Renewable Resources as Feedstock

Jürgen O. Metzger
University of Oldenburg

http://www.chemie.uni-oldenburg.de/oc/metzger

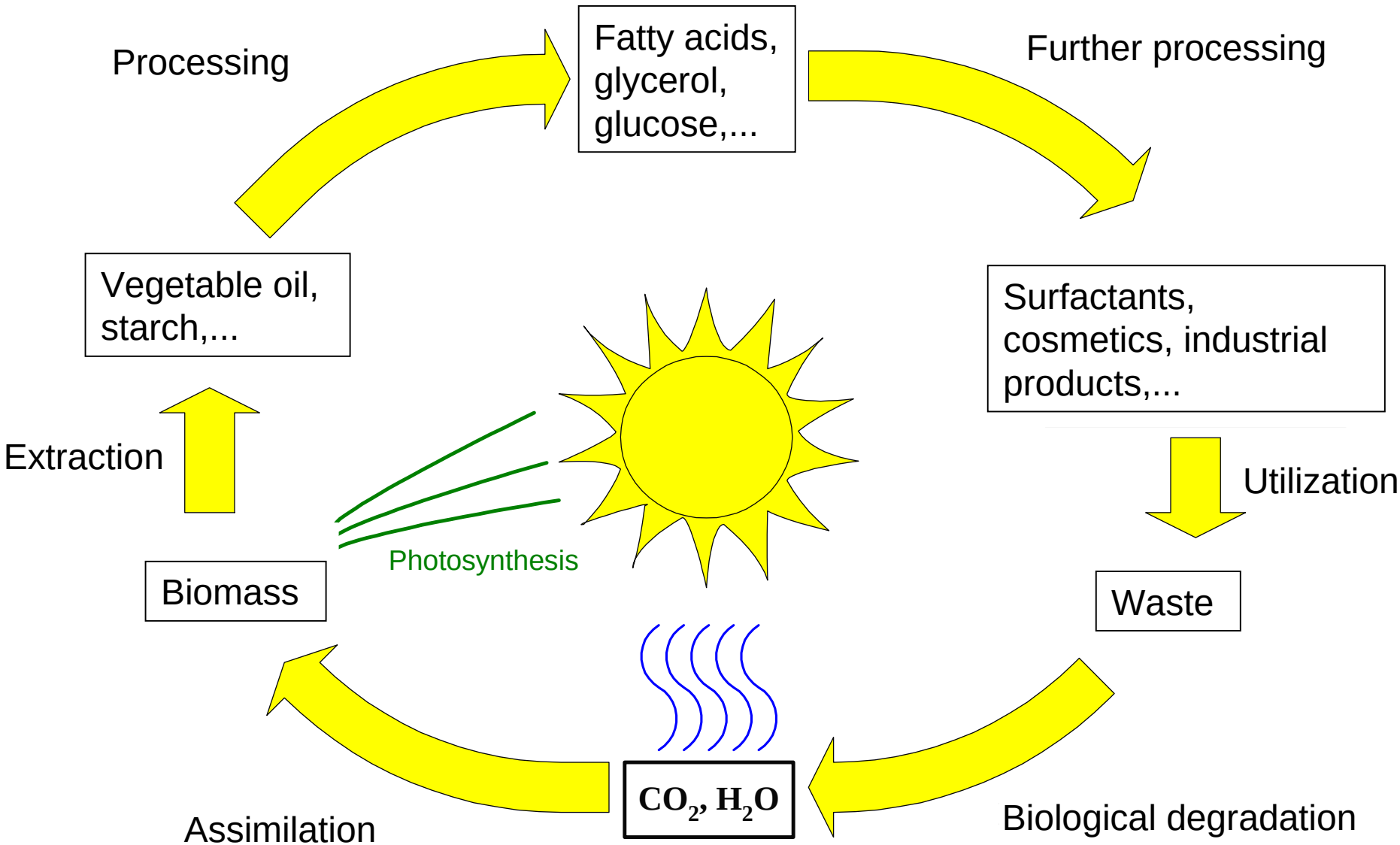
Agenda 21

Chapter 4
CHANGING CONSUMPTION PATTERNS

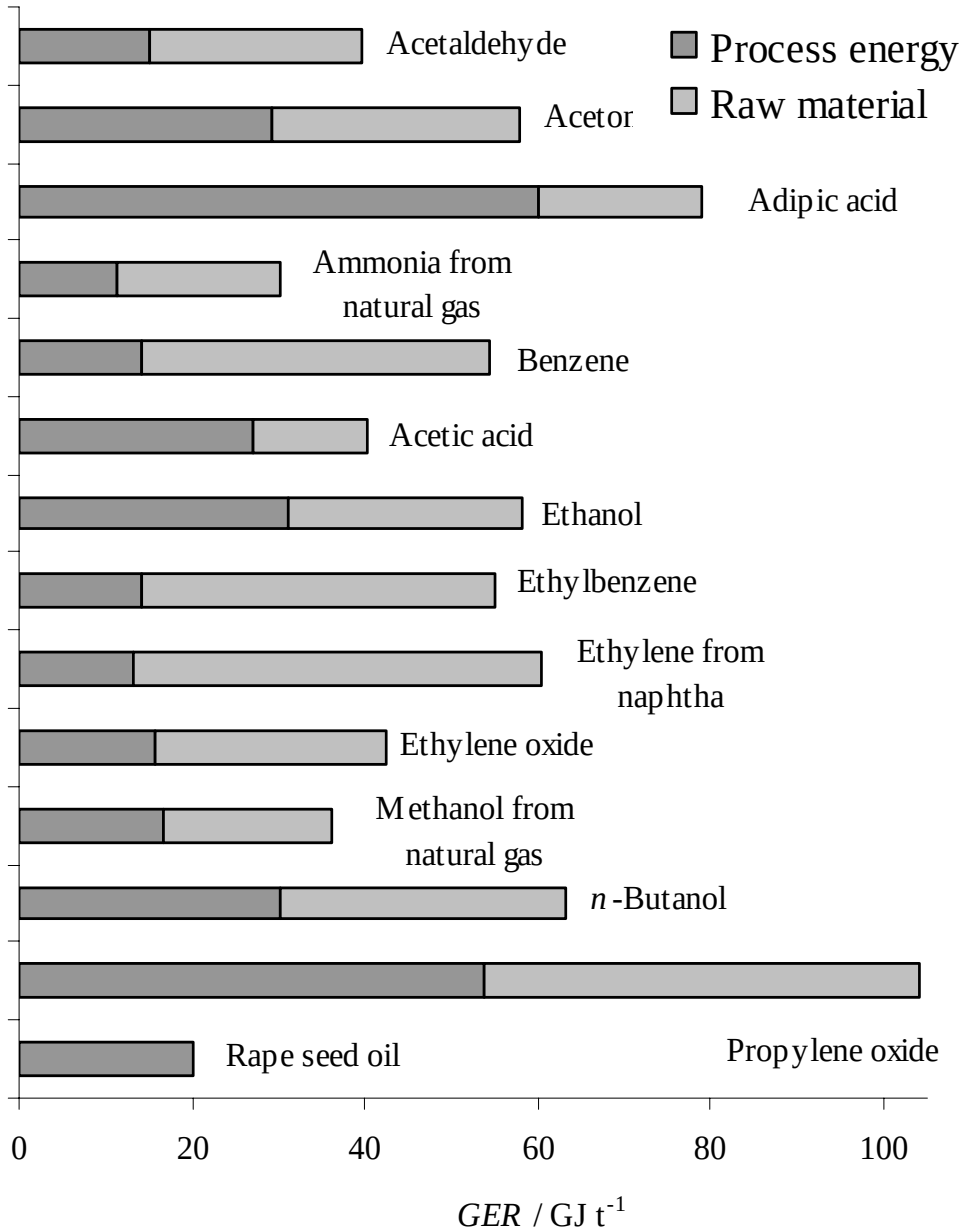
4.18. (e)
Encouraging the **environmentally sound and sustainable use of renewable natural resources.**

