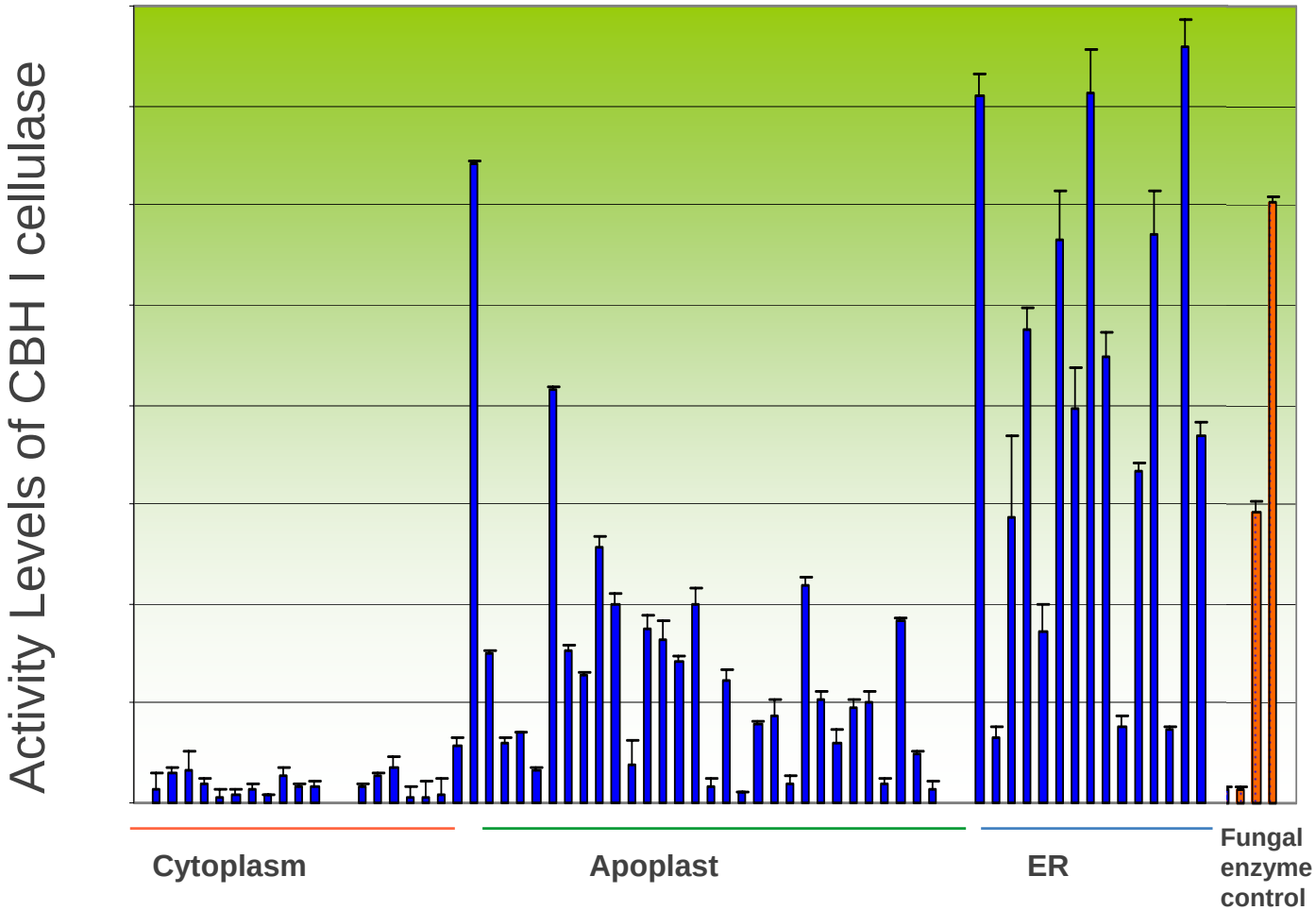
Accumulation of active CBH1 cellulase in grain is dependant on sub cellular targeting



