



Challenges for the regional food industry: Role of biotechnology in agriculture and rural development

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Outline of presentation

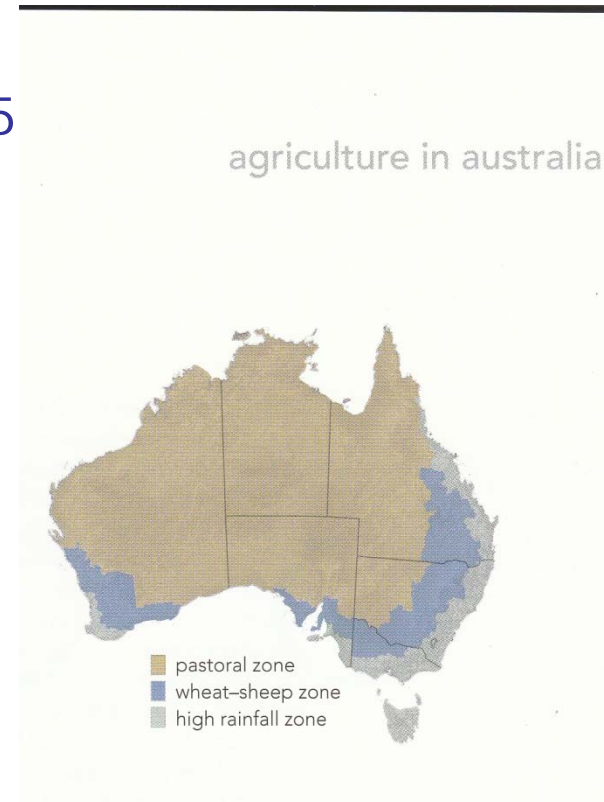
- Background information on agriculture in Australia
 - uncertain weather; highly variable production
 - export orientation of our agricultural industries
- Organisation of agricultural R&D in Australia
 - Biotechnology research in sugar and wheat
- Challenges facing adoption of biotechnology in agriculture

Introduction

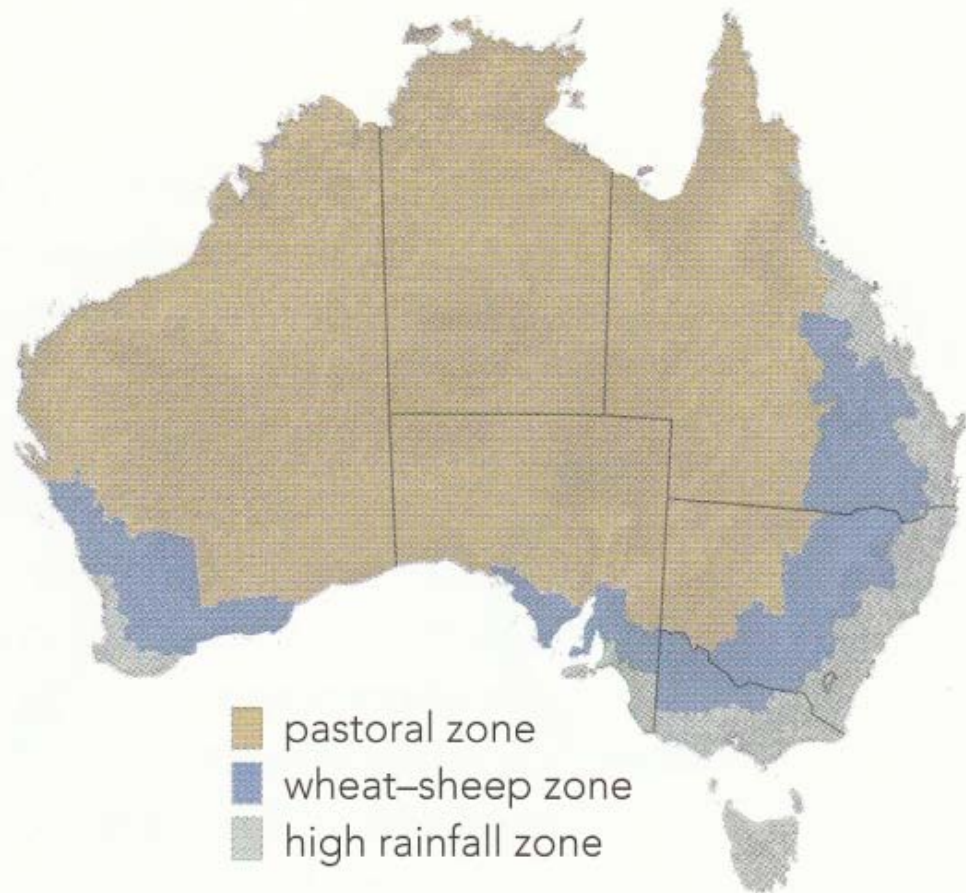
- World population currently 7 bn, expected to reach 9 bn by 2050
 - 'Emerging markets for bio-commodities could increase by as much as 80 percent of the current total world market to account for a larger share of the global workforce and the market for goods and services'
 - 'a major transformation of the global food system is needed to address future threats to food supply and security' Dr Megan Clark, CEO, CSIRO Australia
 - 'Australia needs to reduce its GHG emissions from agriculture by 50-80 percent by 2050 while contributing to a 30-80 percent increase in global food production' Peter Carberry, Deputy Director, CSIRO Flagship Program, on Sustainable Agriculture

Overview

- 52% of Australian landmass devoted to agriculture
- Agriculture is a vital part of the Australian economy
- >350 000 people employed in farming
- about 120 000 commercial farms in 2004-05
- 20% fewer farms than in 1984-85
 - 5 000 farms in pastoral zone
 - 54 000 farms in wheat-sheep zone
 - 57 000 farms in high rainfall zone
- average size >2 000 ha and increasing
- average area cropped: increased from 450 to 710 ha (58%) between 1985-86 and 2005-06



agriculture in australia



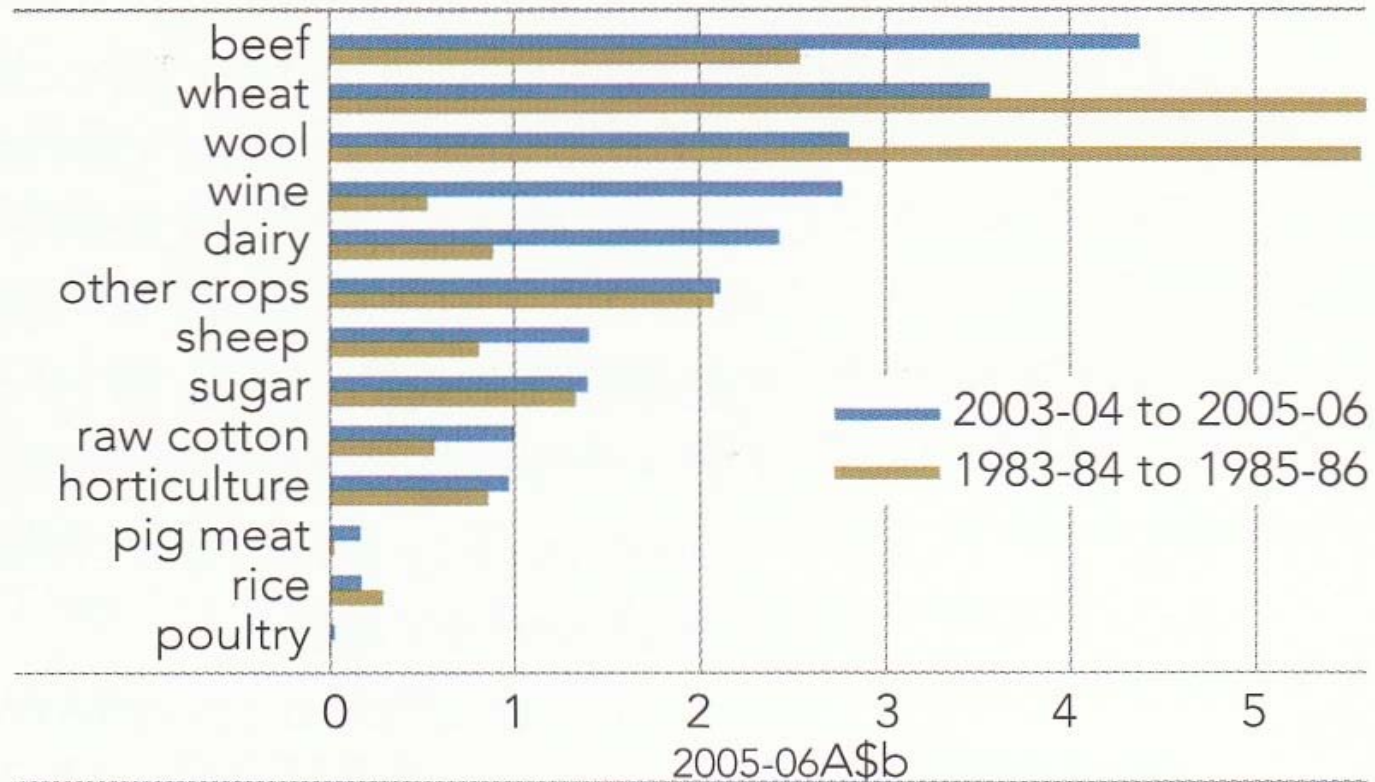
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Changes in Australian land use