http://www.bmu.de/fset1024.php; http://www.un.org/esa/sustdev/

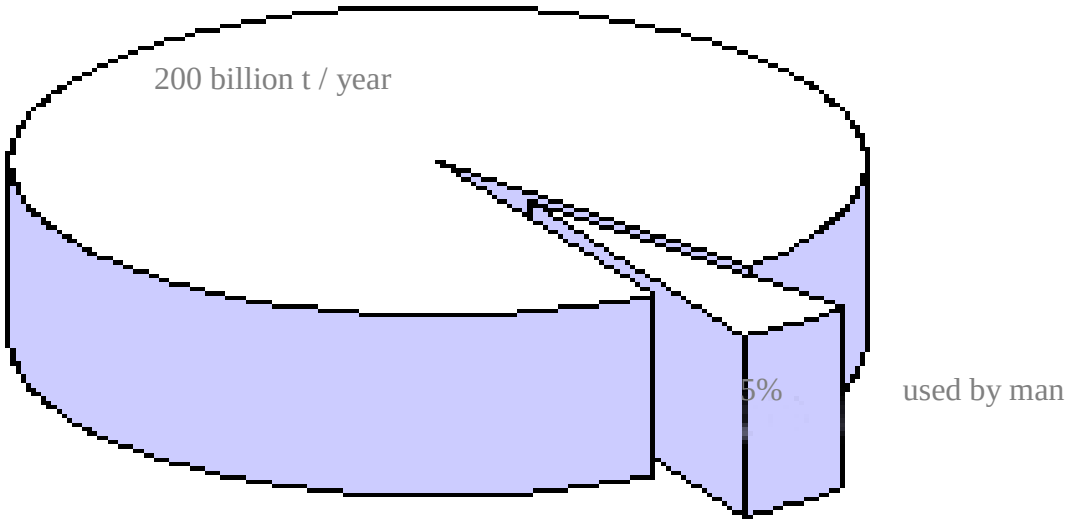
Biomass Cycle



Gross Energy Requirements of Important Base Chemicals

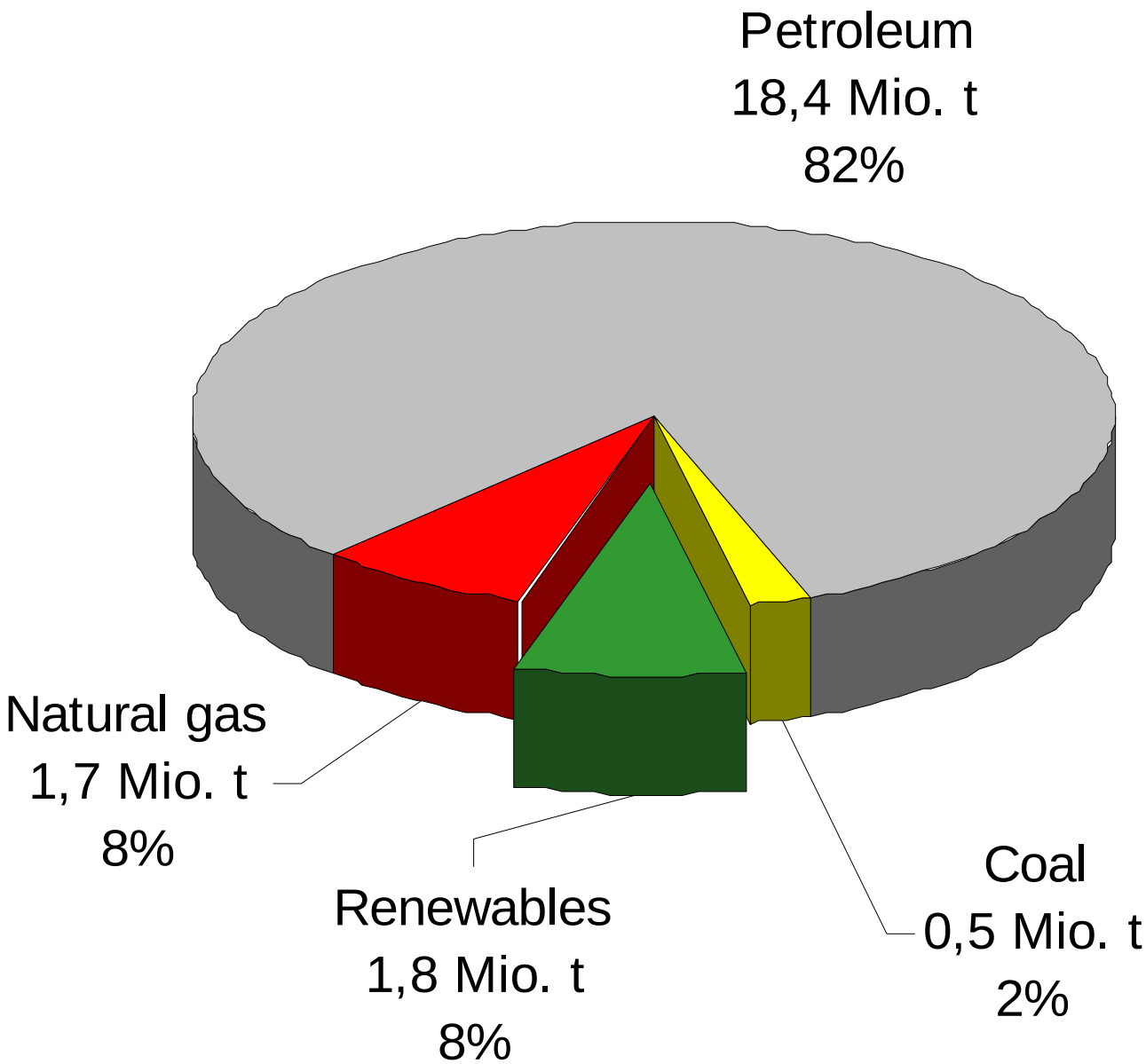


Biomass

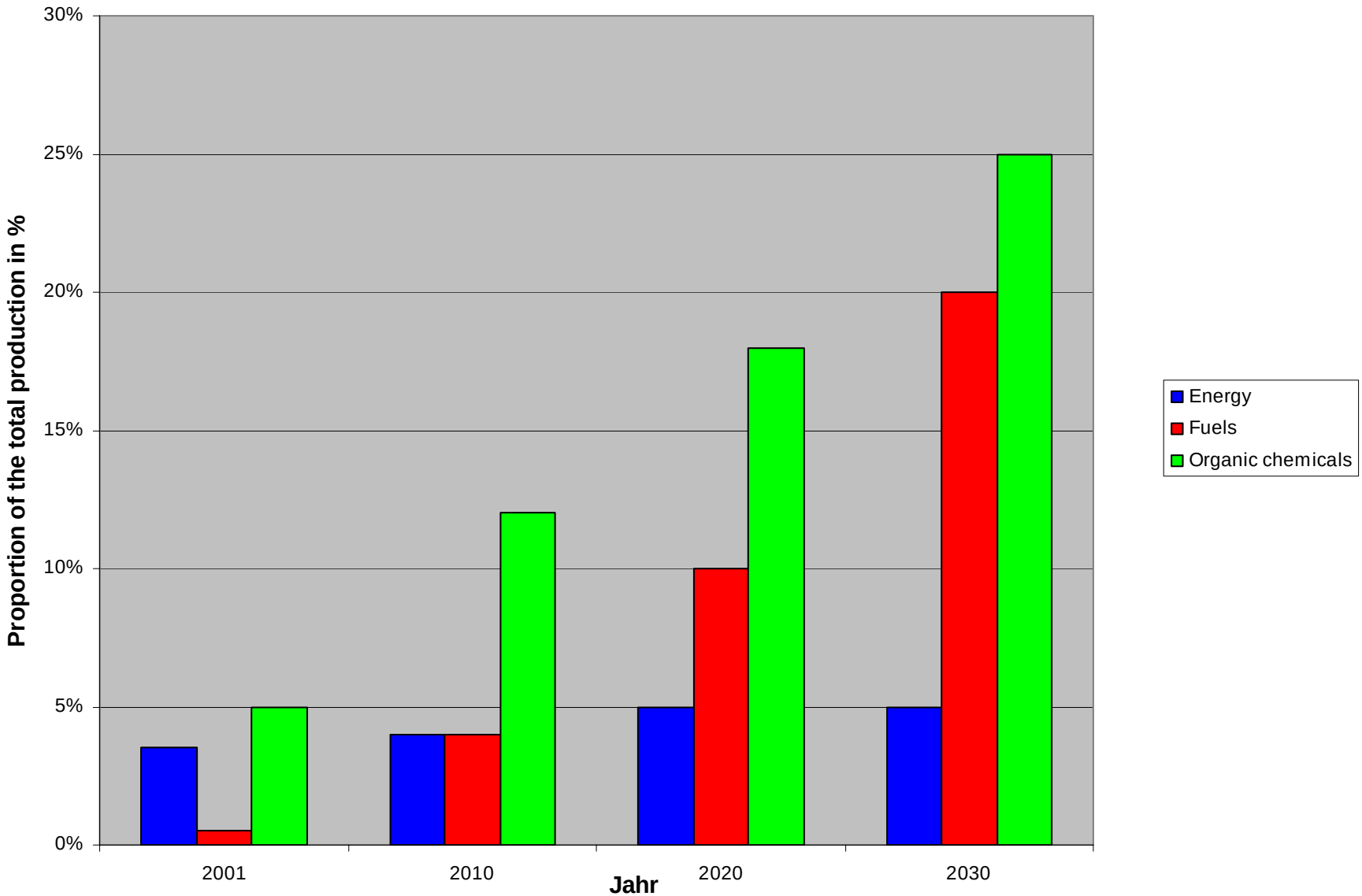


Carbohydrates	75 %
Lignin	20 %
Fats, Proteins, Terpenoids, etc.	5 %

Feedstocks of the Chemical Industry in Germany (1991)

