Ecological Literacy

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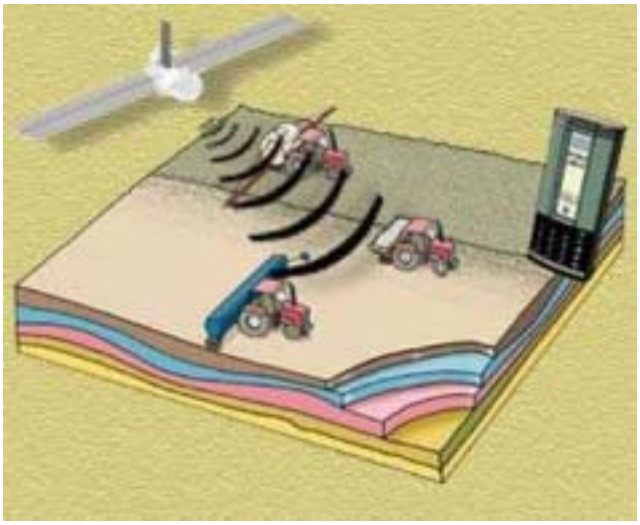
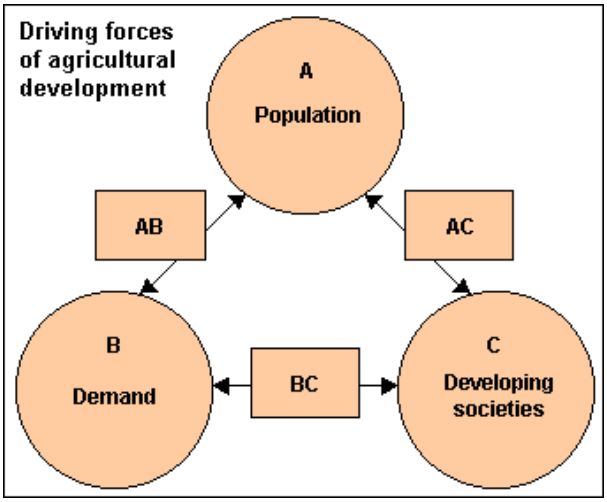


Food security in the 20th century

- Food situation, Green revolutions: Productivity
- Per ha., per man hour, per kg of input
- Food prices; absolute, relative

Food situation in the 20th century

- Demographic developments
- Food production

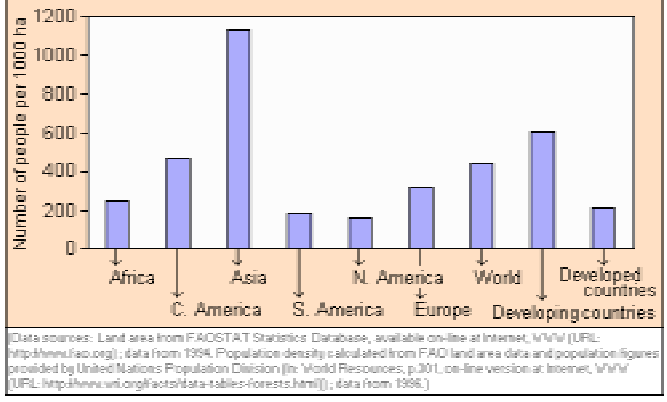


Birth and death rates (number of children born and of people died per 1000 inhabitants per year) and net population growth rates for the USA, all continents and the world

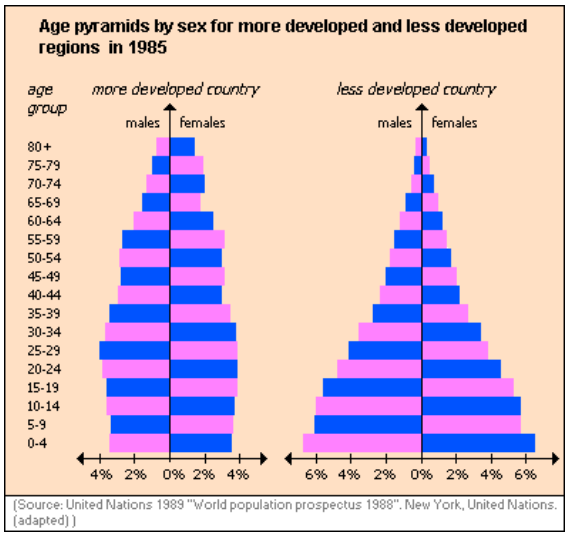
Area	Birth rates		Death rates		Net growth rate	
	1970-75	1990-95	1970-75	1990-95	1970-75	1990-95
USA	15.7	15.9	9.2	8.8	6.5	7.1
Africa	46.5	41.9	19.2	13.7	27.3	28.2
Asia	33.9	25.2	11.4	8.4	22.5	16.8
Europe	15.6	11.6	10.1	11.2	5.5	0.4
N. and C. America	22.8	20.2	9.2	7.8	13.6	12.4
Oceania	23.9	19.2	9.6	7.8	14.3	11.4
S. America	32.9	24.8	9.7	7.1	23.2	17.7
World	30.9	25.0	11.7	9.3	19.2	15.7

