## Tables and Figures for Chapter 8

### Tables

***Table 8.2.1*** *Agricultural land use in the last four decades (Source: FAOSTAT, 2005)*

| | Area (Mha) | | | | | Change 2000's/1960's | |
|---|---|---|---|---|---|---|---|
| | 1961-70 | 1971-80 | 1981-90 | 1991-00 | 2001-02 | % | Mha |
| **1. World** | | | | | | | |
| Agricultural land | 4,562 | 4,684 | 4,832 | 4,985 | 5,023 | +10 | 461 |
| Arable land | 1,297 | 1,331 | 1,376 | 1,393 | 1,405 | +8 | 107 |
| Permanent crops | 82 | 92 | 104 | 123 | 130 | +59 | 49 |
| Permanent pasture | 3,182 | 3,261 | 3,353 | 3,469 | 3,488 | +10 | 306 |
| **2. Developed countries** | | | | | | | |
| Agricultural land | 1,879 | 1,883 | 1,877 | 1,866 | 1,838 | -2 | -41 |
| Arable land | 648 | 649 | 652 | 633 | 613 | -5 | -35 |
| Permanent crops | 23 | 24 | 24 | 24 | 24 | +4 | 1 |
| Permanent pasture | 1,209 | 1,210 | 1,201 | 1,209 | 1,202 | -1 | -7 |
| **3. Developing countries** | | | | | | | |
| Agricultural land | 2,682 | 2,801 | 2,955 | 3,119 | 3,184 | +19 | 502 |
| Arable land | 650 | 682 | 724 | 760 | 792 | +22 | 142 |
| Permanent crops | 59 | 68 | 80 | 99 | 106 | +81 | 48 |
| Permanent pasture | 1,973 | 2,051 | 2,152 | 2,260 | 2,286 | +16 | 313 |

***Table 8.2.2*** *Evolution of per capita food supply in developed and developing countries. (Source: FAOSTAT, 2005)*

| | | | | | | Change 2000's/1960's | |
|---|---|---|---|---|---|---|---|
| | 1961-70 | 1971-80 | 1981-90 | 1991-00 | 2001-02 | % | cal/d or g/d |
| **1. Developed countries** | | | | | | | |
| Energy, all sources (cal/day) | 3,049 | 3,181 | 3,269 | 3,223 | 3,309 | +9 | 261 |
| % from animal sources | 27 | 28 | 28 | 27 | 26 | -2 | -- |
| Protein, all sources (g/day) | 92 | 97 | 101 | 99 | 100 | +9 | 8 |
| % from animal sources | 50 | 55 | 57 | 56 | 56 | +12 | -- |
| **2. Developing countries** | | | | | | | |
| Energy, all sources (cal/day) | 2,032 | 2,183 | 2,443 | 2,600 | 2,657 | +31 | 625 |
| % from animal sources | 8 | 8 | 9 | 12 | 13 | +77 | -- |
| Protein, all sources (g/day) | 9 | 11 | 13 | 18 | 21 | +123 | 48 |
| % from animal sources | 18 | 20 | 22 | 28 | 30 | +67 | -- |

***Table 8.3.1*** *Animal numbers (m head except chickens in b head) and nitrogenous fertilizer consumption (000 Mt) by regions in 1990 and 2004 (provisional) and % increase over that time*

| | Africa | Asia | Europe | N & C America | Oceania | S. America | World |
|---|---|---|---|---|---|---|---|
| Cattle 1990 | 189 | 402 | 125 | 161 | 32 | 272 | 1297 |
| Cattle 2004 | 232 | 426 | 97 | 161 | 37 | 327 | 1335 |
| % change | 23.5 | 6.1 | -22.4 | 0.2 | 15.7 | 20.0 | 2.9 |
| Sheep 1990 | 204 | 348 | 157 | 22 | 218 | 103 | 1186 |
| Sheep 2004 | 246 | 394 | 121 | 18 | 135 | 70 | 1038 |
| % change | 20.9 | 13.2 | -22.6 | -19.8 | -38.4 | -32.1 | -12.4 |
| Pigs 1990 | 16 | 437 | 183 | 85 | 4.7 | 52 | 857 |
| Pigs 2004 | 22 | 572 | 164 | 100 | 5.5 | 57 | 952 |
| % change | 33.2 | 31 | -10.0 | 17.9 | 16.1 | 9.6 | 11.1 |
| Chickens 1990 | 0.92 | 5.24[a] | 1.32 | 1.83 | 0.07 | 0.92 | 10.68 |
| Chickens 2004 | 1.37 | 8.08 | 1.30 | 2.91 | 0.12 | 1.89 | 16.19 |
| % change | 49.2 | 54.2 | -1.9 | 58.9 | 55.3 | 103.9 | 51.6 |
| N fertiliser consumption 1990 | 2101 | 36975 | 13751 | 13361 | 504 | 1745 | 77175 |
| N fertiliser consumption 2002 | 2116[b] | 44455[b] | 11725[b] | 14312 | 846 | 2319 | 78357[b] |
| % change | 0.7 | 20.2 | -14.7 | 5.6 | 157.3 | 97.3 | 1.53 |

