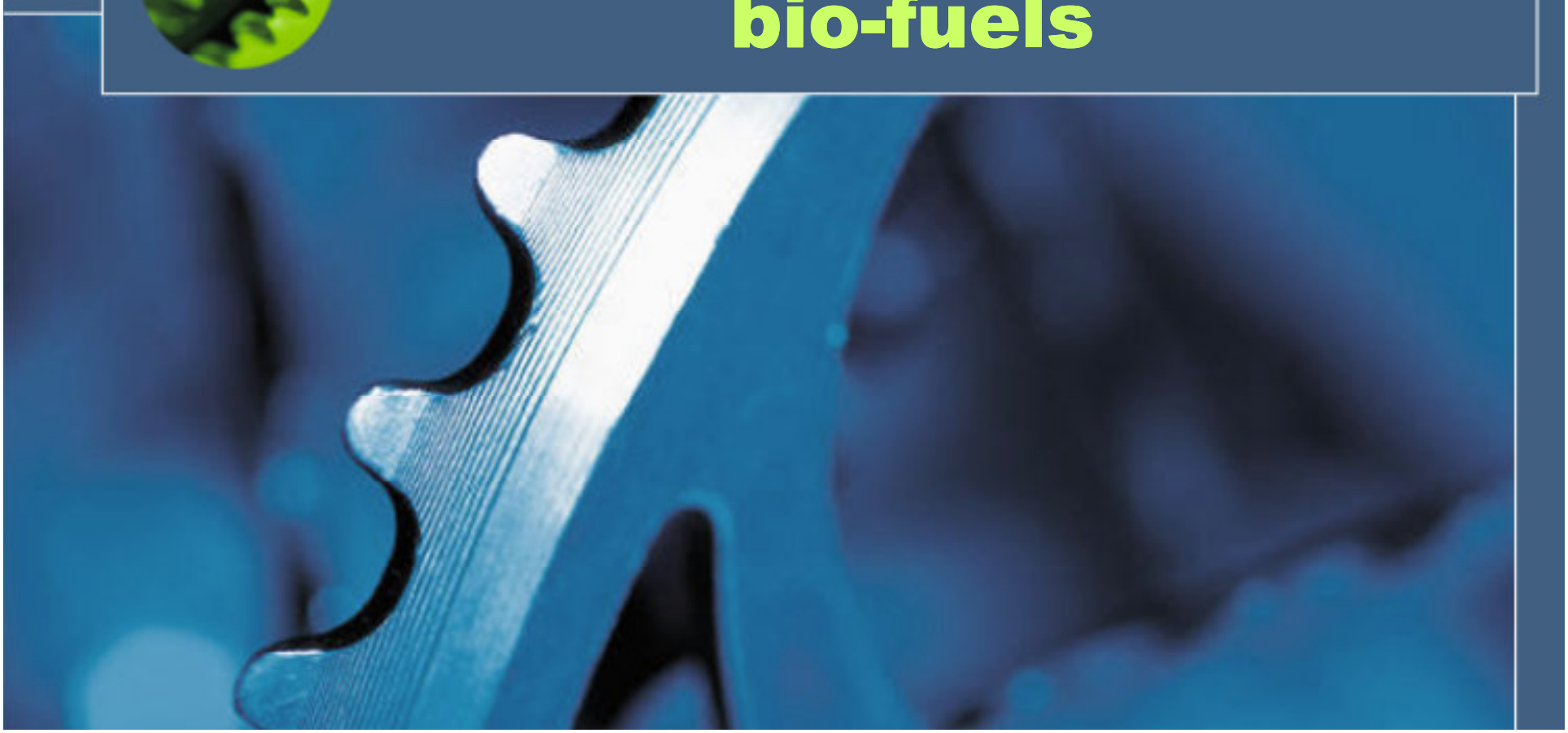
PlantBio's initiatives in bio-fuels



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Exploring energy crops in South Africa

Antonio Llobell
CEO, PlantBio Trust

Johannesburg, January 2010

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PlantBio Trust
National Innovation Centre for Plant Biotechnology

Established in 2004 by DST as a part of the National Biotech Strategy

Vision

"To serve and lead South Africa towards developing a sustainable Plant Biotechnology sector that is competitive and world class in specific areas and address poverty alleviation"