[Data source: UNITED NATIONS POPULATION DIVISION, 1996. - In Internet, WWW. - URL: http://www.wri.org. - (World Resources Institute, Washington, DC, USA)]

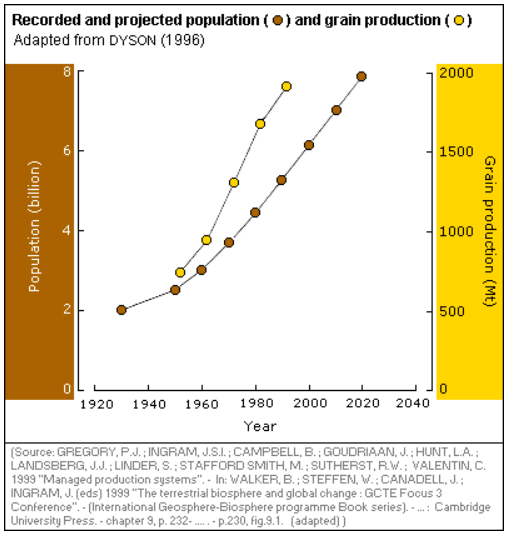
Population density (1996) in different continents, in the world, and in developing and developed countries.



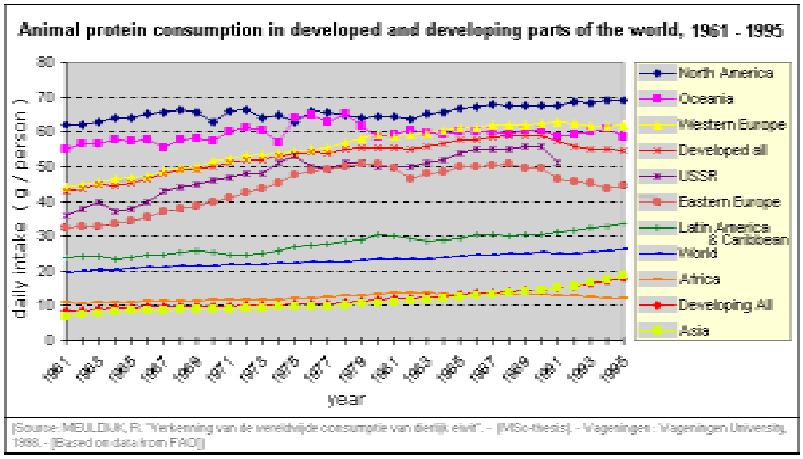
[Data sources: Land area from FAOSTAT Statistics Database, available on-line at Internet, WWW (URL: http://www.fao.org) ; data from 1994. Population density calculated from FAO land area data and population figures provided by United Nations Population Division (in 'World Resources, p.301, on-line version at Internet, WWW (URL: http://www.wri.org/facts/data-tables-forests.html)) ; data from 1996.]

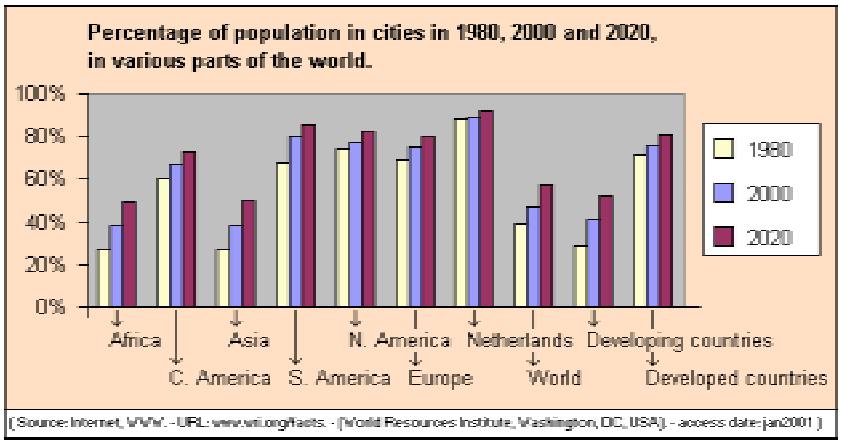


(Source: United Nations 1989 "World population prospectus 1988". New York, United Nations. (adapted))