[a]1992 data, [b]1995 data
Source: FAO Statistics

***Table 8.4.1.2a*** *Per-area annual mitigation potentials for each climate region for non-livestock mitigation options*

| Climate zone | Activity catogory | $CO_2$ (t $CO_2$ $ha^{-1}$ $y^{-1}$) Emission reduction (estimate) | Low | High | $CH_4$ (t $CO_2$-eq. $ha^{-1}$ $y^{-1}$) Emission reduction (estimate) | Low | High | $N_2O$ (t $CO_2$-eq. $ha^{-1}$ $y^{-1}$) Emission reduction (estimate) | Low | High | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cool-dry | 1. land cover (use) change | 1.65 | -0.04 | 3.34 | 0.02 | n/d | n/d | 2.3 | 0 | 4.6 | 1 |
| | 2. agroforestry | 1.57 | n/d | n/d | n/d | n/d | n/d | 2.4 | -0.2 | 4.8 | 2 |
| | 3. crop management | 0.29 | 0.07 | 0.51 | n/d | n/d | n/d | 0.1 | 0 | 0.2 | 3 |
| | 4. tillage/residue management | 0.11 | -0.51 | 0.73 | n/d | n/d | n/d | 0 | -1 | 1 | 4 |
| | 5. nutrient management | 0.29 | -0.44 | 1.03 | n/d | n/d | n/d | 0.05 | 0.02 | 0.08 | 5 |
| | 6. rice management | 0.70 | -3.56 | 4.95 | 0.03 | n/d | n/d | 0.19 | n/d | n/d | 6 |
| | 7. water management | 1.14 | -0.55 | 2.82 | n/d | n/d | n/d | n/d | n/d | n/d | 7 |
| | 8. manure/biosolid management | 1.98 | -1.14 | 5.10 | n/d | n/d | n/d | 0 | -0.17 | 1.3 | 8 |
| | 9. grazing land management / pasture improvement | 0.11 | -0.62 | 0.84 | 0.015 | 0.008 | 0.02 | n/d | n/d | n/d | 9 |
| | 10. management of organic soils | 36.67 | 3.67 | 69.67 | n/d | n/d | n/d | n/d | n/d | n/d | 10 |
| | 11. land restoration | 3.45 | -0.37 | 7.26 | 0.08 | 0.04 | 0.14 | n/d | n/d | n/d | 11 |
| | 12. bioenergy | 1.57 | n/d | n/d | n/d | n/d | n/d | n/d | n/d | n/d | 12 |
| | 13. enhanced energy efficiency | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| | 14. increase C storage in agricultural products | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| | 15. manure management | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| Cool-moist | 1. land cover (use) change | 3.04 | 1.17 | 4.91 | 0.02 | n/d | n/d | 2.3 | 0 | 4.6 | 1 |
| | 2. agroforestry | 1.57 | n/d | n/d | n/d | n/d | n/d | 2.4 | -0.2 | 4.8 | 2 |
| | 3. crop management | 0.88 | 0.48 | 1.25 | n/d | n/d | n/d | 0.1 | 0 | 0.2 | 3 |
| | 4. tillage/residue management | 0.55 | 0.04 | 1.06 | n/d | n/d | n/d | 0 | -1 | 1 | 4 |
| | 5. nutrient management | 0.55 | 0.01 | 1.10 | n/d | n/d | n/d | 0.1 | -0.05 | 10.15 | 5 |
| | 6. rice management | 1.58 | -1.47 | 4.62 | 0.3 | n/d | n/d | 0.006 | 0.004 | 0.009 | 6 |
| | 7. water management | 1.14 | -0.55 | 2.82 | n/d | n/d | n/d | n/d | n/d | n/d | 7 |
| | 8. manure/biosolid management | 2.90 | 0.44 | 5.35 | n/d | n/d | n/d | 0 | -0.17 | 1.3 | 8 |
| | 9. grazing land management / pasture improvement | 0.81 | 0.07 | 1.54 | -0.004 | n/d | n/d | n/d | n/d | n/d | 9 |
| | 10. management of organic soils | 36.67 | 3.67 | 69.67 | n/d | n/d | n/d | n/d | n/d | n/d | 10 |
| | 11. land restoration | 3.45 | -0.37 | 7.26 | 1 | 0.69 | 1.25 | n/d | n/d | n/d | 11 |
| | 12. bioenergy | 1.57 | n/d | n/d | n/d | n/d | n/d | n/d | n/d | n/d | 12 |