Land use	2010 398 Mha	2001 456 M ha	1990 467 Mha	1980 496 M ha
Land used %	52.0	59.2	60.7	64.5
Wheat M ha	12.6	12.1	9.2	11.2
Wheat M t	13.6	22.1	13.1	16.2
Rice '000 ha	19	177	105	116
Rice '000 t	197	1,643	846	613
Cotton '000 ha	196	536	240	75
Cotton '000 t	352	666	792	244
Sugar cane	389	403	322	267
Sugarcane M t	31.235	28.117	26.940	21.151
Cattle M	26.550	27.772	23.191	26.203
Sheep M	68.085	110.928	170.300	135.985
Pigs '000	2,289	2,748	2,648	2,518

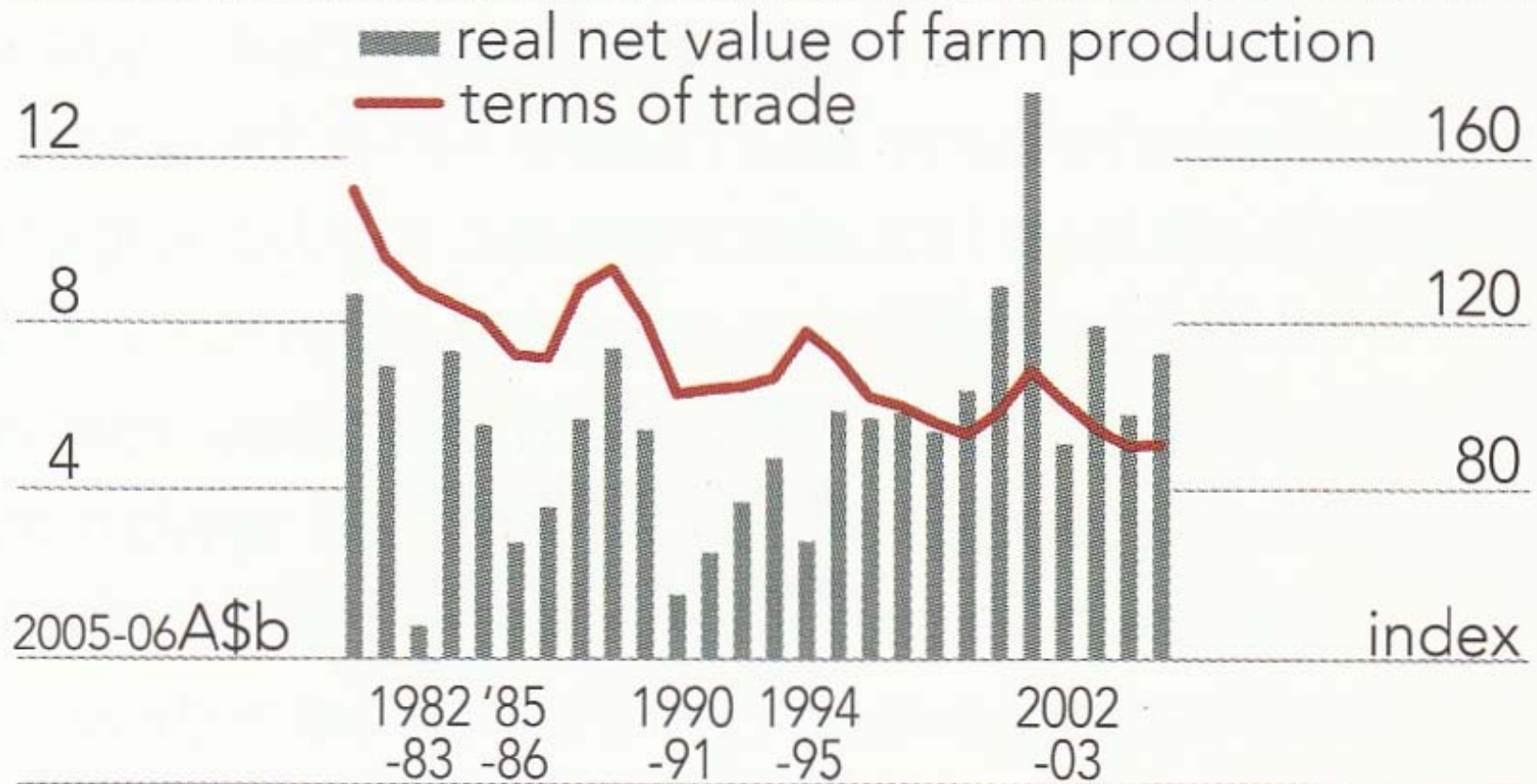
Trade

Major agricultural exports Australia, 3 year averages



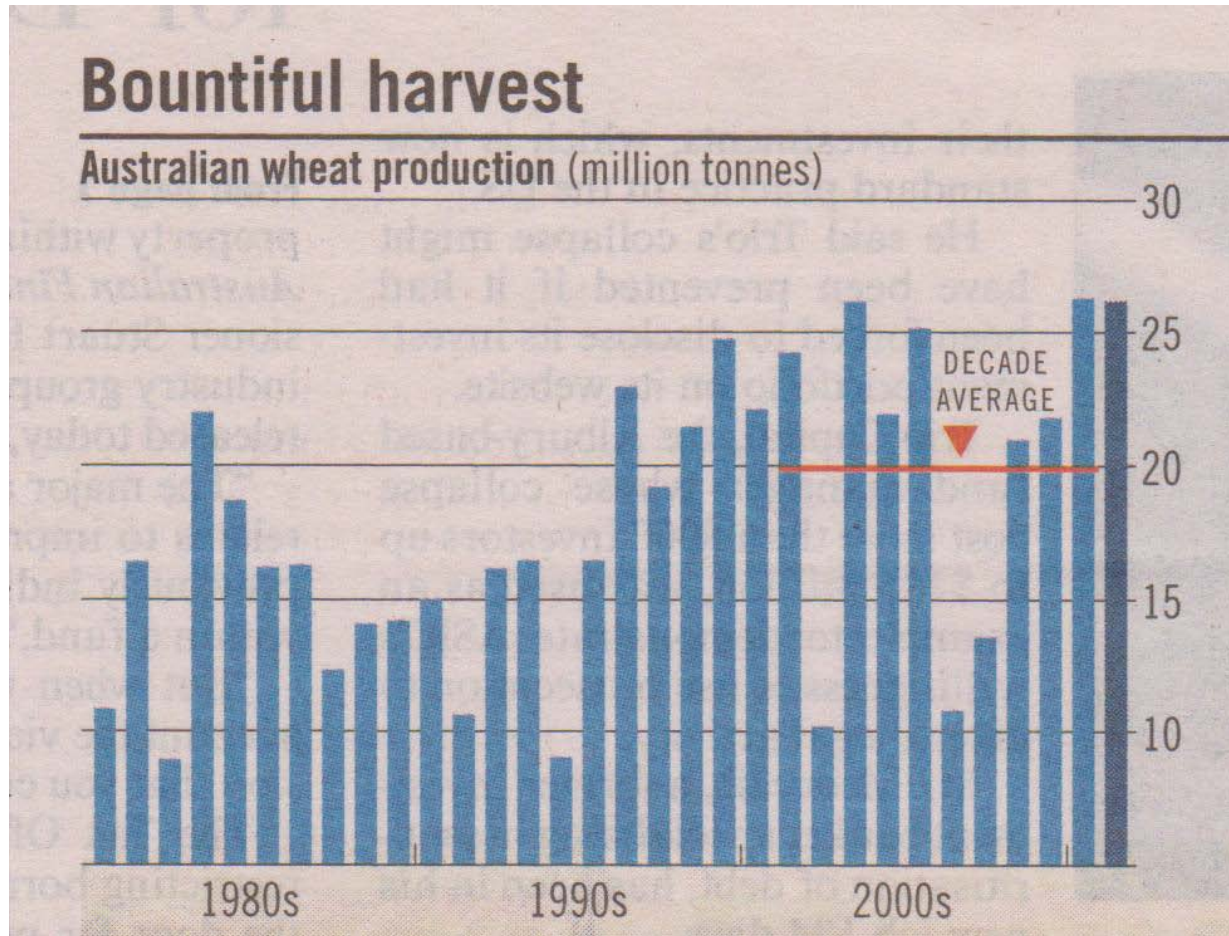
Farm sector income and terms of trade

Australia



- Source: Agricultural Economies of Australia and New Zealand

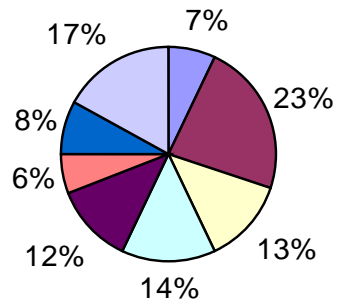
Variability in Australia's wheat crop:



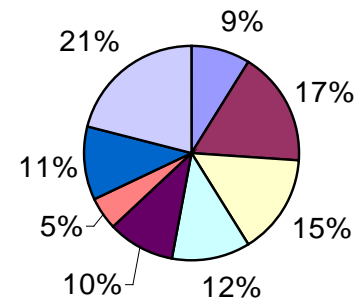
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Markets for Australia's agricultural exports

Average 1992-3 to 1994-5 A\$22 billion



Average 2002-3 to 2004-5 A\$28.4 billion



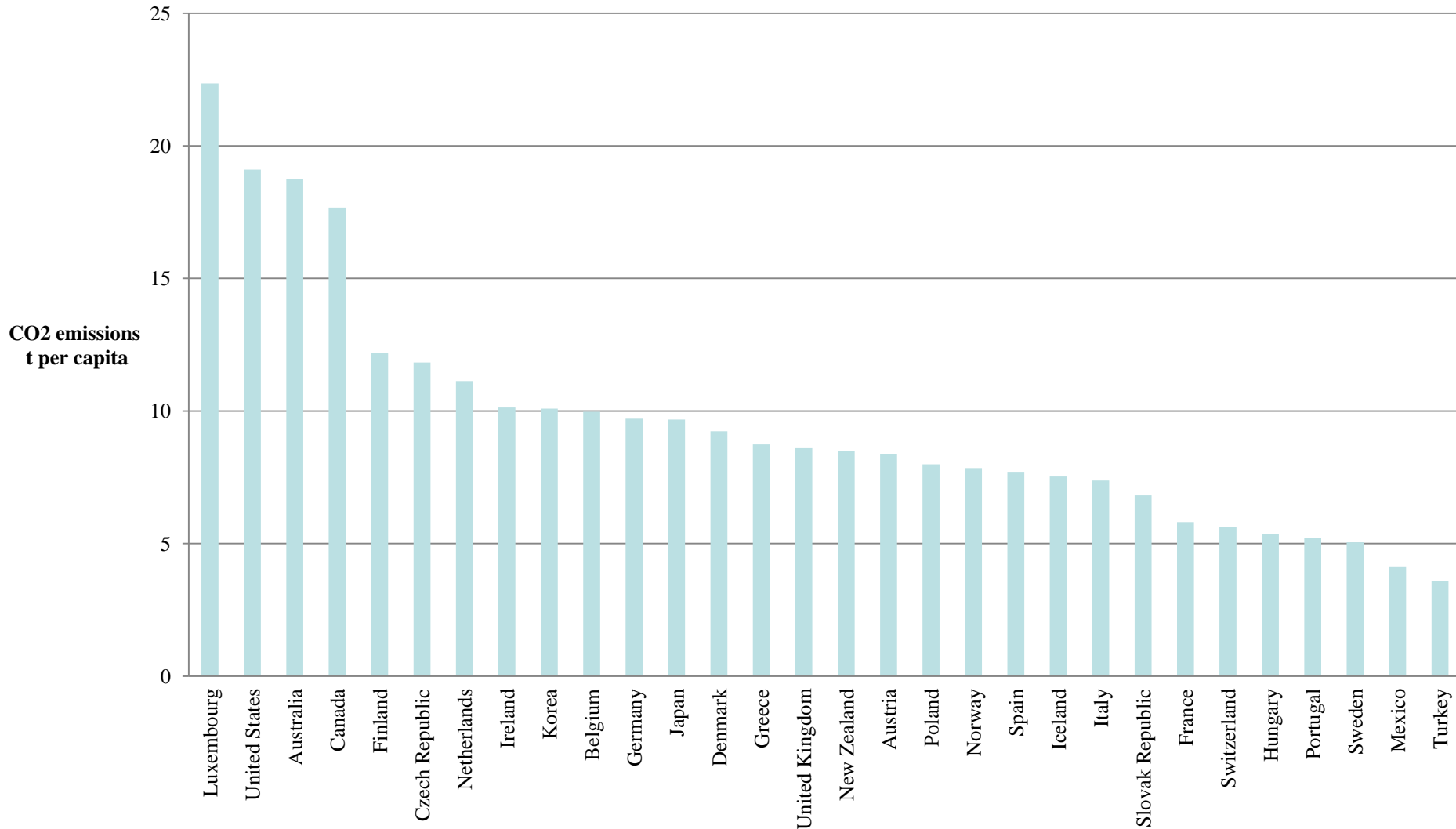
- China
- Japan
- ASEAN
- Other Asia
- Europe
- Middle East
- United States
- Other countries

Greenhouse gas emissions in Australia

- Total Australian greenhouse gas emissions were nearly 600 million tonnes carbon dioxide equivalent in 2007
 - 23.8 tonnes CO₂ per person
 - sixth highest in OECD countries
 - Much higher emissions per \$ of real output than OECD average
 - Electricity 33 per cent
 - Road transport 11 %
 - Livestock 10 %
 - Other sources 46 %



International comparison: GHG emissions per person



Australian agricultural research system

- Australian Government agencies
 - CSIRO, DAFF, ABARES, BREE, universities
 - Research funding agencies
 - Rural Research and Development Corporations
 - Industry Owned Corporations
- State government departments of agriculture
- Private companies
- Collaborative research organisations
 - Cooperative Research Centres

Biotechnology research in Australian grains

- Grains Research and Development Corporation
 - Recently announced six research themes
 - Meeting market requirements
 - Improving crop yield; Crop protection
 - Profitable farming systems
 - Managing the farm resource base
 - Building skills and capacity
 - Funds two 'public' wheat breeding program
 - Biotech research includes disease resistance, sprouting, and late-maturity alpha-amylase



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Biotechnology research in Australian wheat

- CSIRO: developing wheat with health attributes, higher yield, and more sustainable production
- Australia could be first country with GM wheat
 - High amylose wheat
 - Makes starch more resistant to digestion
 - More efficient uptake of nitrogen
 - Yield increase by suppressing expression of one gene
 - Trial near Canberra destroyed by Greenpeace activists

Biotechnology research in Australian sugar

- Cooperative Research Centre for Sugar Industry Innovation through Biotechnology, 2003-2010
 - Two research programs
 - Advanced breeding of sugarcane varieties using genetic modification
 - Development of new products from sugarcane
 - International cooperation in research, Brazil and USA
 - Breeding for drought tolerance
 - Sugarcane as biomass for energy production

International biotech research in sugarcane

- Syngenta (USA): excellent opportunities for GM cane
 - GM sugarbeet was 92% of market after 2 years
 - High-quality sett planting material
- Bayer (Germany): demand for biomass feedstock
 - Advantages of sugarcane ethanol
 - Interest in therapeutics and novel compounds
- Monsanto (Brazil): biotechnology to complement conventional breeding
 - Breeding for drought resistance to expand possible area of production