(Source: GREGORY, P.J. ; INGRAM, J.S.I. ; CAMPBELL, B. ; GOUDRIAAN, J. ; HUNT, L.A. ; LANDSBERG, J.J. ; LINDER, S. ; STAFFORD SMITH, M. ; SUTHERST, R.W. ; VALENTIN, C. 1999 "Managed production systems". - In: WALKER, B. ; STEFFEN, W. ; CANADELL, J. ; INGRAM, J. (eds) 1999 "The terrestrial biosphere and global change : GCTE Focus 3 Conference". - (International Geosphere-Biosphere programme Book series). - ... : Cambridge University Press. - chapter 9, p. 232- .... - p.230, fig.9.1. (adapted))

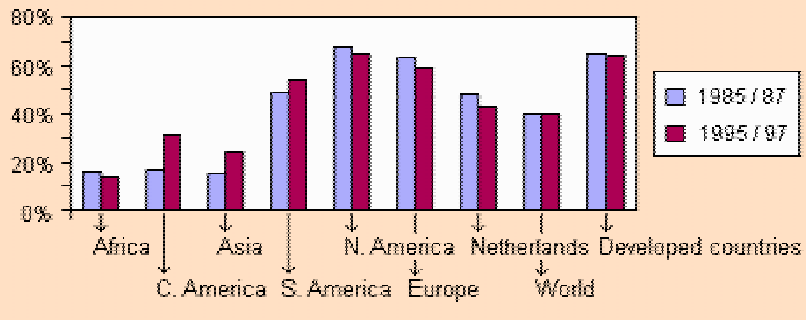

Animal protein consumption in developed and developing parts of the world, 1961 - 1995
daily intake (g / person)
year
North America
Oceania
Western Europe
Developed all
USSR
Eastern Europe
Latin America & Caribbean
World
Africa
Developing All
Asia


Percentage of population in cities in 1980, 2000 and 2020, in various parts of the world.
100%
80%
60%
40%
20%
0%
1980
2000
2020
Africa
C. America
Asia
S. America
N. America
Europe
Netherlands
World
Developing countries
Developed countries

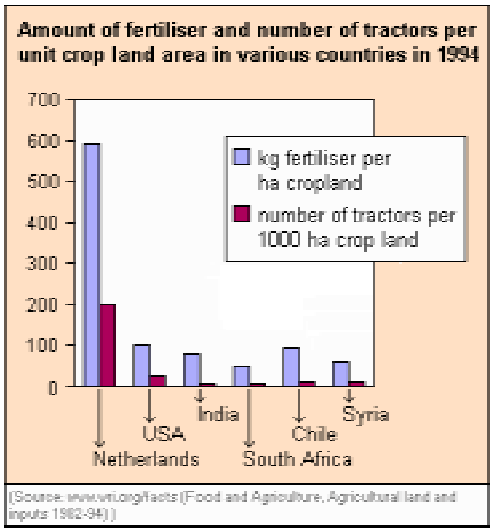
Ester BOSERUP
Copenhagen 1910 - ... 1999

Thomas Robert MALTHUS
Surrey 17feb1766 - ... 13dec1834

Grain fed to livestock as a percentage of total grain consumption in various parts of the world in the years 1985 to 1987 and 1995 to 1997.



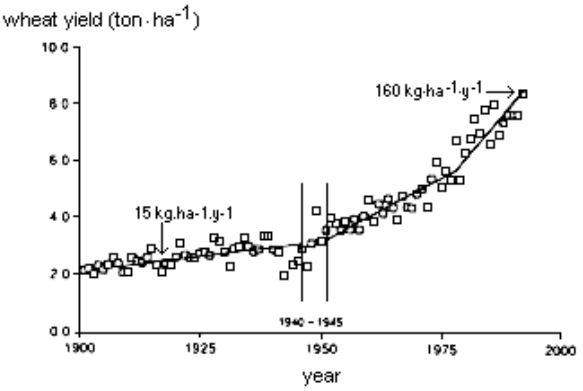
(Data source: FAO 1999 "Livestock to 2020 : the next food revolution". - Discussion paper 28. - Rome : Food and Agriculture Organization of the United Nations, 1999.)



Green Revolutions

- Discontinuities in productivity rise
- Causes for productivity rise

Wheat yields in the Netherlands from 1900 onwards



(Source: RABBINGE, R. 1993 "The ecological background of food production 2 : discussion". - In: "Crop protection and sustainable agriculture"/ CHADWICK, D.J. ; MARSH, J.. - (CIBA Foundation Symposium ; 177). – Chichester [etc.] : Wiley. - 285 p. - p.1-29, fig.1.)