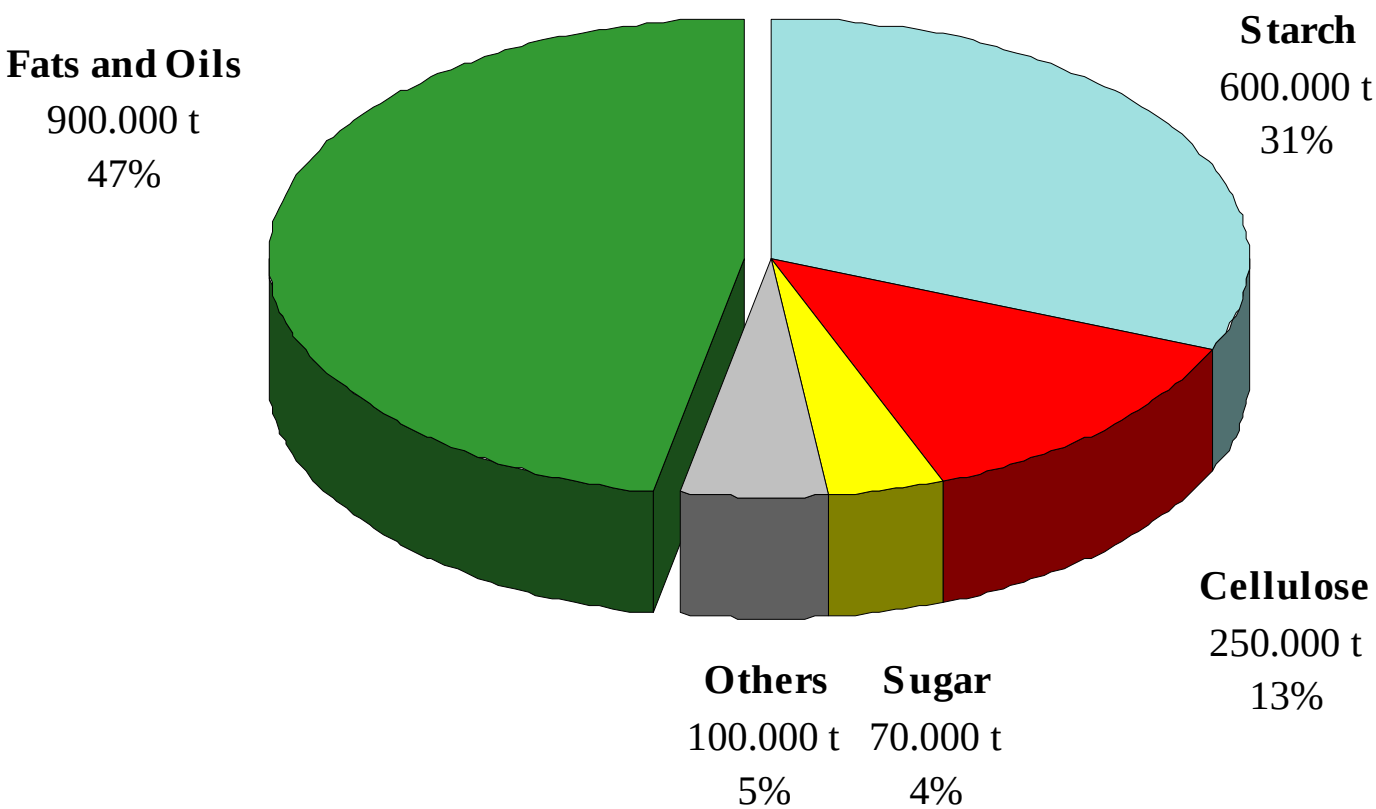


Targets of Biobased Products in the USA



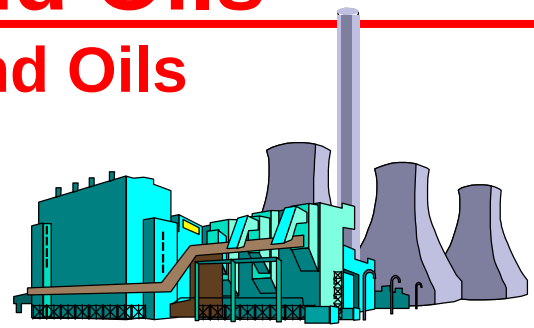
Vision for Bioenergy & Biobased Products in The United States, Biomass Research and Development Technical Advisory Comitee, October 2002, http://www.bioproducts-bioenergy.gov/pdfs/BioVision_03_Web.pdf.

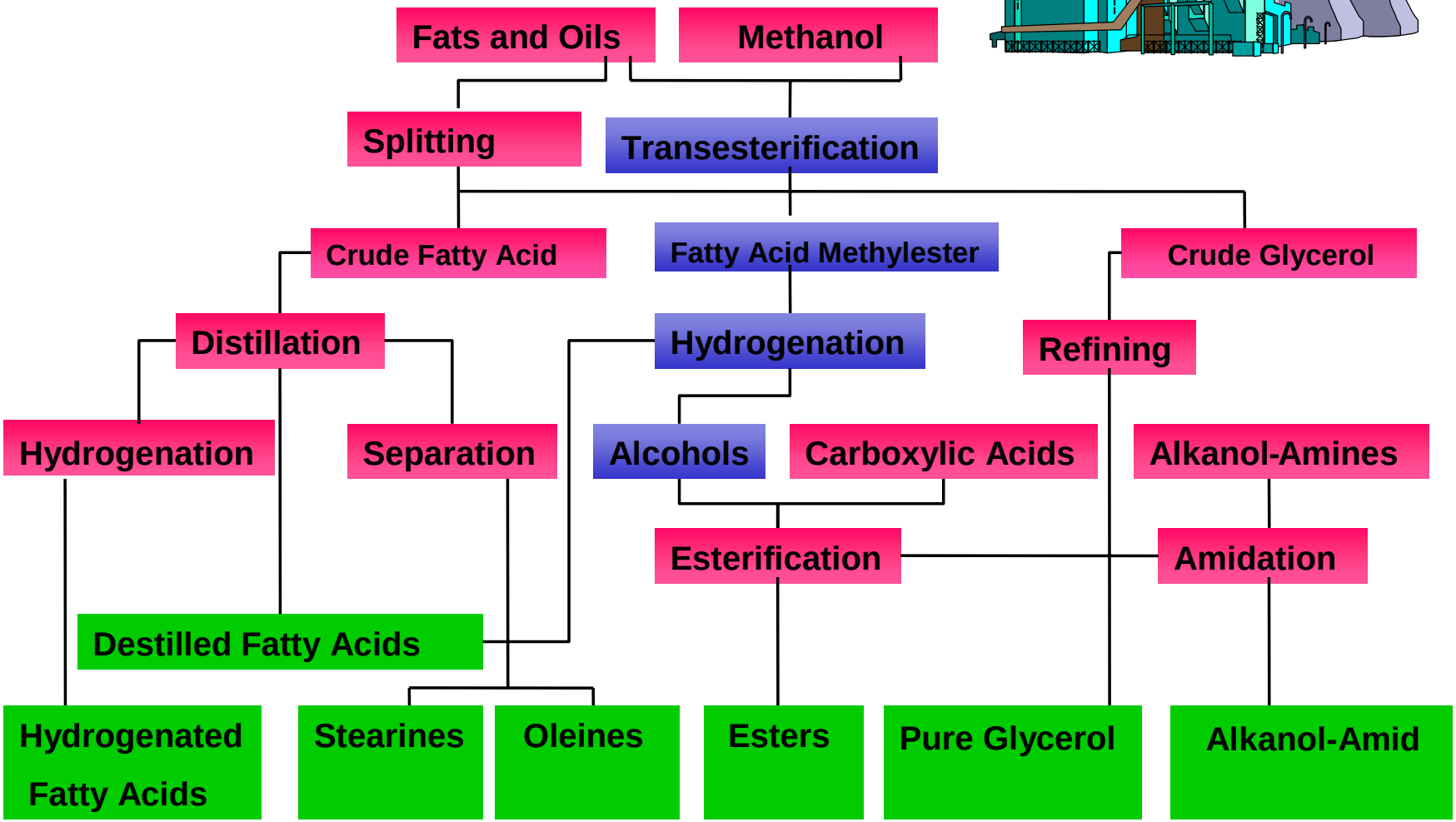
Renewable Feedstocks of the Chemical Industry in Germany (2002)