Opportunities for bio-products from sugarcane

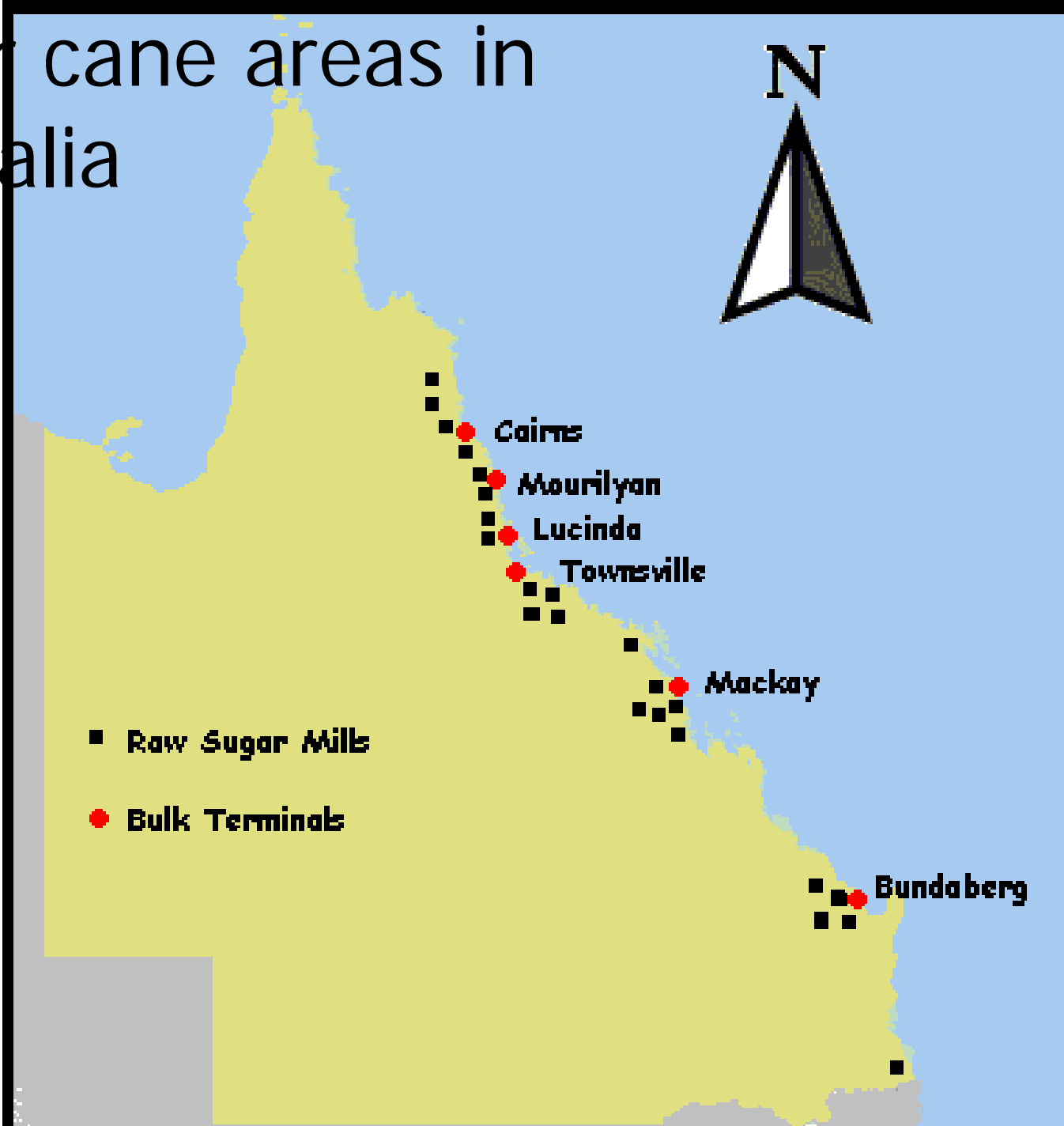
- Biomass as a renewable energy source
 - Cane sugar mills traditionally powered by residue
 - Molasses or cane juice fermented to ethanol
 - Cane fibre and sugar can be converted to many other carbohydrate chemicals
- Genetic transformation of cane plants to produce bioplastics (PHAs, polyhydroxyalkionates) in leaves
 - \$60 bn plastic products in US per year, nearly all derived from petrochemical sources
 - Significant source of greenhouse gases



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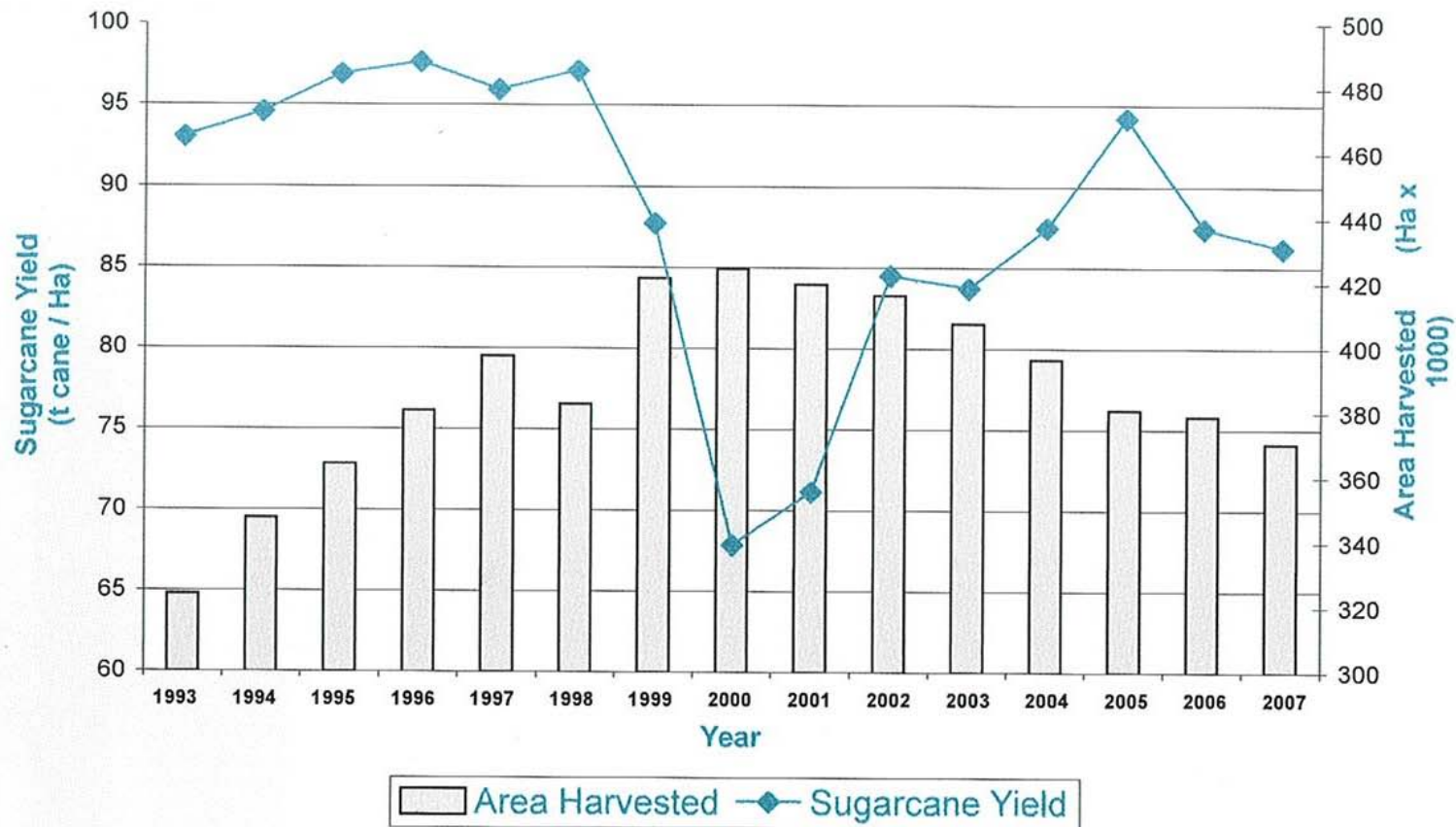
Sugar cane areas in Australia



Background information on the Australian sugar industry

- Current production: 35-40 million tonnes cane/y
 - 400 000 hectares of cane harvested per year
 - 4 000 independent sugarcane farmers
 - 25 raw sugar mills producing mainly raw sugar for export
 - 3 mills with ethanol distilleries
 - half of the molasses produced is exported; domestic consumption shared between ethanol production and livestock feeding