Increase in rice and wheat production and productivity between 1965 and 1993 in India.

Crop	1965-1966		1989-1990		1992-1993	
	production ($x10^6$ Mg)	productivity (Mg ha^{-1})	production ($x10^6$ Mg)	productivity (Mg ha^{-1})	production ($x10^6$ Mg)	productivity (Mg ha^{-1})
rice	0.20	1.06	1.99	2.73	1.86	2.65
wheat	0.87	1.28	5.91	3.18	7.08	3.61

1 Mg = 1000 Kg

(*Source*: SINGH, R.B. 2000 "Environmental consequences of agricultural development : a case study from the green revolution state of Haryana, India". - Agriculture, ecosystems & environment 82: 97-103)

Contribution of area expansion and land productivity growth to cereal production increase, and the percentage irrigated land of total arable land

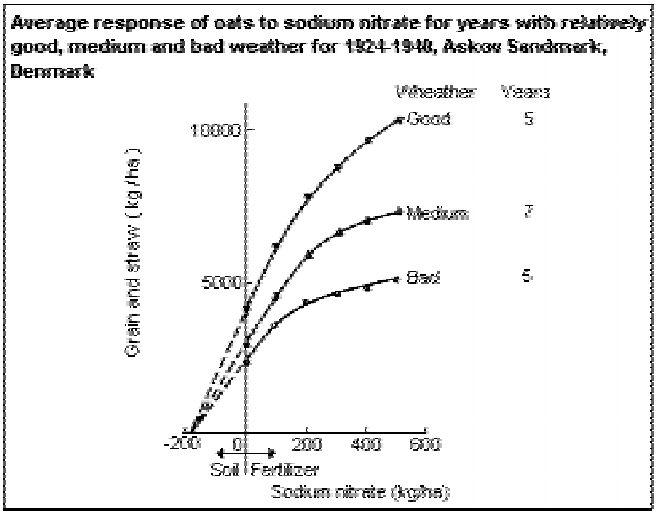
Region	Contribution (%) to output growth between 1969/71 and 1986/88		Irrigated land area (% of total arable land area)	
	area	yield/ha	1965	1987
World	-2	102	11	15
Low-income countries	**17**	**83**	**13**	**17**
Africa	13	87	1	3
Latin America	24	76	8	9
Near East	41	59	20	22
Far East	10	90	19	29
Asian CPE*)	-35	135	31	43
Industrialized countries	**5**	**95**	**8**	**9**
North America	20	80	7	8
Western Europe	-21	121	7	12
Oceania	48	52	4	4

*) Centrally planned economies

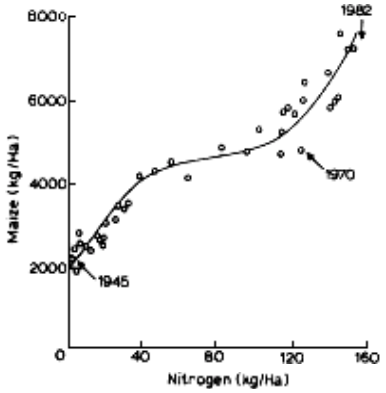
Data source (production): FAO Production Yearbook, various years.

Source: IVENS *et al.* 1992 "World food production : textbook 1 : world food situation". - Heerlen : Open universiteit, 1992. - 161 p. - p.103,tab.4.4, p.105,tab.4.7. - (adapted).

Average response of oats to sodium nitrate for years with relatively good, medium and bad weather for 1924-1948, Askov Sandmark, Denmark



Maize yield versus nitrogen fertiliser rate in the USA during the period 1945-1982



Characteristics of old and new varieties of winter wheat grown under optimal conditions at Cambridge, UK, 1984-1986

Variety	Total above ground dry matter (ton ha^{-1})	Grain yield (85 % dry matter) (ton ha^{-1})	Harvest Index	Stem length (cm)
very old	15.0	5.94	0.34	145
old	15.4	6.55	0.36	134
intermediate	14.8	7.87	0.45	96
modern	15.9	9.47	0.51	78

Source: AUSTIN, R.B. ; FORD, M.A. ; MORGAN, C.L. 1989 "Genetic improvement in the yield of winter wheat : a further evaluation". - Journal of agricultural science, 1989, 112()295-301.