Treatment of Fats and Oils

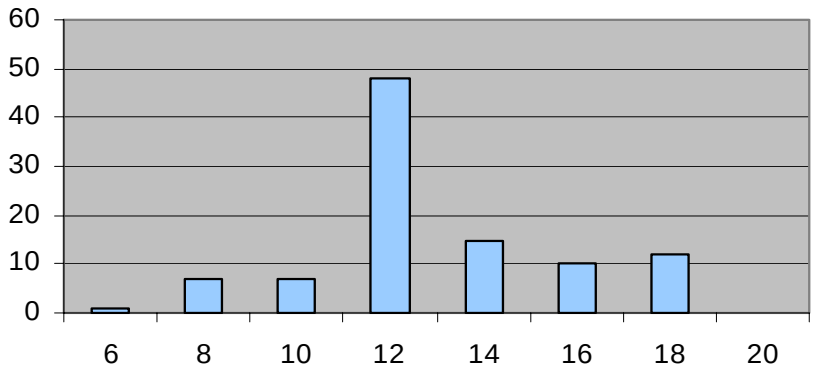
Production Tree of Fats and Oils



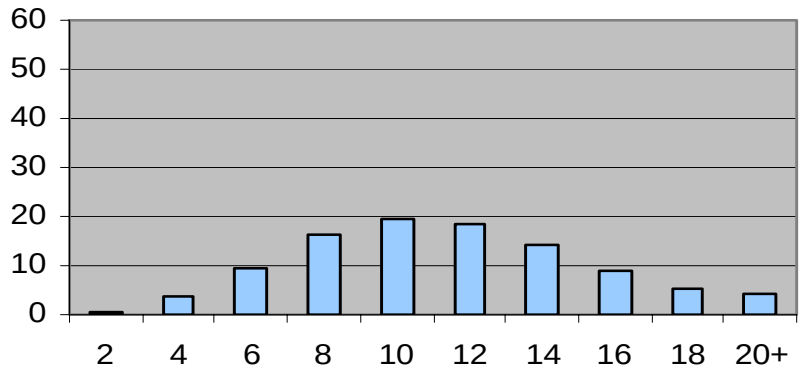


Fatty Alcohol Compositions by Different Processes

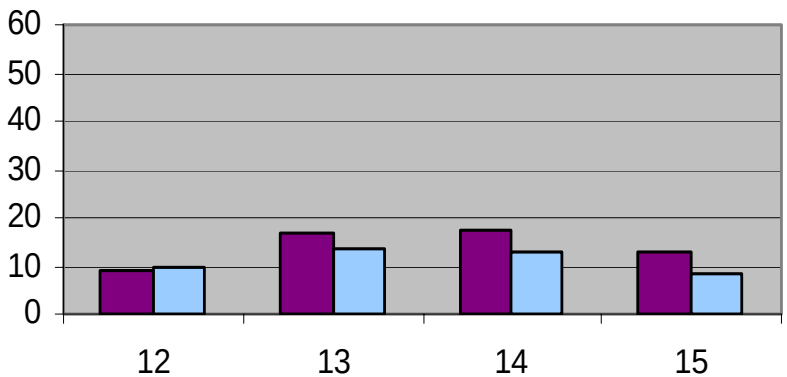
Alcohols based on Coconut Oil by High Pressure Hydrogenation



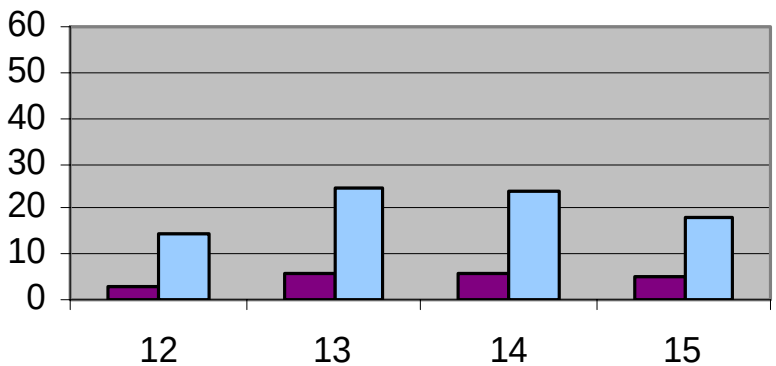
Alcohols based on Ethene by the Ziegler-Alfol-Process



Alcohols based on Statistical n-Olefins by the Oxo-Process



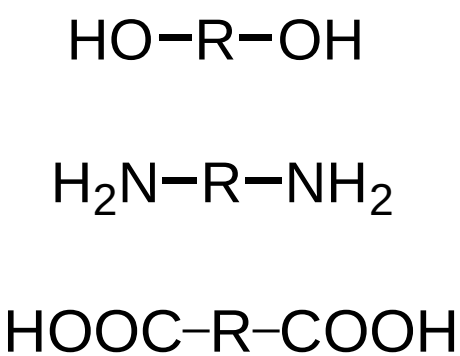
Alcohols based on alpha-Olefins by the Modified Oxo-Process