Area of sugarcane harvested and cane yield in Australia, 1993-2007



Source: ASMC Statistics



Sugarcane harvest and transport, Mackay, Australia







Assessing the environmental impact of Australian sugar production

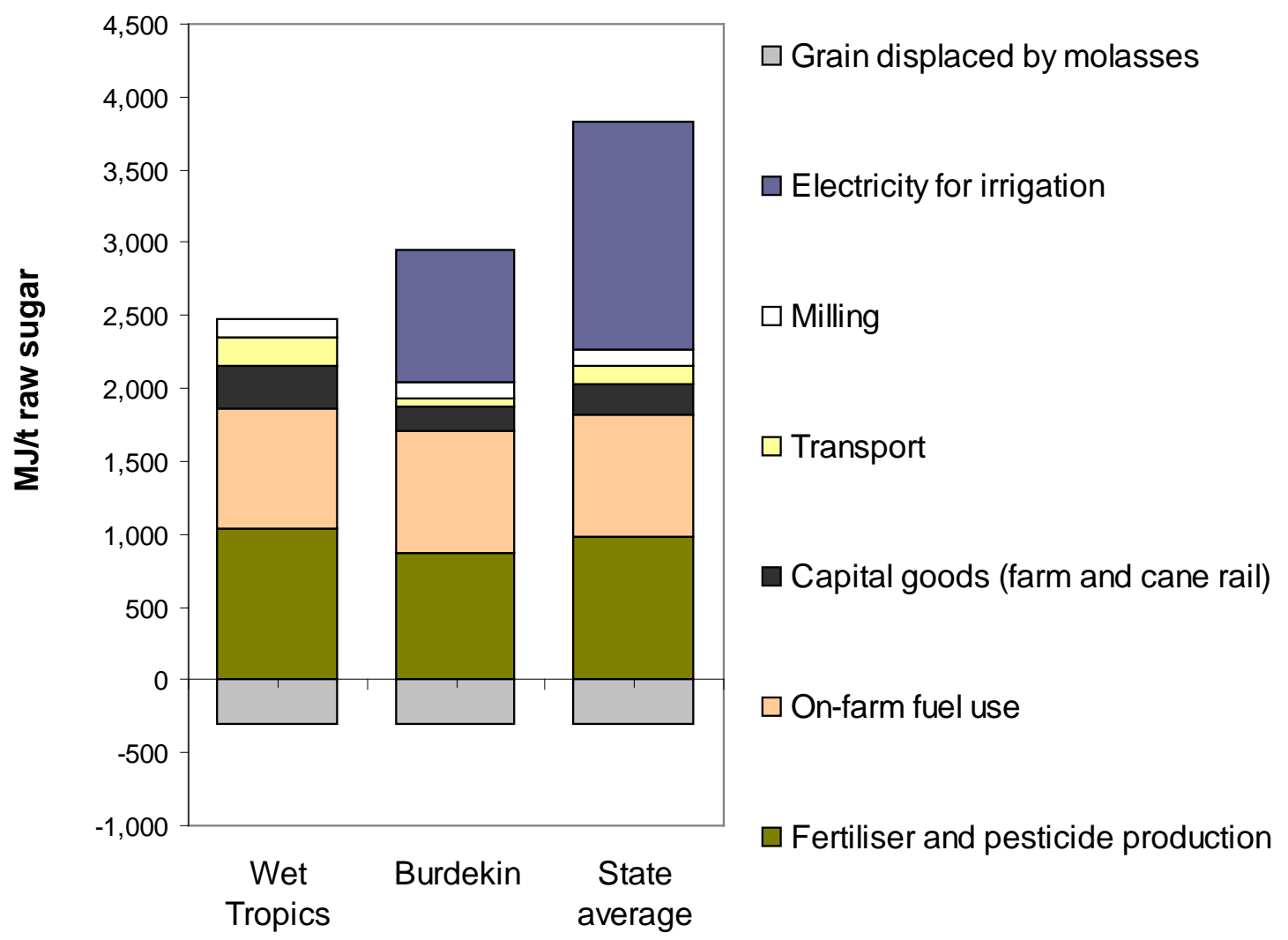
- Environmental Life Cycle Analysis (LCA)
- assess environmental impact of a product over its entire life cycle, accounting for:
 - all resources consumed
 - all emissions to the environment
in production, in use, and after disposal
- report and compare:
 - Depletion of non-renewable resources (energy inputs)
 - Greenhouse gas emissions
 - Water quality impacts (eutrophication potential)
 - Water use
 - Land use



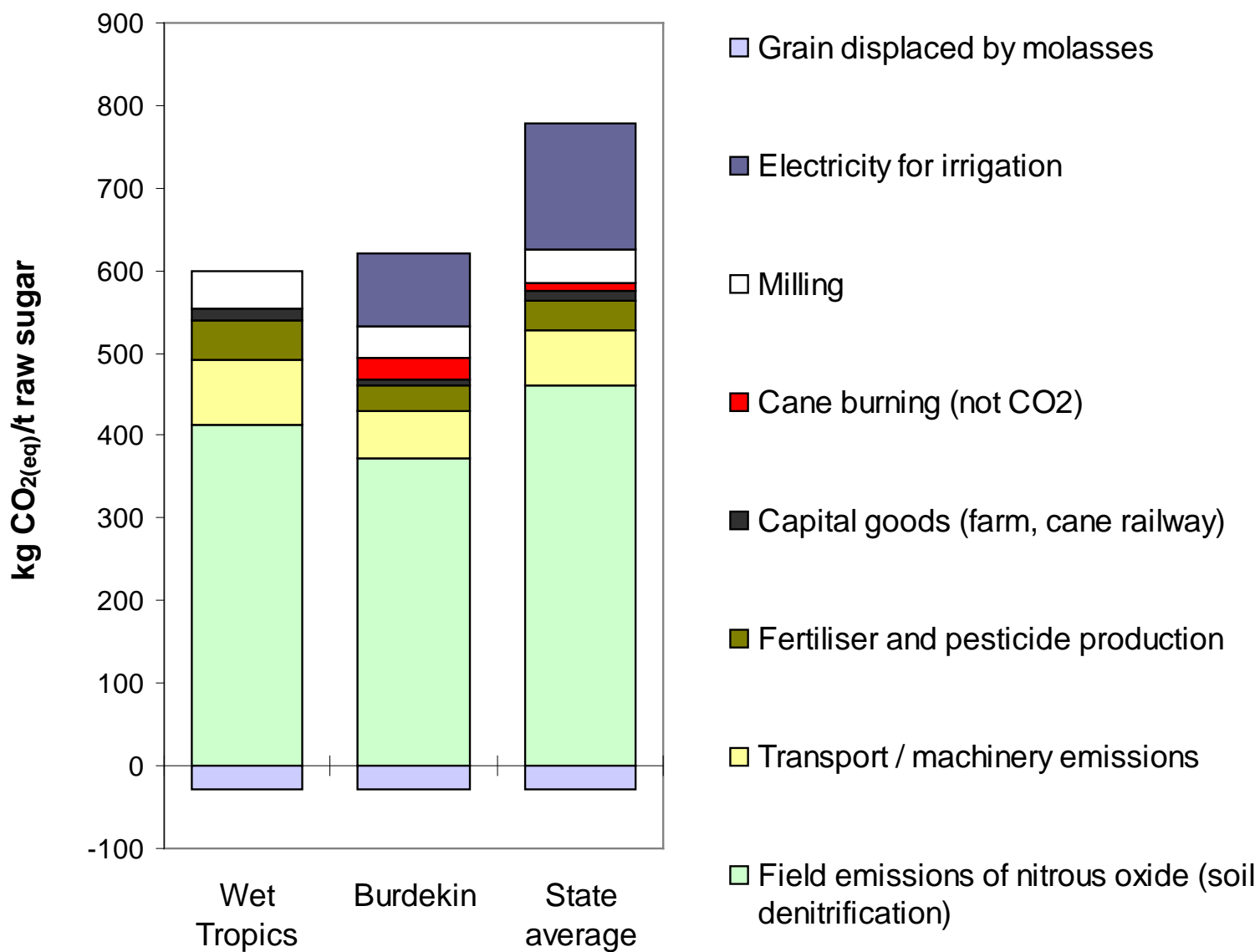
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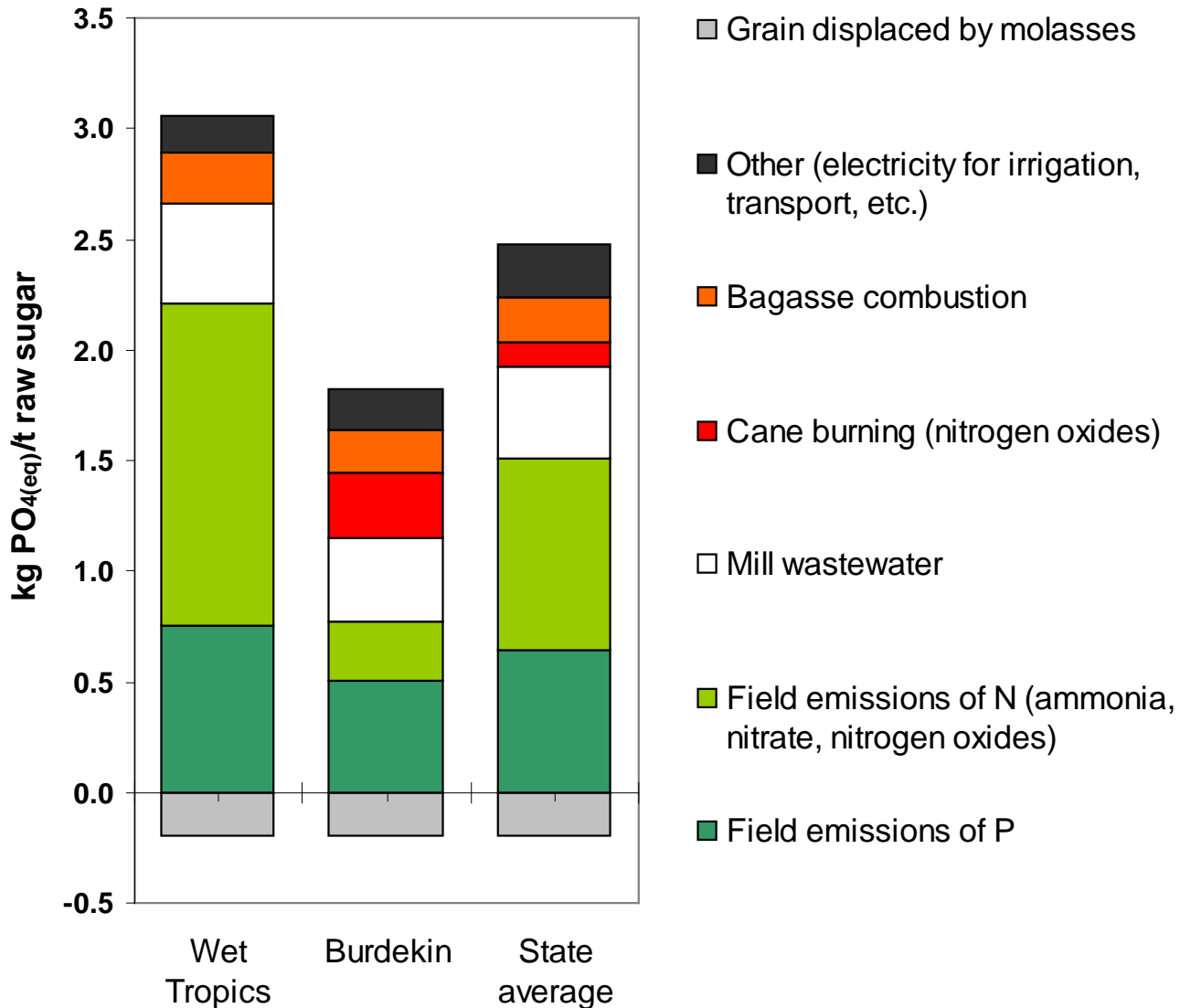
Breakdown of energy inputs – per tonne sugar