Role of external inputs

- Productivity increase
- Influence crop growth:
  - limiting and reducing factors
- Increase stability of yields
- Reduce soil erosion
- Enrich marginal soils

Causes of discontinuities

- Innovation from various scientific disciplines
  - soil fertility, plant nutrition, irrigation, plant breeding, crop protection, water management
  - development farming systems
- Fair market policies; protection when needed, free market when possible
- Investment and promotion good farming conditions
- Organization of farming unions and intermediate structures

Needs for evergreen revolutions in the 21th century

- Demographic development
- Change in diets
- Regional differences
- Limited availability of agricultural well endowed land
- Maintain land for nature / biodiversity

Regional differences

1980 - 2000

	Increase Kg grain ha^{-1} y^{-1}	Yield gap
Europe	150	20 – 40%
USA, Australia, Canada	50	40 – 60%
Former Sovjet Union	10	50 – 70%
Asia, China, India, Vietnam	100	20 – 30%
Africa	-5	60 – 80%

Changing role of research and technology

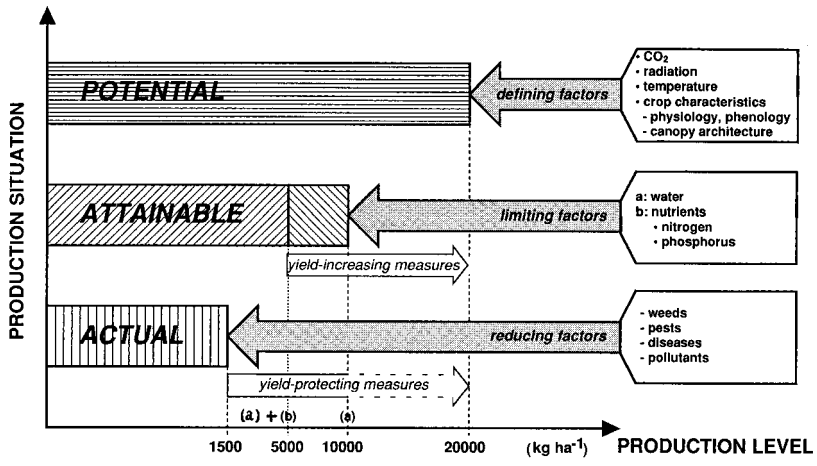
- Past
  - technology push
  - linear knowledge model
  - dose - effect
  - limited disciplinary integration
  - crop level
- Future
  - technology pull
  - interactive knowledge model
  - production ecological concepts
  - multidisciplinary approaches
  - eco regional approaches

Ecological literacy

- Prevent diseases and pests
- Precision agriculture

Production ecological principles

- Yield -defining, -limiting, -reducing factors
- Best technical means; best ecological means
- Systems approaches



Crop protection -5 phases of development

- till 1900	→	diseases, inevitable punishment of God
1900 - 1945	→	preventive measures, biological control
1945 - 1970	→	chemical revolution, pesticides
1970 - 1995	→	ecological revolution, increase of biological control, prevention, pheromones, chemical substances for fine tuning, antagonists
1995 -	→	systems innovations

Precision agriculture

- Dose-effect versus insight based innovations
- Heterogeneity from: liability to asset
- Cost reduction
- Better use of natural regulation mechanisms

Ecological literacy, conditions

- Investment in agriculture
- Innovation oriented, stimulate use of endigenous knowledge
- Green fingers and green brains
- Introduce farmers field schools
- Active land use policy

Ecological literacy, perspectives

- Crop level
  - precision agriculture
  - biological control, wide spread
  - integration of techniques
- Farm level
  - renaissance mixed farming
  - prevention of reducing factors
  - increased efficiency and efficacy
- Ecoregional level
  - appropriate land use
  - increased water productivity, sophisticated use of external inputs
  - save land, water, energy and nature
  - use biological mechanisms

Myths, bans, praemisses, dilemma's, paradoxes

- Myths
  - intensive agriculture is devastating for ecological aims
- Bans
  - no use of chemical inputs in agriculture
- Praemisses
  - organic farming better for environment
- Dilemma's
  - market policy, protection or free market
- Paradoxes
  - surplus of land at macro-level and shortage of land at micro-level

Ecological literacy

- Policy Agenda:
  - stimulate private-public investment in upgrading agriculture
  - fight unjustified claims
  - eliminate incorrect myths, bans and praemisses
  - make choices on land use and water use
  - organize / stimulate farmers field schools

Ecological literacy

- Research agenda
  - improve production ecological insights
  - stimulate research on preventive mechanisms in pest, disease and weed control
  - stimulate research in precision agriculture
  - stimulate research on balanced use of inputs
  - stimulate research on better understanding of biological control mechanisms, pests, diseases and weeds