Propylene oxide

4 Mill. t/a Propylene oxide

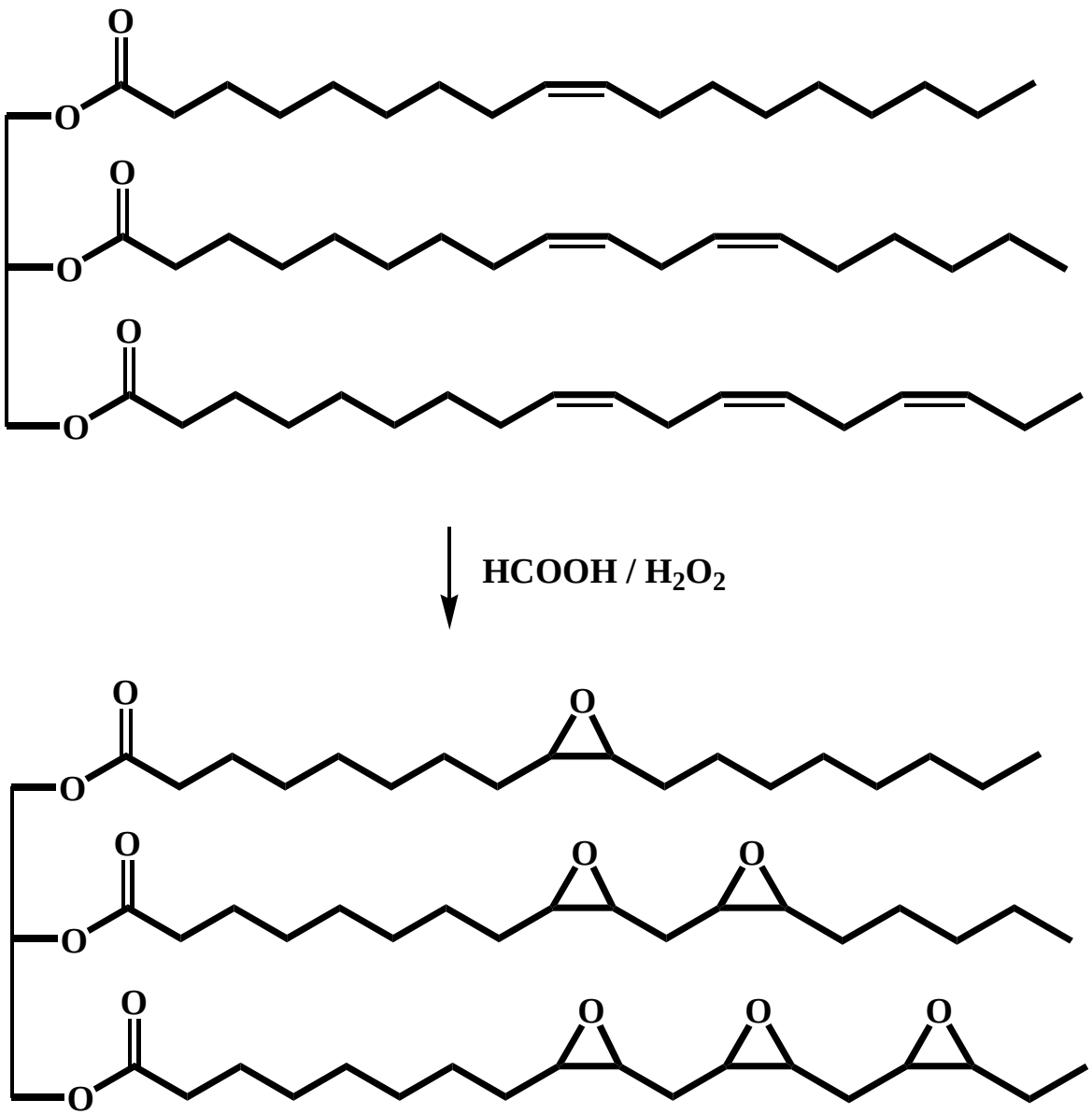
Polyether polyoles (for polyurethanes)	**70%**
Propylene glycol (for polyesters)	**22%**



Renewable feedstocks

- **Carbohydrates**
- **Oils and fats**
- **Proteins**
- **Lignins**

Epoxidation of a Vegetable Oils



Cationic Photopolymerization of Linseed Oil Epoxide

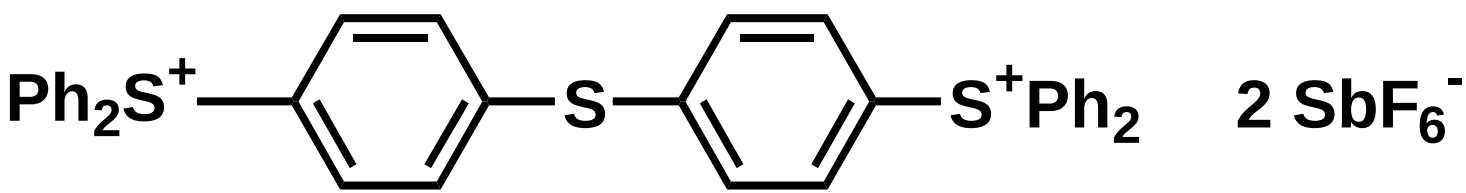
Linseed oil epoxide

$h\nu$

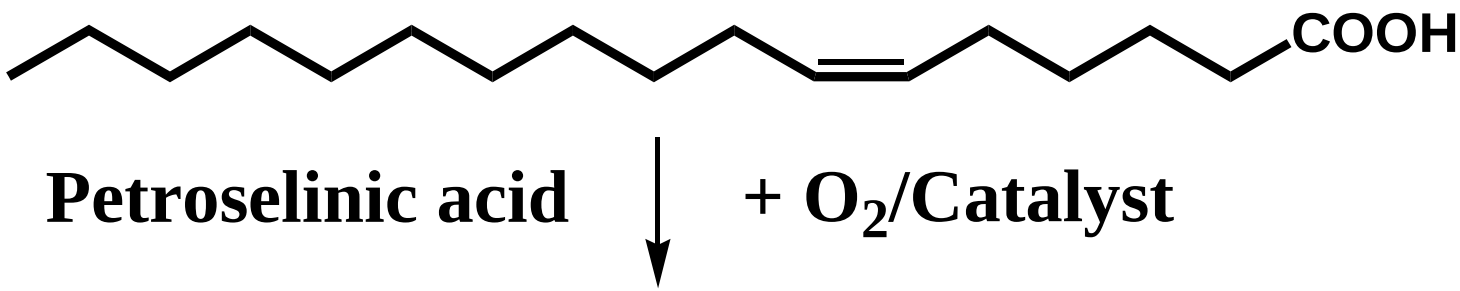
Coating

No solvents, no VOCs!!!

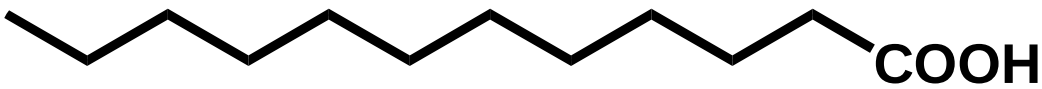
Initiator:



Adipic Acid Produced from the Seed Oil of Coriander Sativum



Petroselinic acid + O_2/Catalyst



Lauric acid

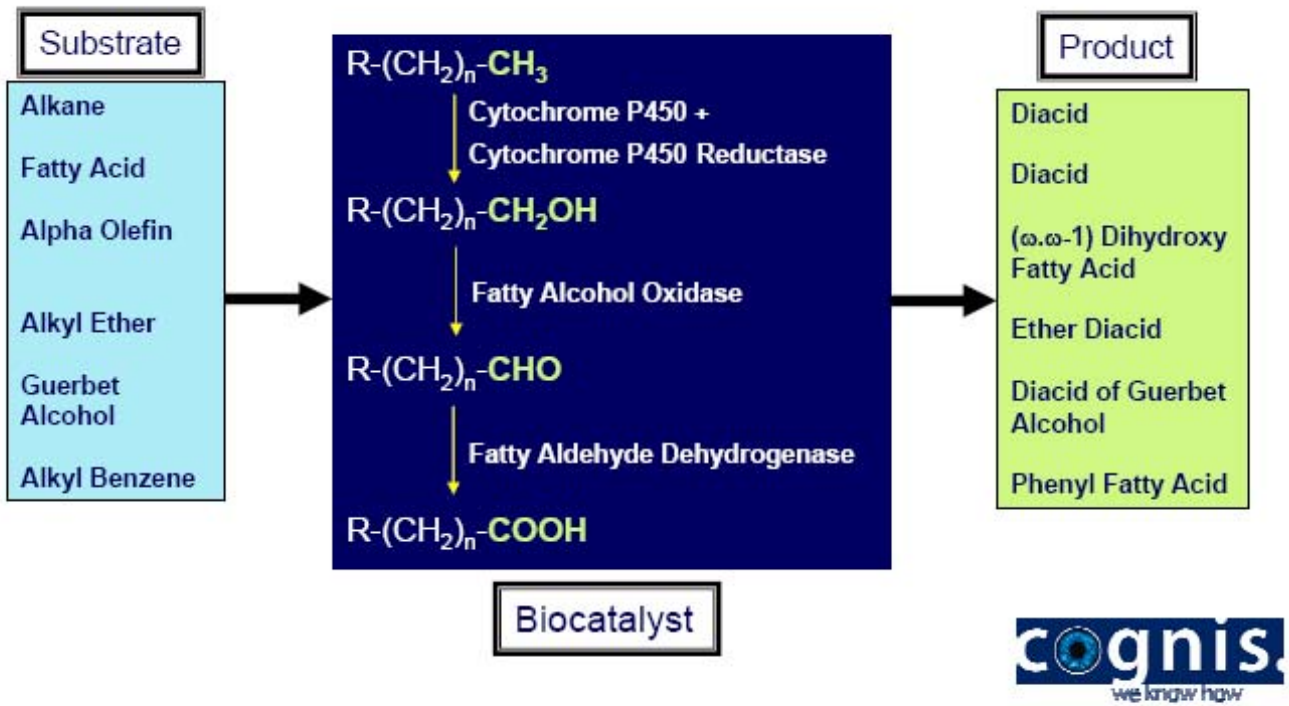
\+

Adipic acid

Biotechnological selective Oxidation of Methyl Groups

Technology Summary

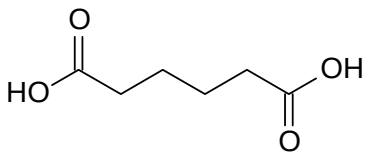
- Cognis uses a metabolically-engineered strain of *Candida tropicalis* to oxidize a terminal methyl group on the end of an aliphatic carbon chain.