Each bar represents an independent event

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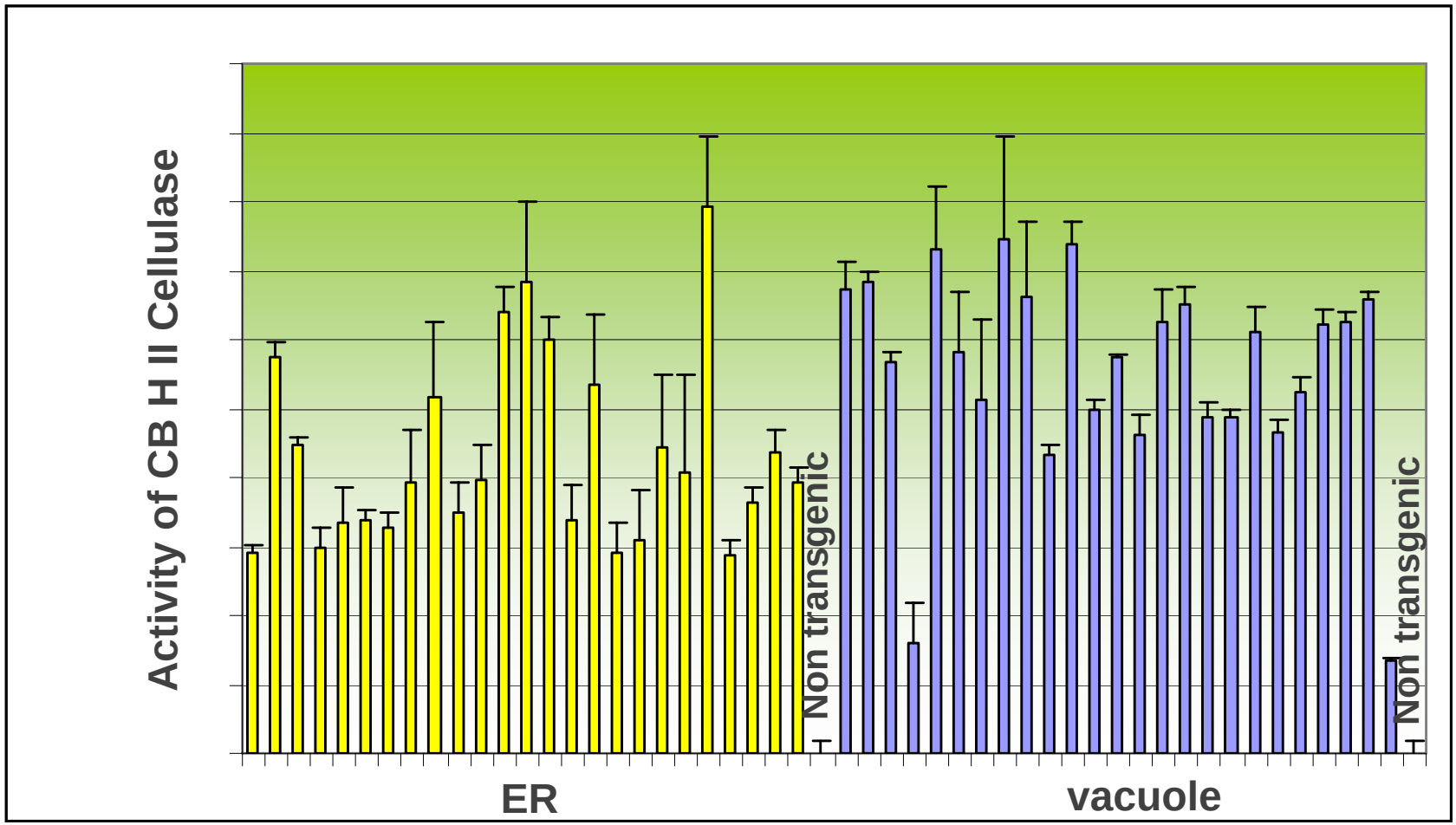
CBH II cellulase expression in maize leaf