PlantBio is migrating into the new Technology Innovation Agency (TIA)

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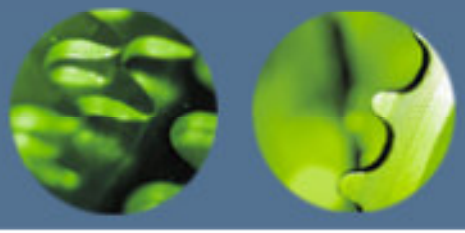

Industrial Crops and Biofuels

- **PlantBio's thematic area due to national and global relevance**
- **Integrating projects in energy crops with different technology approaches**
  - Ethanol/Biodiesel crops
  - Plant breeding (molecular markers)
  - Plant transformation and genomics
- **Integrating all aspects required to develop the entire value chain leading to sustainable commercialization**
  - Crop improvement/Agronomy
  - Fermentation and chemical processes
  - Management of by-products (value addition)
  - Distribution and logistics

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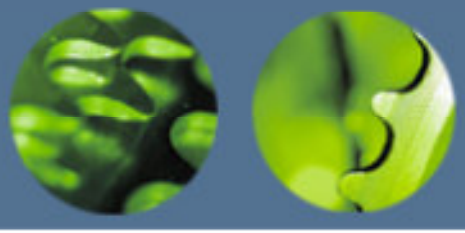

PlantBio strategy in biofuels

- **Assessment and update of technology developments and biofuels initiatives globally**
- **Definition of priorities considering the South African and African context**
  - Crops vs climate and soil availability
  - Technologies developed in SA (possibility to license technologies from abroad)
  - Sustainability of biofuel production
    - Non competition with food crops
    - Use of marginal land
    - Low input (dry land vs irrigation, low fertilizer and pest control costs)
    - Energy balance
    - Environmental impact
    - Economic profitability

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The Biofuels value chain

Upstream
Production of feedstock

- Starch
- Fermentable sugars
- biomass (ligno-cellulose)

Downstream
Industrial processing of feedstock

- Biological (fermentation)
- Chemical

Integration of both upstream and downstream aspects is essential

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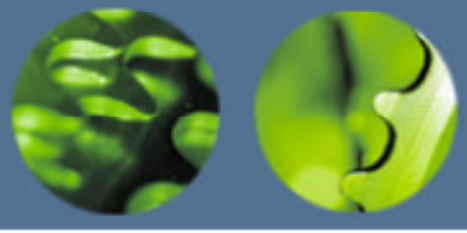

Upstream processes

Feedstock

Industrial/energy crops

- First generation
  - Starch crops (maize, **sorghum**, **triticale, cassava**)
  - Fermentable sugar crops (sugar cane, **sugar beet**, **sweet stem sorghum**)
  - Oil crops (sunflower, soya, rape seed)
- Second generation (marginal land, low inputs & non food crops)
  - Biomass crops (require ligno-cellulose to biofuel conversion)
    - Forestry trees
    - **High biomass sorghum, millet**
    - **Triticale, bamboo, miscanthus**

Other sources of biomass

- Waste
- **Algal biomass**

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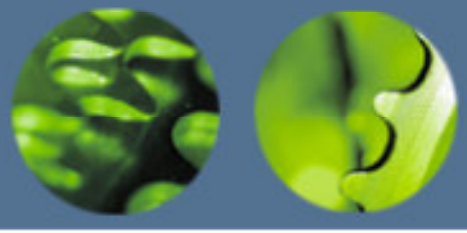


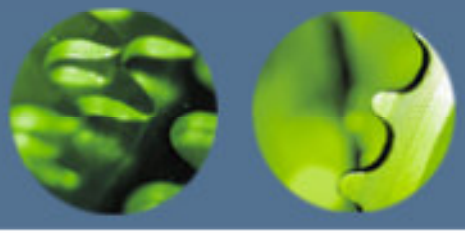
Downstream processes

Available:

- Starch to fermentable sugars
- Fermentable sugars to ethanol

Development:

- Biomass (ligno-cellulose) to fermentable sugars
- Fermentable sugars to hydrocarbons (gasoline or diesel) through fermentation using metabolically engineered microorganisms
- Biomass to hydrocarbons (gasoline/diesel) through chemical processes with favorable energy balance ("low temperature" pyrolysis processes)



Opportunities for innovation in SA

New technologies:

- Development of second generation energy crops
- Transformation of biomass (ligno-cellulose) including byproducts (bagasses) into fermentable sugars
- Bio-transformation of fermentable sugars into hydrocarbons
- Chemical transformation of biomass into hydrocarbons using processes requiring low energy input
- Conversion of fermentable sugars/biomass into industrial products
  - Biopolymers
  - Other chemical industry products
  - Food products

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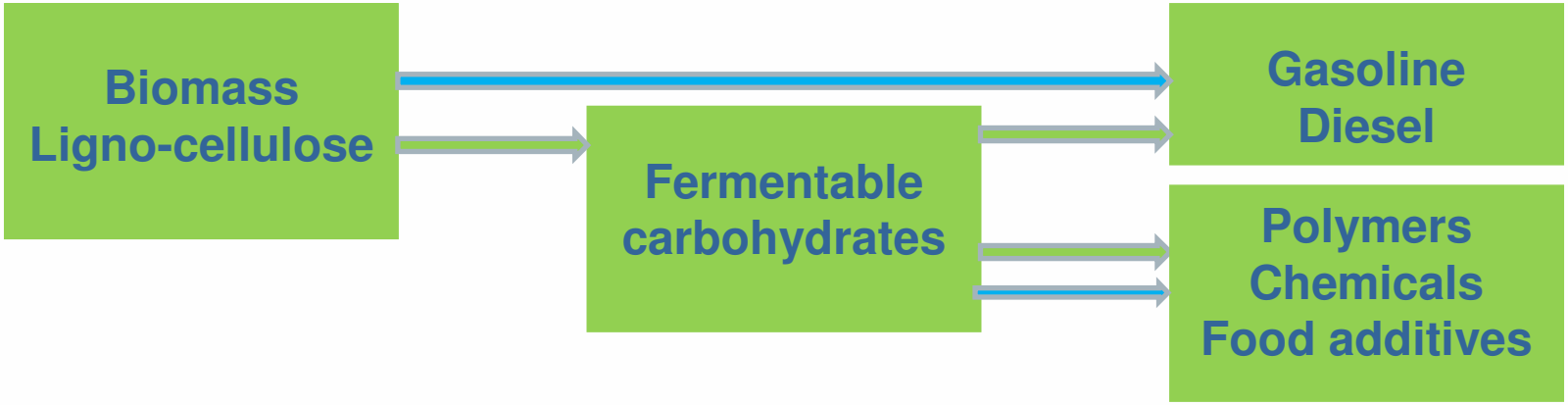
Opportunities for innovation in SA

Collaborative model:

- Target innovation in emerging areas (biomass to hydrocarbons)



- Value addition of different by-products (Biorefinery)
- Integration of R&D with industrial and business development
- Attracting overseas technologies to be developed/demonstrated in SA
- Coordination of activities at different levels (R&D, funding) to optimize resources