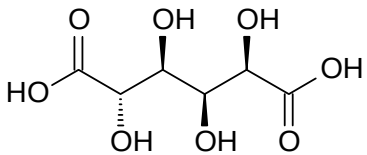
cognis
we know how

U. Biermann, W. Friedt, S. Lang, W. Lühs, G. Machmüller, J.O. Metzger, M. Rüsch gen. Klaas, H.J. Schäfer, M.P. Schneider, *Angew. Chem.Int.Ed.*, ***2000***, *39. 3675-3677.*

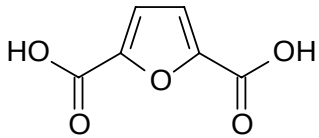
Monomers for Polyamides of the Nylon-6,6 Type:



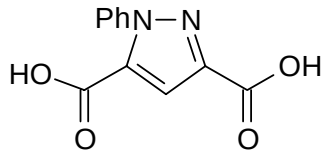
Adipic Acid



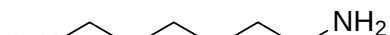
D-Glucaric Acid



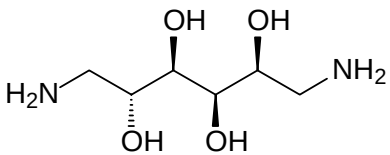
Furan-2,5-dicarboxylic Acid



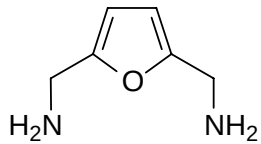
Pyrazol-3,5-dicarboxylic Acid



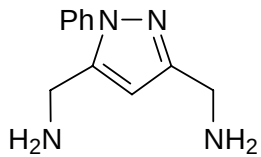
Hexamethylenediamine



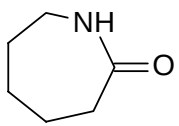
2,6-Diamino-glucitol



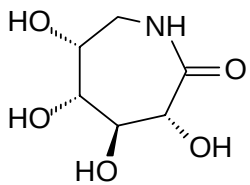
2,5-Di-(aminomethyl)-furan



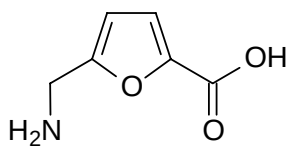
3,5-Di(aminomethyl)-pyrazol



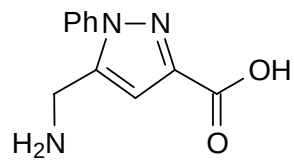
ε-Caprolactam



6-Aminoglucono-Lactam

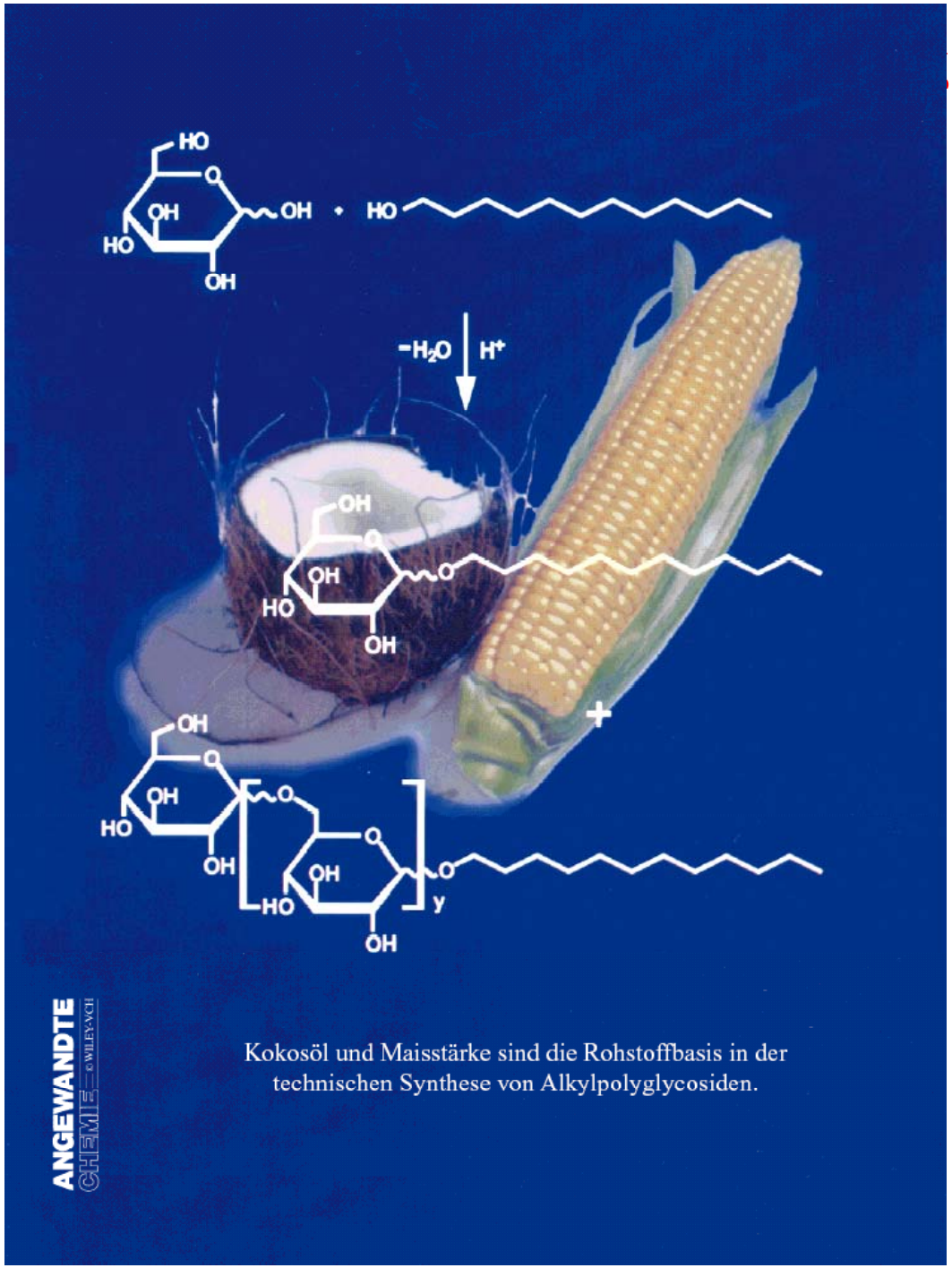


5-Aminomethyl-furoic Acid



5-Aminomethyl-pyrazolic Acid

F. W. Lichtenthaler, Acc. Chem. Res. **2002,** *35*, 728 – 737.



Kokosöl und Maisstärke sind die Rohstoffbasis in der technischen Synthese von Alkylpolyglycosiden.