Breakdown of GHG emissions – per tonne sugar



Water polluting potential – per tonne sugar



Comparing cane with corn and sugar beet

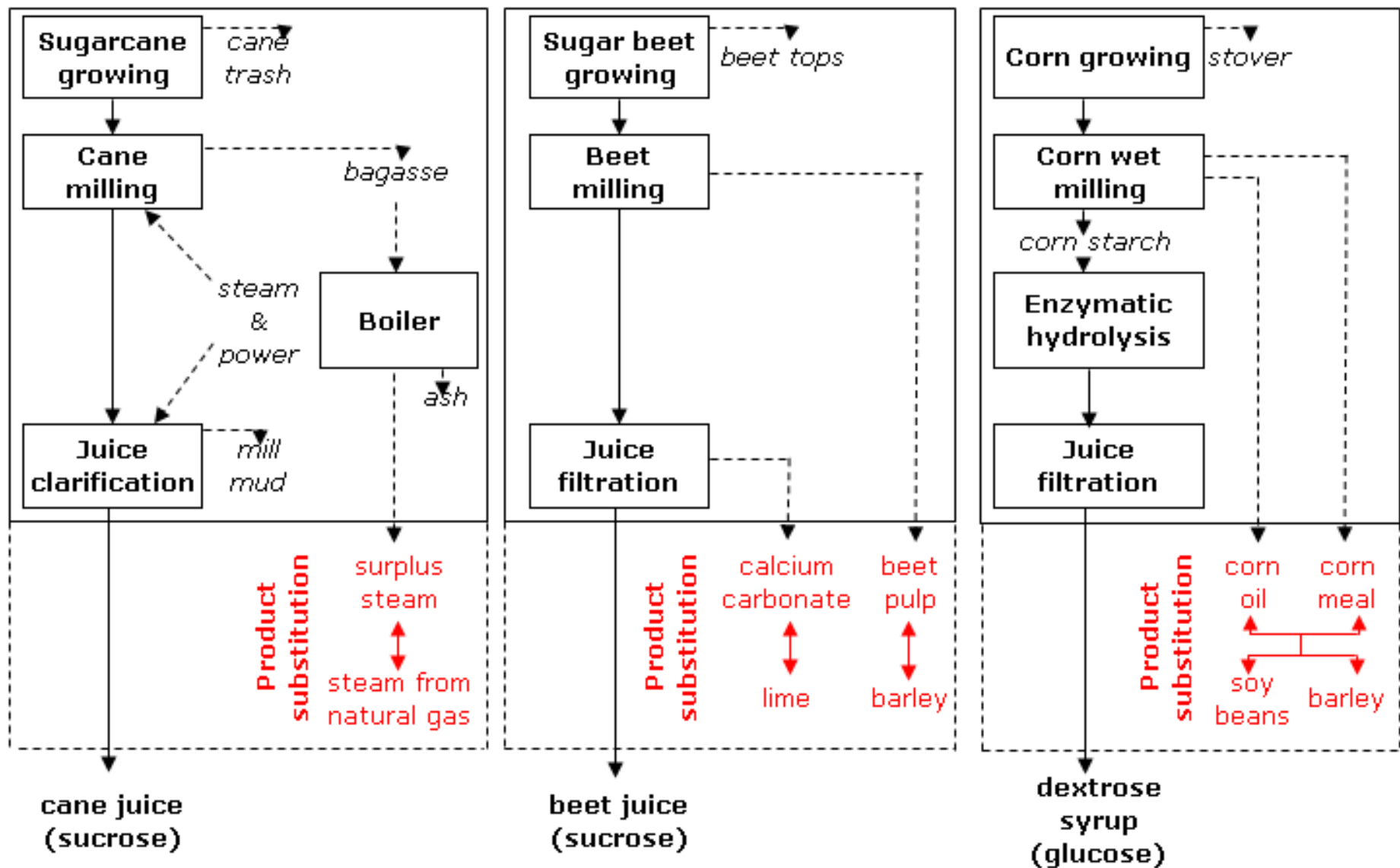


Each plant produces a sugar or starch solution

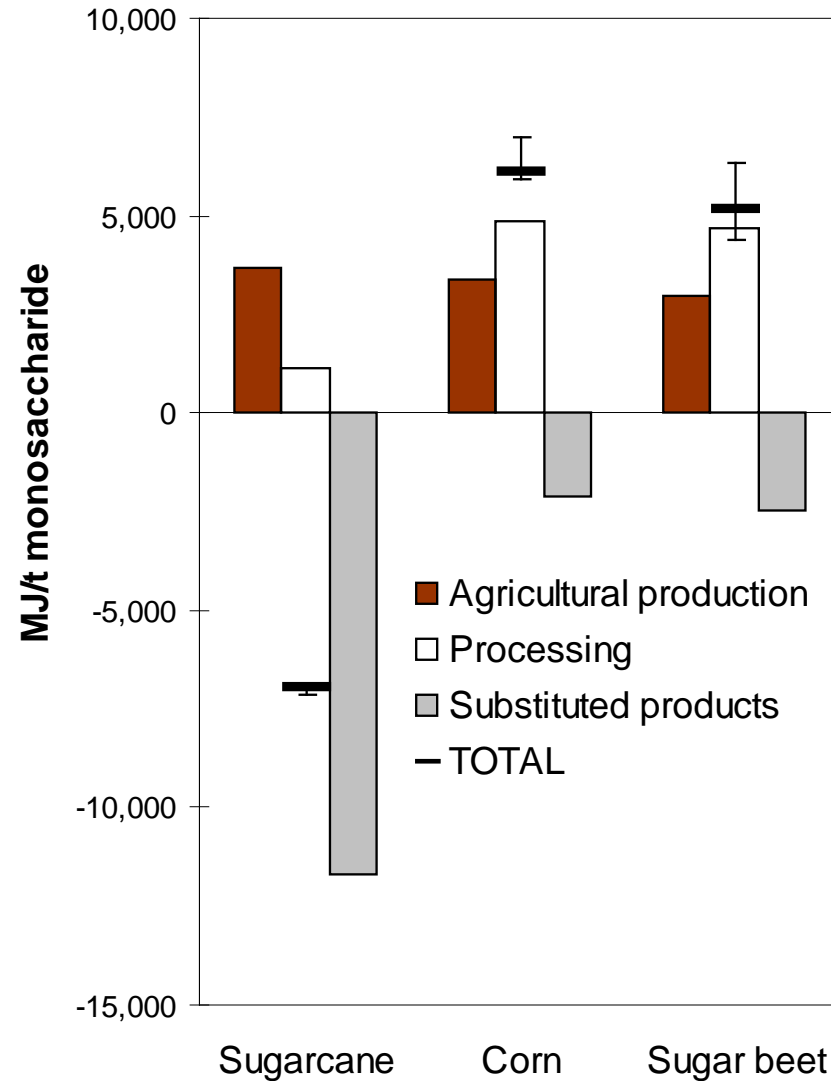