CBHII from collaboration with VERENIUM THE NATURE OF ENERGY™

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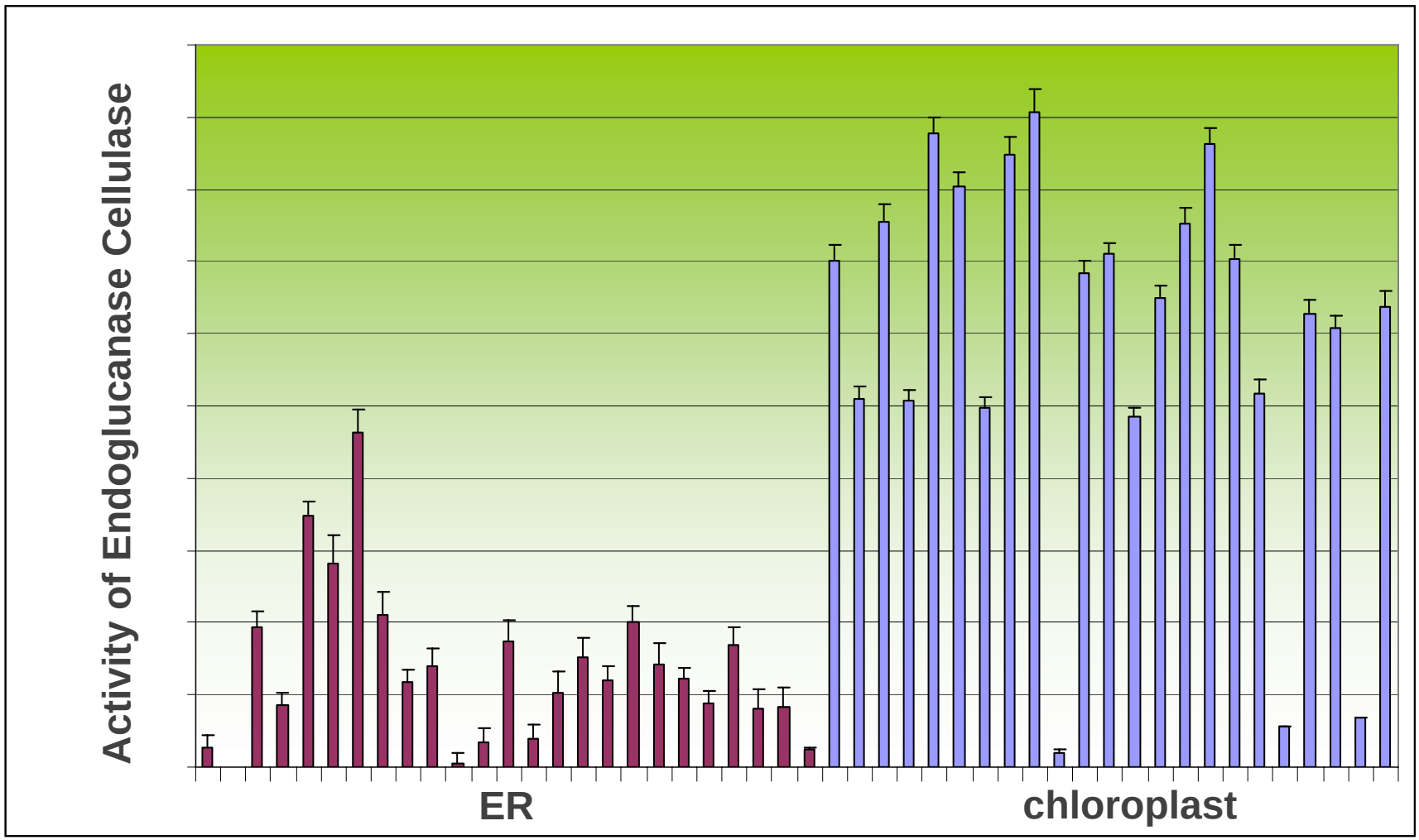
Endoglucanase cellulase activity in maize leaf