Production 70,000 t/a

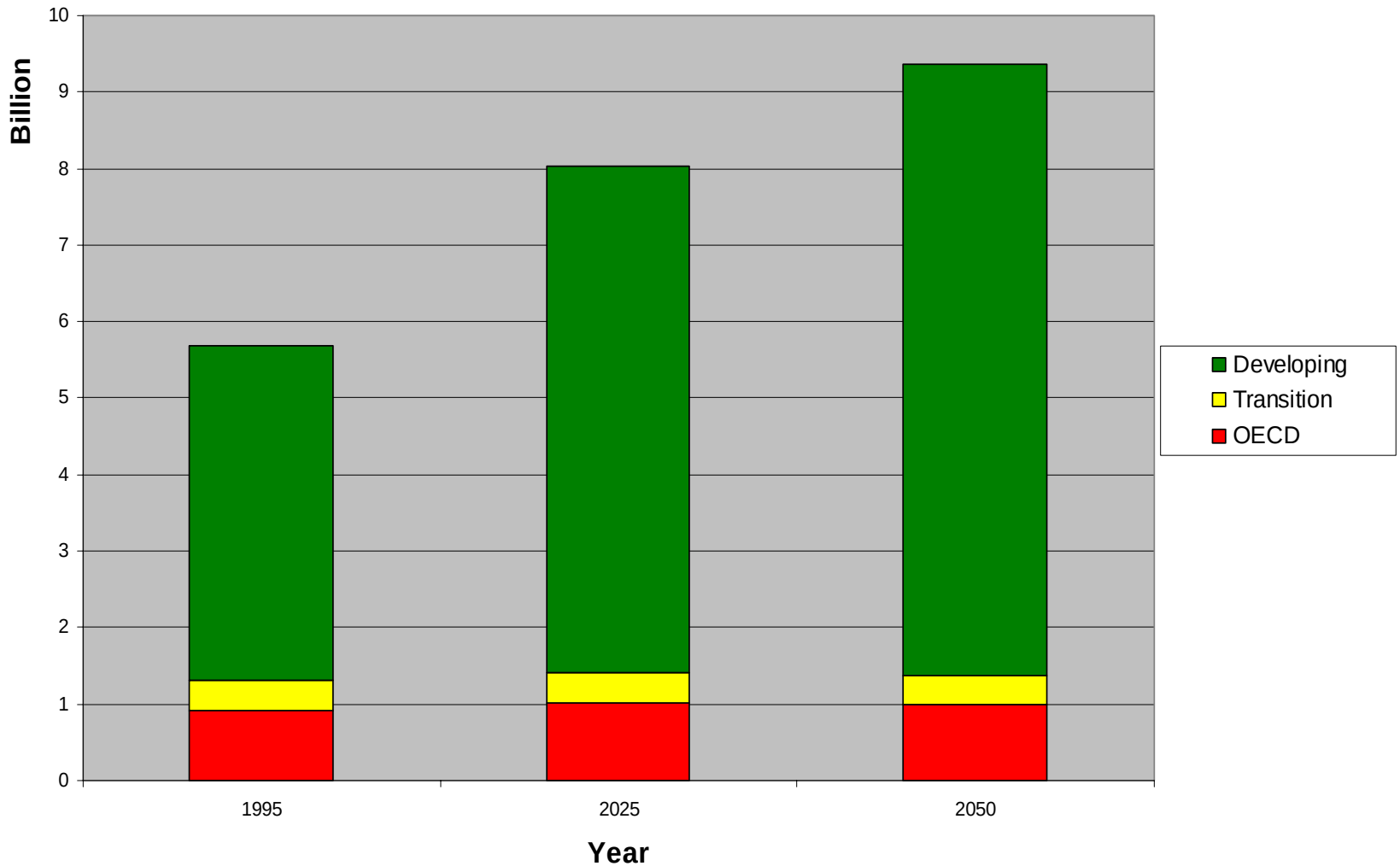
W. von Rybinski, K. Hill,
Angew. Chem. **1998**, *100*, 1394 –1412.

GDCh and Renewable Raw Materials

Most products obtainable from renewable raw materials may at present not be able to compete with the products of the petrochemical industry, but this will change as oil becomes scarcer and oil prices rise. **The German Chemical Society calls on governments to step up promotion of the necessary basic research** and to create frame conditions that encourage the kind of private-sector research that would make sustainable substitute processes and products ready in good time.

Position paper of the GDCh presented to the governments of the countries participating in the World Summit on Sustainable Development in Johannesburg, **2002**.

Development of Global Population



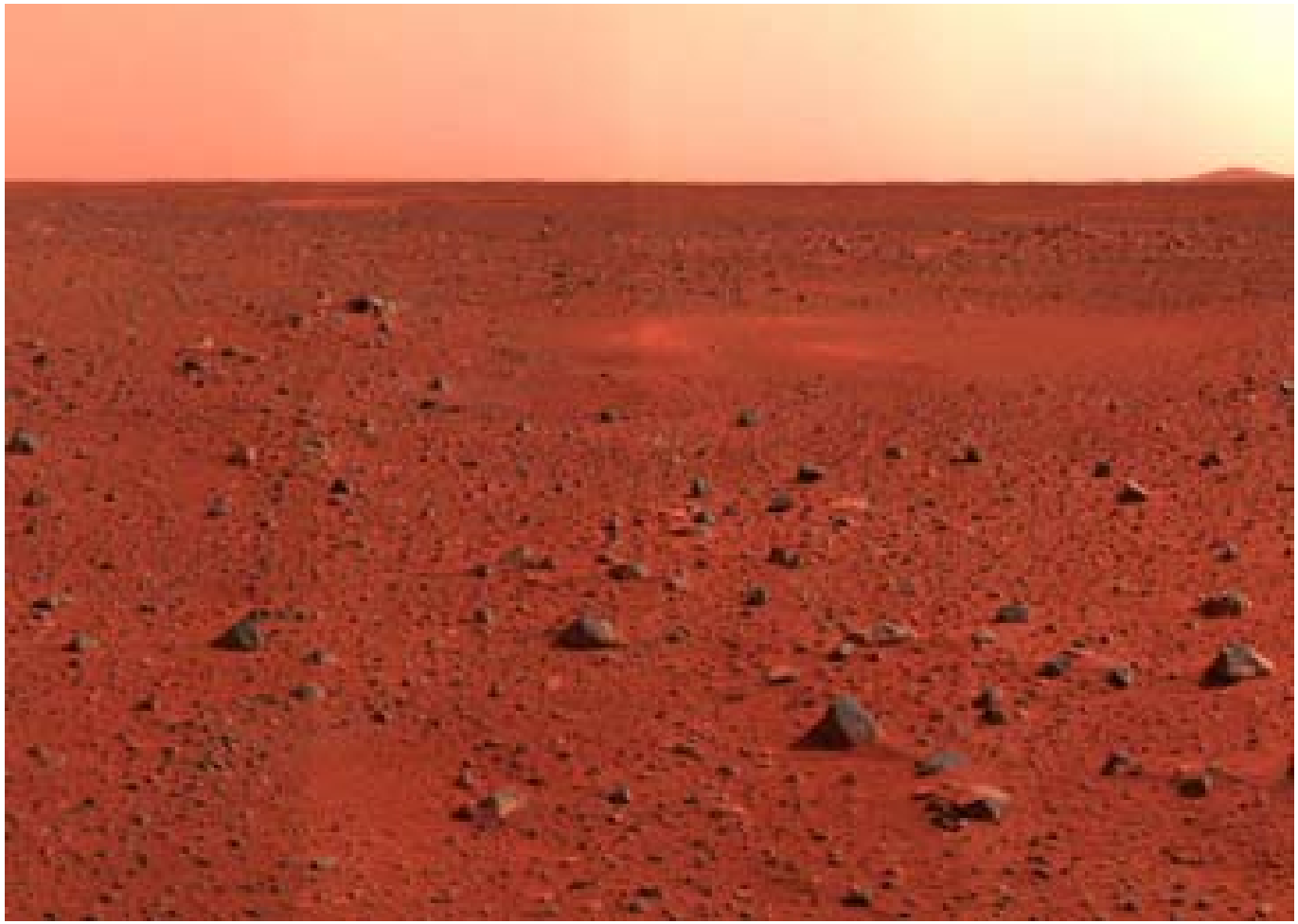
Our Common Journey, a transition toward Sustainability, NRC, 1999

Agenda 21, Chapter 12

MANAGING FRAGILE ECOSYSTEMS: COMBATING DESERTIFICATION AND DROUGHT

12.17c To increase the vegetation cover and support management of biotic resources in regions affected or prone to desertification and drought, notably through such activities as afforestation/reforestation, agroforestry, community forestry and vegetation retention schemes.

Mars, January 2004



Combating Desertification

CO_2-Sequestration

http://www.cooretec.de

The costs for separation of CO_2 are estimated to 18 – 60 €/t and for transport and deposition to 10 – 24 €/t .