Each is a potential source of fermentable substrate for bio-products

Add cassava and other crops to this potential list

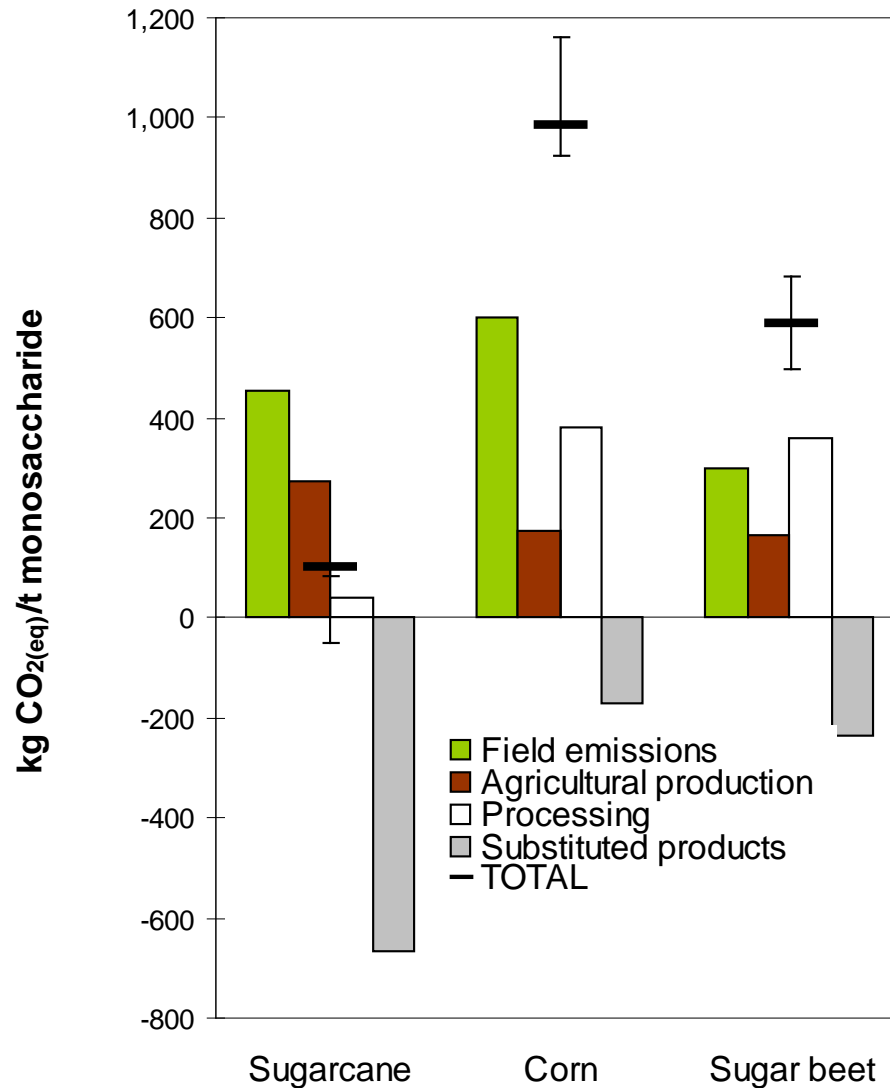
Comparing cane with corn and sugar beet



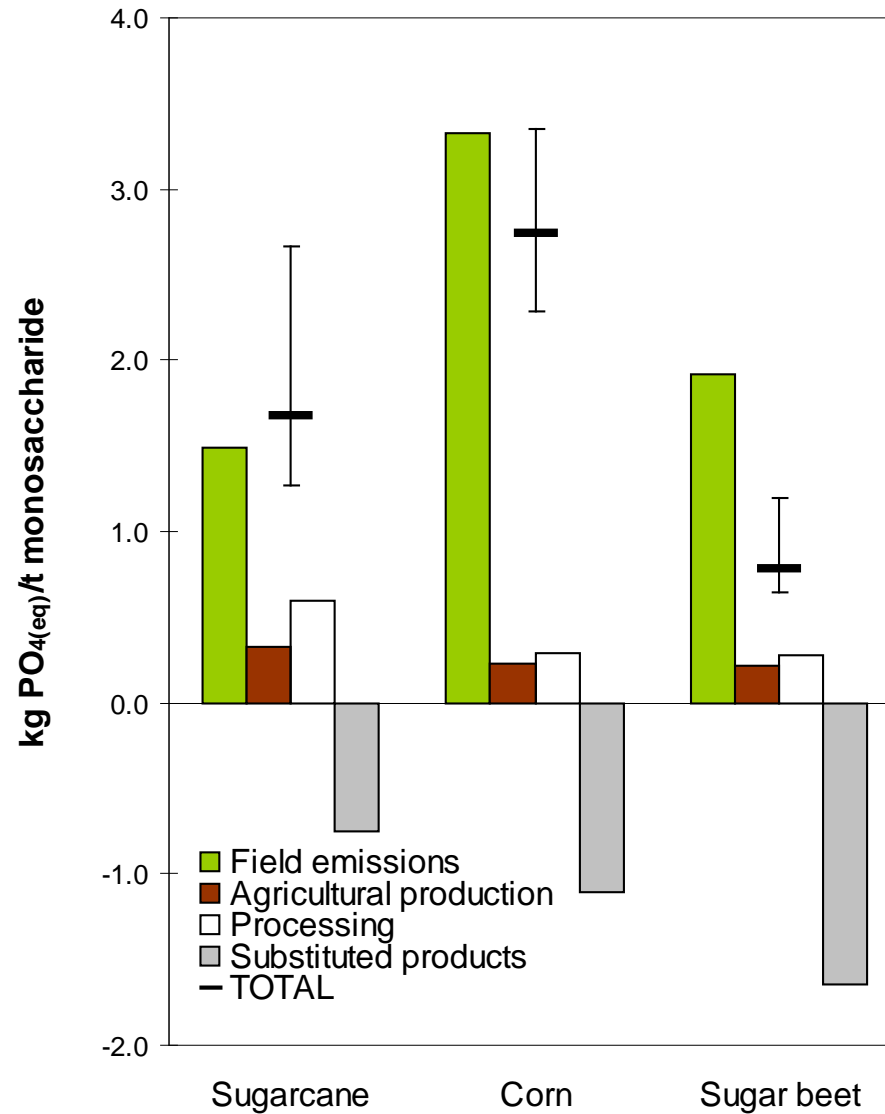
Energy inputs – per tonne saccharide (glucose)