EG from collaboration with VERENIUM THE NATURE OF ENERGY™

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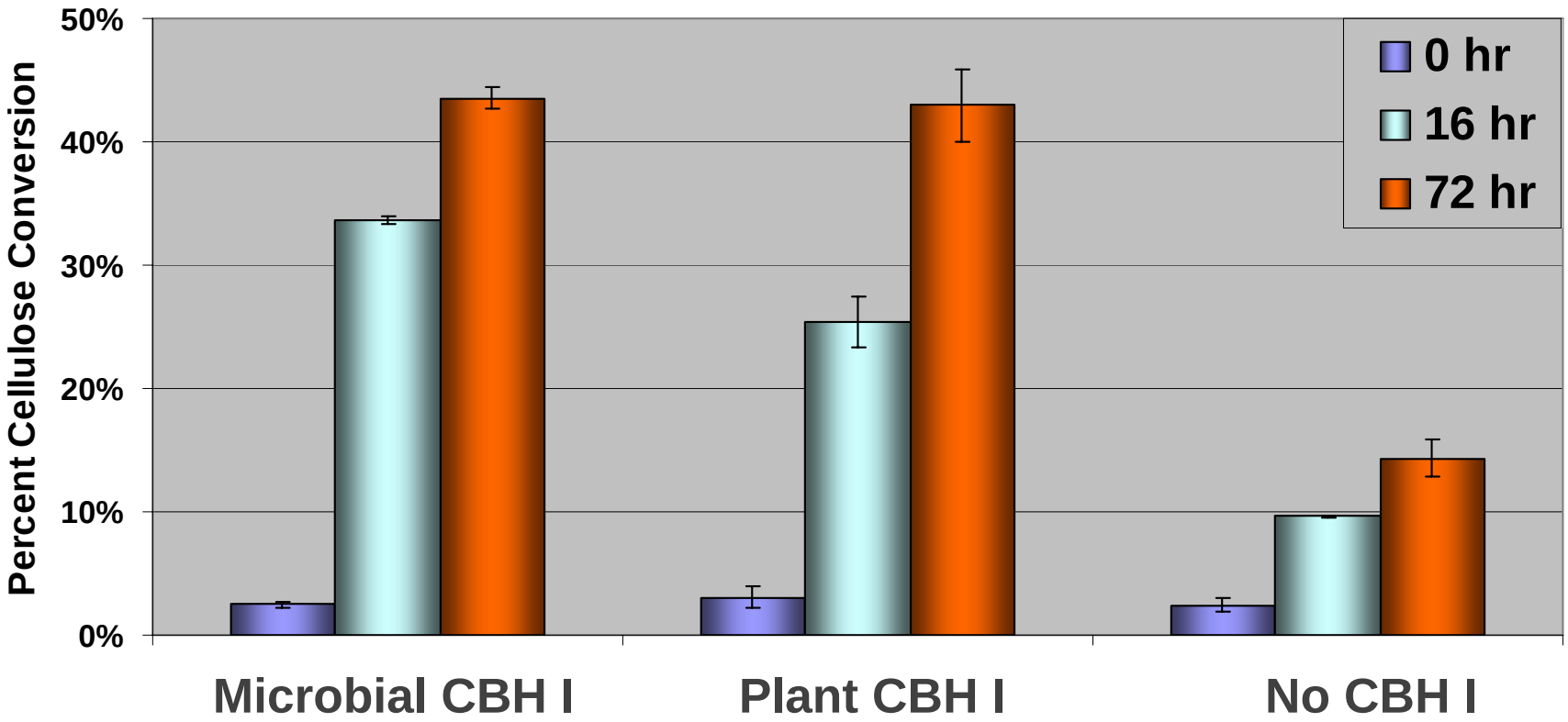
Plant produced cellulases perform like microbial cellulases in cocktails



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Syngenta plant-expression capability for two concepts

Concept	Feedstock Expression	Plant-Expressed Additive
	 	
Description	● Enzymes expressed in the biomass that is to be processed (e.g. Corn, cane & beet)	● Enzymes expressed in an “additive” protein crop (e.g. canola, soy)
Advantages	● “Self-processing” feedstock ● Lowest cost enzyme production ● Large amounts may be made	● Flexible for different feedstocks ● Can be added after pretreatment ● Storage and transport possible
Challenges	● Process design around feedstock ● Limited application outside feedstock	● Additional logistics necessary ● Carries some additional processing cost

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How will the world deliver enzyme cocktails?

Concept	Feedstock	Plant Additive	Microbial
			
Enzyme cost today $/gal EtOH	$0.05 - $ 0.25	$1 -10	$0.75 -$1.0
Enzyme cost at target $/gal EtOH	Approx $0	$0.01 - $0.1	Approx $0.13
Capital need	No	Existing processor	Fermentation
Running Costs	Zero	Low	High
25+ M/Tonne/yr Enzyme capacity	Yes	Not certain	Capex Cost $

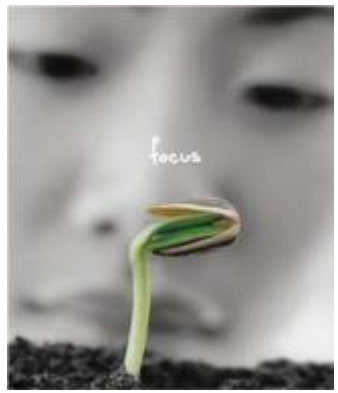
Target assumes DOE enzyme cost reductions are met

What does this mean for wheat?

- Unlikely GM wheat will be first to market
- Abengoa has a 70M tonne/year cellulosic ethanol plant – wheat and cereal straw – Salamanca Spain
- Iogen has a demo plant – wheat and wood
- Syngenta will be the lowest cost enzyme producer
- Some of our product concepts rely on low cost active enzyme production in plants to apply to any feedstock
  - Wood, miscanthus, switch grass, corn stover, rice and wheat straw
- Import of formulated enzymes into the EU will be subject to a simplified approval process

Conclusions

Plant expression of cellulases will be critical to making cellulosic ethanol a commercial reality



Thank you