Costs for sequestration of CO_2 by reforestation are estimated to 1 – 5 €/t. Additional advantages: Biomass; improvement of water retention; generating employment. (A. Hüttermann, Göttingen)

Pampers

Hydrogel I

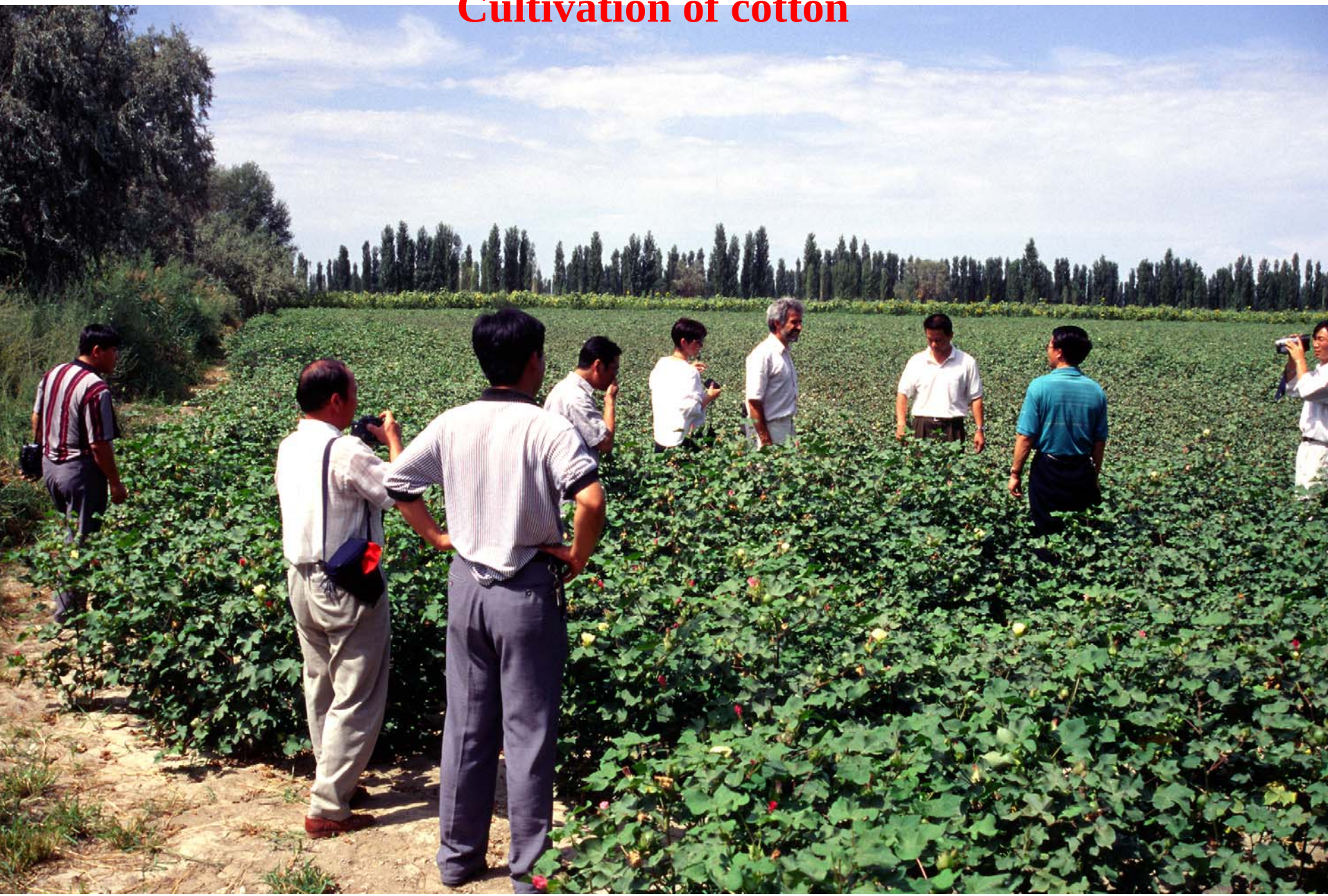
Hydrogel II

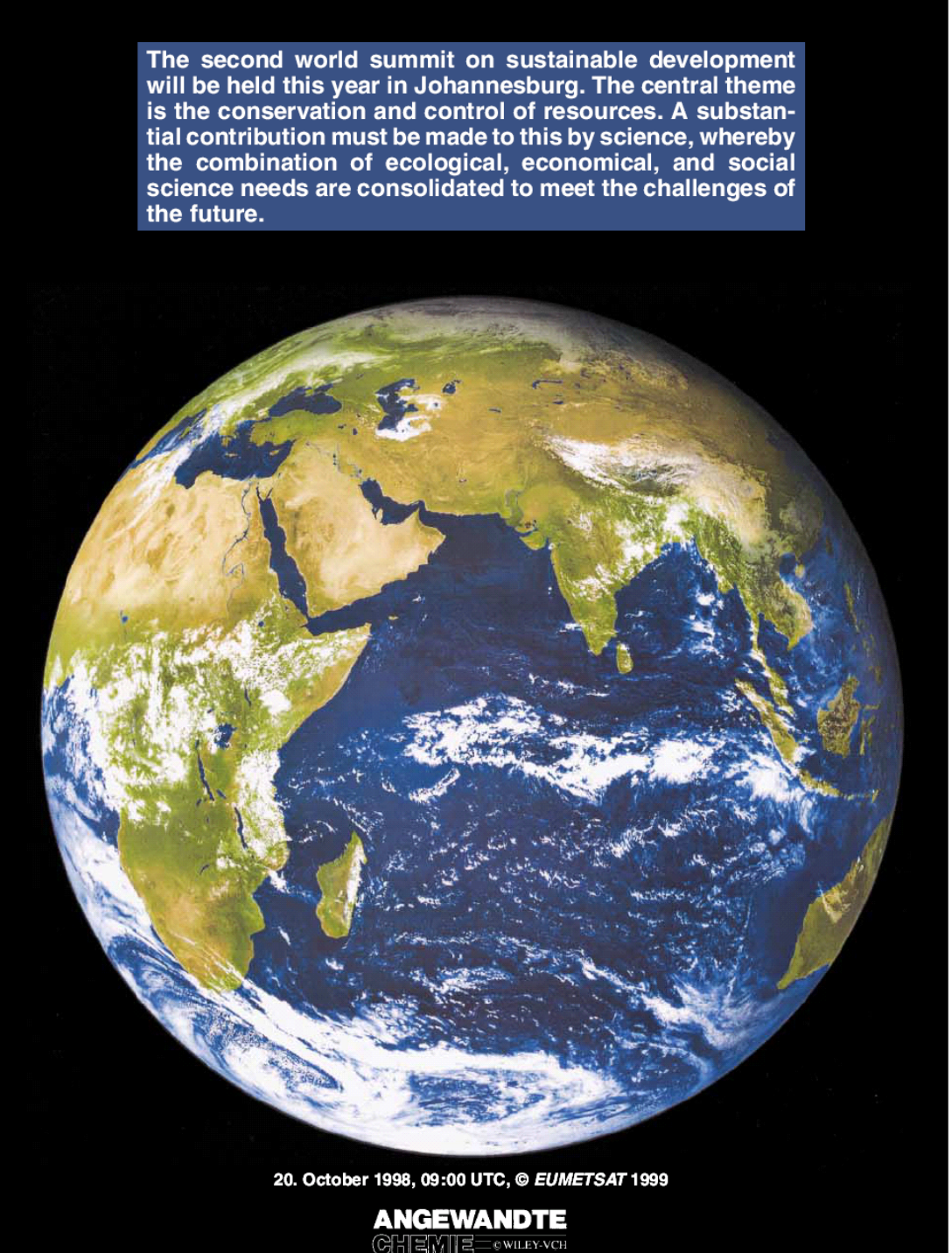
Sinkiang

TZU-CHI CHOU
Peski
Kurbantongut
Dzosotin Elisun
DZUNGARIA
CH'ANG-CHI HUI-TZU
TZU CHI-CHOU
Ma-na-ssu (Manass) (Sui-lai)
Wu-lu-mu-ch'i (Urumchi)
I-ning (Kuldja)
Ch'i-t'ai
T'u-lu-fan (Turfan)
Yen-ch'i (Kara Shahr)
K'u-ch'e (Kucha)
Ku-lu-k'o Shan (Kuruk Tagh)
SINKIANG
UIGHUR
PA-YIN-KUO-LENG MENG-KU
Lo-pu Po (Lop Nor)
(Tarim Basin)
Sha'ari Kum
HA-M

Desert in Sinkiang

Cultivation of cotton





M. Eissen, J. O. Metzger, E. Schmidt, U. Schneidewind, 10 Years after Rio – Concepts on the Contribution of Chemistry to a Sustainable Development, Angew. Chem. Int. Ed. **2002**, *41*, 414 – 436.