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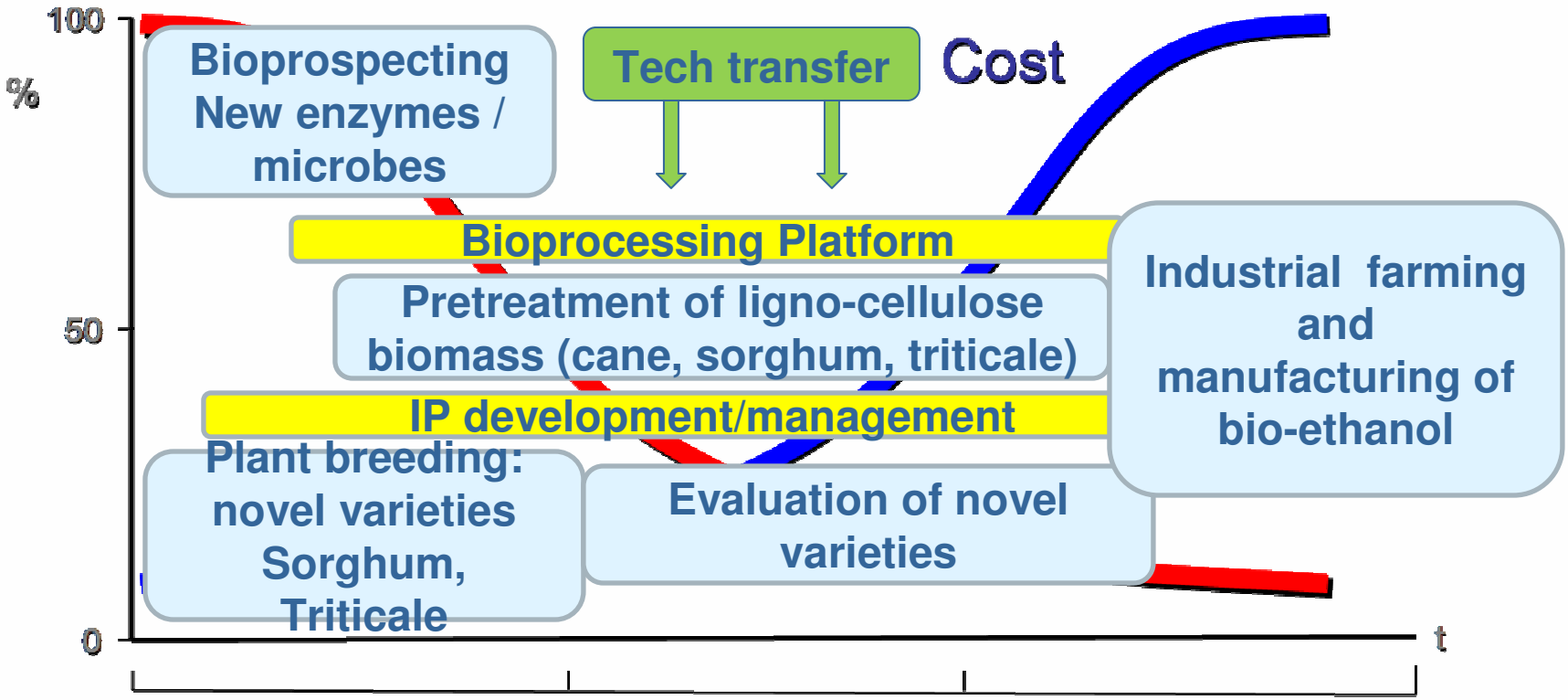
Sweet stem sorghum as feedstock for ethanol production

Late stage provides commercial/social value at short term
Early stage creates higher value at long term



