



# Potential ecological and social benefits from globalisation in agriculture

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## Objectives

- **Ecological:** To demonstrate that agricultural resource use efficiency can be improved by a global homogenisation of input intensity and the use of comparative site advantages between temperate and tropical areas
- **Social:** To show that for maximising social welfare globally, national borders of social accountability have to be removed corresponding to free trade regulations of the WTO

## Methods

FAO and experimental yield data were related to net primary production (NPP) in tropical and temperate zones. Inefficiencies in the avg. global fertiliser use caused by inhomogeneous nutrient input intensities were modelled with standard curves of diminishing response.

**Fig. 2:** Data sources: meat from Steinmüller et al. (1998), cereals (1997-99 yields of developing African countries) from FAO (2000), fish from Lopez et al. (1995)

**Fig. 3:** Wheat yield (cereals in 1998 to 1999) from BML (2000); sugar cane (6-yr avg., trash blanket, well-drained soil) from Wood (1991); cassava in the subhumid tropics (4-yr avg. root yield of fertilised no-tree control and *Cajanus cajan* alleys) from Akondé et al., (1996); oil palm (1997 to 1999 FFB yields of Cameroon, Colombia, Malaysia) from FAO (2000) multiplied by 25% oil extraction rate (22.5% mesocarp oil (Prioux, 1999) + 2.5% kernel oil (9:1 mesocarp:kernel oil ratio; Noel et al., 1997); plantation trees (avg. of 9 tropical species, douglas fir in the temperate zone) from IPCC (1996, p.5.21); temperate forages (avg. of 8 grass species and maize silage) from Quade (1993, p.142:256:464); tropical forages (Elephant grass) from Preston (1988); NPP: humid tropics = 24.4 t dry matter ha<sup>-1</sup> yr<sup>-1</sup>, subhumid tropics = 19.4 t, temperate = 14.3 t; from Melillo et al., (1993) assuming 45% C in dry matter (Scholes & Hall, 1996)

## Results

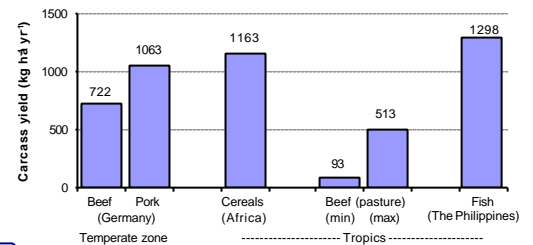
### • Ecological benefits A) Unused yield potentials in the tropics

Many tropical crops produce only **10-20%** of the Net Primary Production (NPP), temperate crops up to **100%**



**Fig. 1.** Global agricultural productivity relative to NPP in 1990 (Esser, 1994).

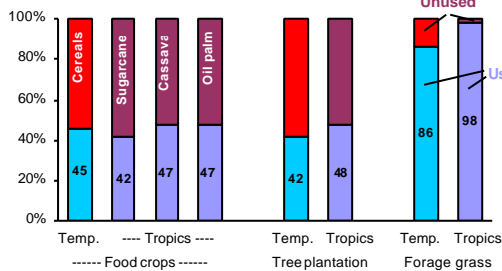
- **Cereal yields in Africa are not higher than meat production per ha in Germany**
- **Meat yields from tropical pastures are much lower than in Germany although the potential would be higher in the tropics using aquaculture (Fig. 2) or stall-feeding systems (s. Fig. 3)**



**Fig. 2.** Meat yield levels in temperate and tropical zones compared to fish and cereal yields in the tropics.

### B. Closing the tropical yield gap

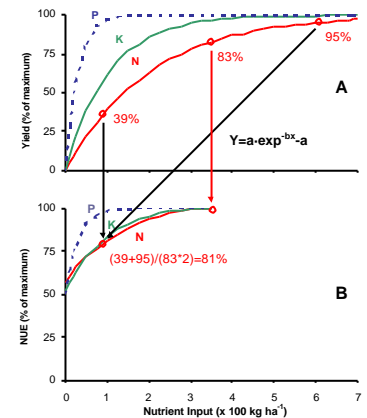
**Perennials** can use the high NPP in the **tropics** as efficiently as corresponding crops in the temperate zone; thus input intensity can be reduced in the temperate zone



**Fig. 3.** Food, tree and fodder production relative to NPP in temperate (Germany) vs. subhumid and humid tropical zones.

The global average fertiliser nutrient use efficiency (NUE) is optimised by a **homogeneous input intensity** relative to maximum yields due to response curves of diminishing returns

**Fig. 4.** A) NPK fertiliser response curves (Malinsky et al. (1990, modified); B) corresponding avg. NUE of 350 kg fertiliser input by two unequal intensities (e.g. (100+600)/2=350 kg) rel. to the max. NUE at the medium intensity of 350 kg.