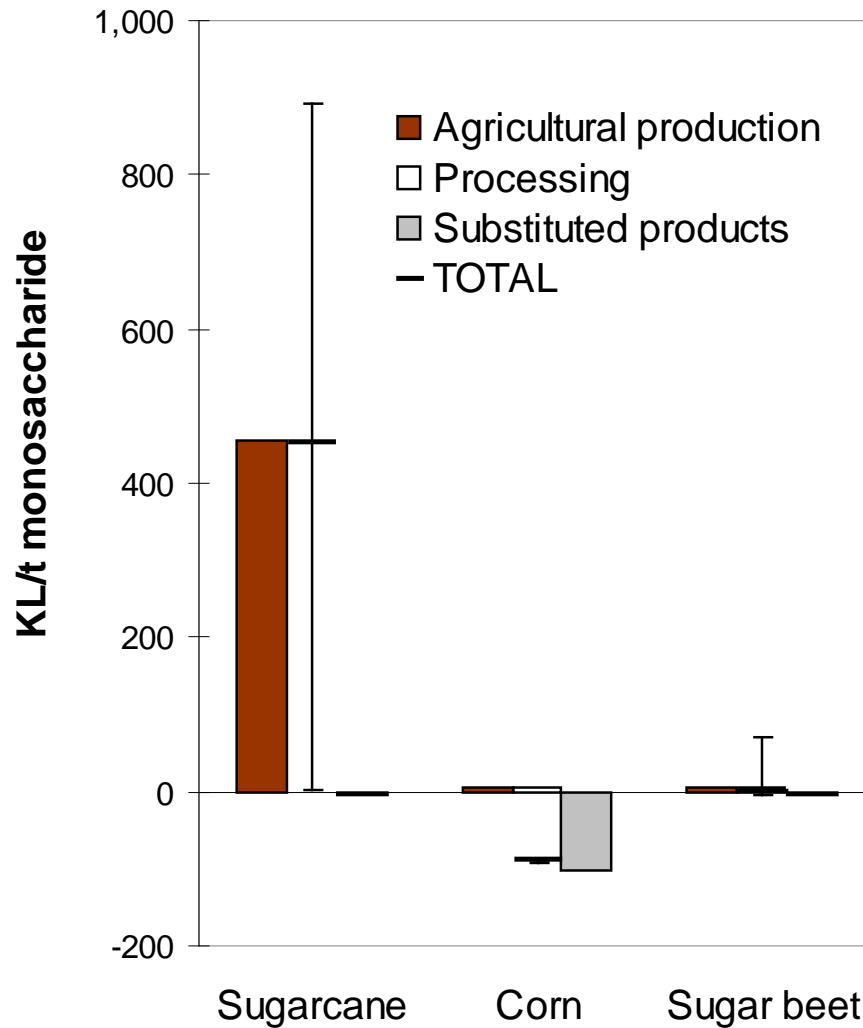
Greenhouse gas emissions – per tonne saccharide



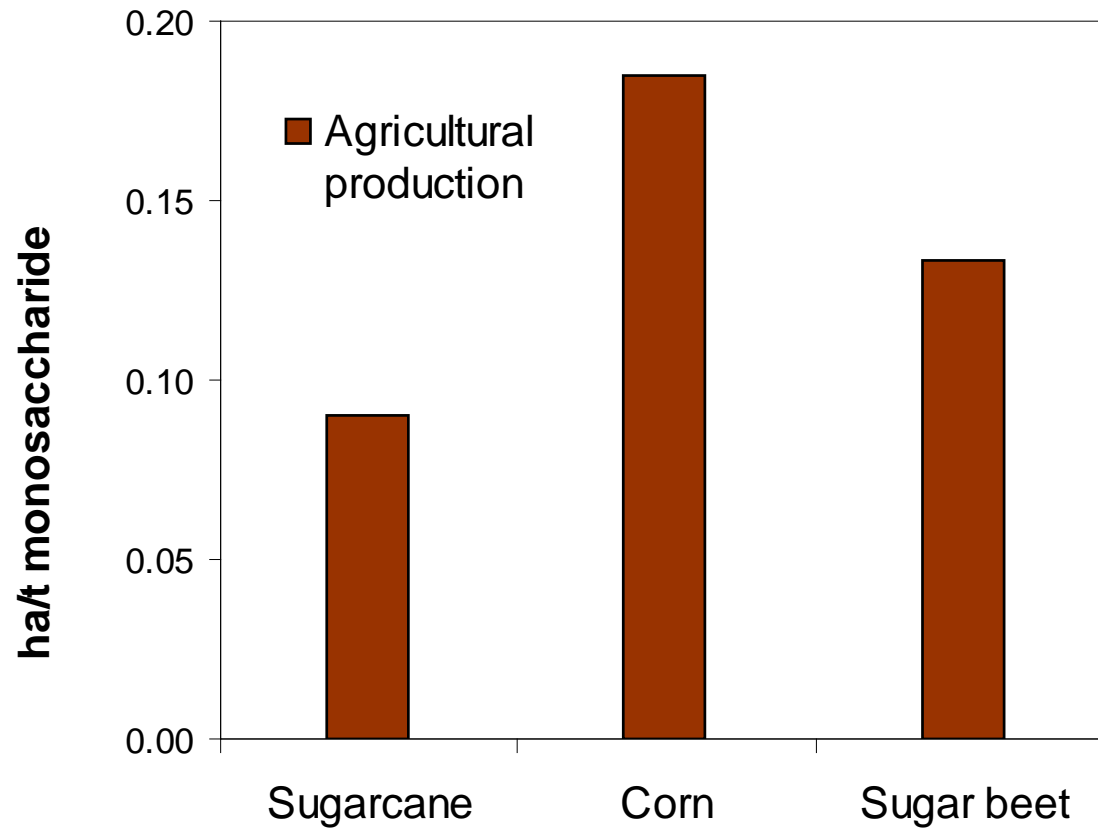
Water polluting potential – per tonne saccharide



Water use – per tonne saccharide



Agricultural land use – per tonne saccharide



Challenges to be faced by agricultural biotechnology

Doing the research

Opportunities to produce wide range of diversified products, sugarcane example

- Ethanol from cane juice or molasses as a transport fuel
- Ethanol from cellulose residue (bagasse)
- Electricity from surplus bagasse for export to power grid
- bio-plastics from soluble carbohydrates
- in plant production of novel bio-materials
- low-value high volume organic chemicals (lactic acid, ethanol) or high-value niche products such as food dyes, essences, food additives, pharmaceuticals

Challenges to be faced by agricultural biotechnology

Managing the policy environment

‘I’m from government and I’m here to help you’.

- lack of clear energy policy in Australia
 - low target for bio-fuels
 - restrictive environmental policies on land clearing, farming in sensitive environmental areas, reduced water for irrigation in the Murray-Darling Basin
 - encouraging policies towards mining and gas extraction to the concern of farmers in strategic cropping lands
 - inconsistent policy in regard to renewable energy favouring roof-top solar panels over commercial production
 - conflict between state and federal policies, carbon tax

Challenges to be faced by agricultural biotechnology

Managing the social reaction

Many of the opportunities to produce new or novel products involve genetic manipulation

- Regulatory and approval processes
- cost of regulatory approval for GM crops
- activities of active opposition groups
 - Greenpeace in Australia and elsewhere
 - legal challenge to production of Round-up Ready sugarbeet in the United States
- commercialisation, venture capital, and investment capital
- consumer awareness and concern about GM crops

Challenges to be faced by agricultural biotechnology

Managing the policy environment

Regulation of glyphosate resistant sugar beet in US approved by USDA in 2005 without an Environmental Impact Statement

legal challenge by Centre for Food Safety et al.

decision by US District Court (Northern California)

9th US Circuit Court of Appeals reversed court order

'stecklings' for seed production or breeding could be grown

growers permitted to grow commercial sugarbeet in 2011 season under controlled conditions

Meeting regulatory needs in sugar

Extensive research to identify potential environmental damage

extent of natural reproduction by sugarcane seedlings

potential for cross-breeding with wild species

plan to provide adequate information for Office of Gene Technology Regulator to approve GM cane

Contrast between Australian and US system of approving GM crops

Conclusions

GM crops widely grown around world, > 120 M ha

soybean, corn, cotton, canola

USA, Argentina, Brazil, Canada, India

- GM wheat available in Australia in 7-10 years
- Attributes in wheat and sugarcane to extend production zone
- Rice??
- Algal production of biofuels, aviation jet fuel
- Continuing irrational resistance to biotech agriculture
- Challenge to get policies and institutions right to utilise biotech to meet rising food and fuel demands with fewer resources and less environmental impact

Thank you

Any questions?