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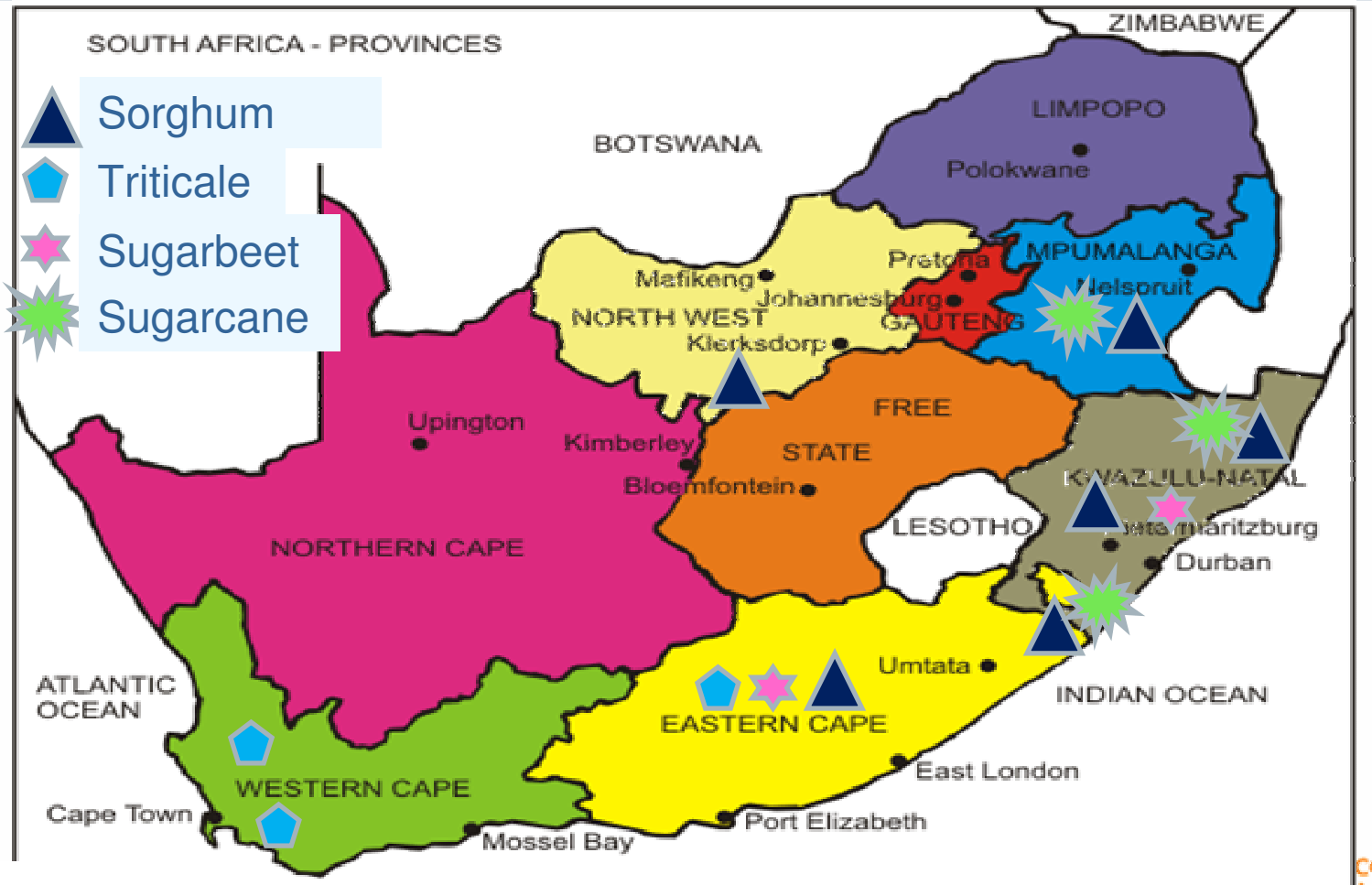
Energy crop trials



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Sweet sorghum varieties vs Grain sorghum varieties in KZN

Feedstock	Biomass Yield (T/ha)	Ethanol Yield (l/ha)
Grain sorghum MSJ2	6.0	2,685
Grain sorghum MSJ 14	4.4	1,969
SS sorghum MSJ13	82	2,482
SS sorghum SS27	72	3,470

Effect of different climate and soil on ethanol yield from sweet stem sorghum

Variety	Eastern Cape Stalk Brix (%)	Eastern Cape Ethanol (l/ha)	KwaZulu-Natal Stalk Brix (%)	KwaZulu-Natal Ethanol (l/ha)
MSJ13	16.6	8,621	8	2,482
MSJ5	12.0	6,802	10.2	2,387
MSJ22	16.8	10,093	3.9	1,229
SS27	14.3	5,561	12	3,470

Ethanol yield from various feedstock

Feedstock	Biomass yield (T/ha)	Ethanol yield (l/ha)
Sugarcane	60	4,200
Sugarbeet	85	5,950
SS sorghum (MSJ22)	84	10,093

Ethanol yield from grain (sorghum and triticale)

Feedstock	Grain Yield (T/ha)	Ethanol Yield (l/ha)
Grain sorghum MSJ2	6.0	2,685
Grain sorghum MSJ 14	4.4	1,969
Grain Triticale ABL-6	7.4	3,312
Grain Triticale ABL-11	7.7	3,313

Way forward

- 2 / 3 more years of trials
- Inclusion of energy cane and millet (sweet stem, high biomass) in at least three sites
- Extension of sugar beet trials to at least one more site
- New trials with bamboo and Miscanthus
- Development of crop improvement programs (breeding and GM)
- Exploration of novel downstream processes
- Co-investment in industrial production facilities

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