## 2. Social benefits

- Returns to life-saving investments are much higher in poor than in rich countries: the implementation of **basic needs services** such as nutrition, education, health care and safe drinking water for preventing 17 mill. deaths per year caused by communicable diseases in developing countries costs only 40 billion US\$ yr<sup>-1</sup> or **0.2% of global GDP** as compared to **10.5% of GDP** for health expenditure alone in Germany 1997 (WHO, 2000; UNDP, 1997, p.138)
- Current public discussions about 'social standards' and 'fair trade' suggest that **market integration** of developing countries will facilitate the opening of national borders for **social accountability**

## Conclusions

- **Ecological:** The global **land and nutrient use efficiency** can be improved (i) by using comparative site advantages of perennials in the subhumid and humid tropics and of cereals in temperate regions (ii) by homogenising fertiliser intensities.
- **Social:** The social benefits from agricultural investments are far higher in poor countries considering **life-saving** a higher humanitarian value than increasing **wealth**.

## Literature

Akondé TP, Leihner DE and NSteinmüller (1996) Alley cropping on an Ultisol in subhumid Benin. Part 1: Long-term effect on maize, cassava and tree productivity. *Agroforestry Systems* 34:1-12.  
 BML (2000) *Agrarbericht 2000* [Online]. Available at <http://www.bml.de/landwirtschaft/ab-2000/ab2000.html> (verified 15 Aug. 2000).  
 Esser G (1994) *Eingriffe der Landwirtschaft in den Kohlenstoffkreislauf*. In: Enquete-Kommission "Schutz der Erdatmosphäre" (ed.), *Landwirtschaft, Studienprogramm*, Economica Verlag, Bonn.  
 FAO (2000) *Statistical databases. Agriculture. Agricultural production. Crops primary* [Online]. [http://apps.fao.org/lim500/html/area\\_of\\_production\\_crops\\_primary\\_domestic\\_sua\\_services.html](http://apps.fao.org/lim500/html/area_of_production_crops_primary_domestic_sua_services.html) (verified 28 Aug. 2000).  
 IPCC (1996) *Revised 1996 IPCC guidelines on national greenhouse gas inventories. Reference manual (vol. 3). Land use change and forestry* [Online]. Available at [http://www.grida.no/publications/other/ipcc\\_glueg/vol3.htm](http://www.grida.no/publications/other/ipcc_glueg/vol3.htm) (verified 15 Aug. 2000).  
 Lopez-E. Sotye JP, Hopkins KD and A Circa (1995) On-farm production trials with Nile Tilapia in fertilized ponds in highland and lowland areas of the Philippines [Online]. Available at <http://www.fao.org/docstore/95000e.htm> (verified 15 Aug. 2000).  
 Malinsky AH, Pichler A and R Prießwieser (1990) *Umweltverträgliche Landwirtschaft: der integrierte Landbau als betriebliches Lösungskonzept*. Trauner, Linz, p. 50  
 Melillo JM, McGuire AD, Kicklighter DW, Moore III B, Vorosmarty CJ and AL Schloss (1993) Global climate change and terrestrial net primary production. *Nature* 363:234-240.

Noel JM, Ecker P, Rouziere A, Graille J and M Pina (1997) Durpalm®: a new asset for palm oil mills. I. Description. *Plantations, Recherche, Développement* 4:179-182.  
 Preston TR (1988) Fractionation of sugarcane for feed and fuel. 310-319 In: Sansoucy, R et al. (eds.) *Sugarcane as feed: proceedings of a FAO expert consultation, held in Santo Domingo, Dominican Republic from 7 - 11 July 1986*. FAO animal production & health paper 72. FAO, Rome.  
 Prioux G (1999) Les analyses de régimes de palme. 'entree usine': L'expérience de la société Plantations et huilières de Côte d'Ivoire. *Plantations, Recherche, Développement* 6:161-174.  
 Quade J (1993) *Faustzahlen für Landwirtschaft und Gartenbau*. 12th ed. Hydro Agri Dilmen GmbH, Dilmen (ed.). *Landwirtschaftsverlag Münster-Hiltrup*, Germany.  
 Scholes R J and Hall D O (1996). The carbon budget of tropical savannas woodlands and grasslands In: A.I. Breyermeier et al., eds. *Global Change: Effects On Coniferous Forests and Grasslands*, SCOPE 56, John Wiley, Chichester, pp. 69-100.  
 Steinmüller N, Zimdahl RL, Leihner DE and W Koch (1998) Resource Limitation and Potential Protection in Globalized Agriculture. In: *Tropenzentrum, Universität Hohenheim (ed.) Technischer Fortschritt im Spannungsfeld von Ernährungssicherung und Ressourcenschutz*. Tropentag 1997, 11-12 December 1997, Stuttgart-Hohenheim Germany, p. 161-166.  
 UNDP (1997) *Bericht über die menschliche Entwicklung 1997*. Deutsche Gesellschaft für die Vereinten Nationen e.V., Bonn, Germany.  
 WHO (2000) *World health report 2000*. World Health Organization, Geneva, Switzerland [Online]. Available at <http://www.who.int/wbr2000/wbr2000.pdf> (verified 4 Sep. 2000).  
 Wood AW (1991) Management of crop residues following green harvesting of sugarcane in north Queensland. *Soil & Tillage Research* 20:69-85.