| | 13. enhanced energy efficiency | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| | 14. increase C storage in agricultural products | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| | 15. manure management | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| Warm-dry | 1. land cover (use) change | 1.65 | -0.04 | 3.34 | 0.02 | n/d | n/d | 2.3 | 0 | 4.6 | 1 |
| | 2. agroforestry | 1.57 | n/d | n/d | n/d | n/d | n/d | 2.4 | -0.2 | 4.8 | 2 |
| | 3. crop management | 0.29 | 0.07 | 0.51 | n/d | n/d | n/d | 0.1 | 0 | 0.2 | 3 |
| | 4. tillage/residue management | 0.33 | -3.12 | 3.78 | n/d | n/d | n/d | 0 | -1 | 1 | 4 |
| | 5. nutrient management | 0.29 | -0.44 | 1.03 | n/d | n/d | n/d | 0.2 | 0.1 | 0.3 | 5 |
| | 6. rice management | 0.70 | -3.56 | 4.95 | 0.03 | n/d | n/d | 0.19 | 0 | 0 | 6 |
| | 7. water management | 1.14 | -0.55 | 2.82 | n/d | n/d | n/d | n/d | n/d | n/d | 7 |
| | 8. manure/biosolid management | 1.98 | -1.14 | 5.10 | n/d | n/d | n/d | 0 | -0.17 | 1.3 | 8 |
| | 9. grazing land management / pasture improvement | 0.11 | -0.62 | 0.84 | n/d | n/d | n/d | n/d | n/d | n/d | 9 |
| | 10. management of organic soils | 73.33 | 7.33 | 139.33 | n/d | n/d | n/d | n/d | n/d | n/d | 10 |
| | 11. land restoration | 3.45 | -0.37 | 7.26 | n/d | n/d | n/d | n/d | n/d | n/d | 11 |
| | 12. bioenergy | 1.57 | n/d | n/d | n/d | n/d | n/d | n/d | n/d | n/d | 12 |
| | 13. enhanced energy efficiency | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| | 14. increase C storage in agricultural products | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| | 15. manure management | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| Warm-moist | 1. land cover (use) change | 3.04 | 1.17 | 4.91 | 0.02 | n/d | n/d | 2.3 | 0 | 4.6 | 1 |
| | 2. agroforestry | 1.57 | n/d | n/d | n/d | n/d | n/d | 2.4 | -0.2 | 4.8 | 2 |
| | 3. crop management | 0.88 | 0.48 | 1.25 | n/d | n/d | n/d | 0.1 | 0 | 0.2 | 3 |
| | 4. tillage/residue management | 0.77 | -2.75 | 4.29 | n/d | n/d | n/d | 0 | -1 | 1 | 4 |
| | 5. nutrient management | 0.55 | 0.01 | 1.10 | n/d | n/d | n/d | 0.2 | 0.1 | 0.3 | 5 |
| | 6. rice management | 1.58 | -1.47 | 4.62 | 0.03 | n/d | n/d | 0.19 | 0 | 0 | 6 |
| | 7. water management | 1.14 | -0.55 | 2.82 | n/d | n/d | n/d | n/d | n/d | n/d | 7 |
| | 8. manure/biosolid management | 2.90 | 0.44 | 5.35 | n/d | n/d | n/d | 0 | -0.17 | 1.3 | 8 |
| | 9. grazing land management / pasture improvement | 0.81 | 0.07 | 1.54 | n/d | n/d | n/d | n/d | n/d | n/d | 9 |
| | 10. management of organic soils | 73.33 | 7.33 | 139.33 | n/d | n/d | n/d | n/d | n/d | n/d | 10 |
| | 11. land restoration | 3.45 | -0.37 | 7.26 | n/d | n/d | n/d | n/d | n/d | n/d | 11 |
| | 12. bioenergy | 1.57 | n/d | n/d | n/d | n/d | n/d | n/d | n/d | n/d | 12 |
| | 13. enhanced energy efficiency | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| | 14. increase C storage in agricultural products | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| | 15. manure management | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |

Footnotes for table 8.4.1.2a:

1 Soil $CO_2$ figures derived from mixed effects modelling (see text). $N_2O$ reduction from Falloon *et al.* (2004) based on $N_2O$ emission figures for cropland and grasslands from Machefert *et al.* (2002). Machefert *et al.* (2002) show mean emissions from forestry, grassland and cropland to be 1.48, 0.99 and 11.82 kg $N_2O$-N $ha^{-1}$ $y^{-1}$, respectively. Also reduced N applied on the headlands compared to cropland. $CH_4$ figure for increased methane oxidation. Data from Follett 2001; Lal et al 1999,2003; Smith et al. 2001; Post and Kwon 2000; Potter et al. 1999;Boeckx and van Cleemput 2001; Bruce et al. 1999; Boehm et al. 2004; VandenBygaart et al. 2003; Mummey et al. 1998; Grant et al. 2004.

2 Same soil C accumulation rate assumed as for natural woodland regeneration reported in Poulton (1996). Some data on $CH_4$ oxidation and $N_2O$ emissions from wooded areas compared to croplands (Zechmeister-Boltenstern, 1998; Goulding et al. ,1998; Butterbach-Bahl et al., 1997; Skiba et al., 1998; Dobbie et al., 1999) but some contradictory and ranges overlap too much for conclusions to be drawn for $CH_4$. For $N_2O$ - Machefert et al. (2002) show mean emissions from forestry, grassland and cropland to be 1.48, 0.99 and 11.82 kg $N_2O$-N $ha^{-1}$ $y^{-1}$ respectively. Wooded area therefore potentially increases $N_2O$ emissions by 0.2 t $CO_2$ eq. $ha^{-1}$ $y^{-1}$ if converted from grassland, or reduce $N_2O$ emissions by 4.8 t $CO_2$ eq. $ha^{-1}$ $y^{-1}$ if converted from cropland. These values used to set minimum and maximum with estimated emission set to half maximum.

3 Soil $CO_2$ figures derived from mixed effects modelling (see text). Insufficient data on $CH_4$. $N_2O$ figures derived from primary sources: Smith et al. 2001; McConkey et al. 2003; Boehm et al. 2004; VandenBygaart et al. 2003; Grant et al. 2004; secondary sources: Follett 2001; Lal 1999; Lal et al. 1998, 1999, 2003; Dumanski et al. 1998; Janzen et al. 1998b. The effect of fallow elimination on $N_2O$ probably varies with moisture content; benefits of reduced $N_2O$ emission will likely increase as soil moisture increases.

4 Soil $CO_2$ figures derived from mixed effects modelling (see text). Insufficient data on $CH_4$. Uncertainty very high for $N_2O$ since the influence of tillage on $N_2O$ is very uncertain; in some studies no-till seems to increase emissions, in other it seems to reduce emissions; probably depends on factors such as soil moisture, and time since adoption of no-till (e.g., Six et al. 2004). Primary sources: West and Post, 2002; West and Marland 2002; Six et al. 2004; Franzluebbers and Steiner 2002; VandenBygaart et al. 2005. Secondary sources: Follet 20001; Smith et al. 2001; Paustian et al. 1997; McConkey et al. 2003; Lal et al 1998, 1999; Janzen et al. 1998a,b; Jackson and Schlesinger 2004; Smith and Conen 2004; Roberston et al. 2000, 2004; Boehm et al. 2004; Helgason et al. 2005; Grant et al. 2004.

5 Soil $CO_2$ figures derived from mixed effects modelling (see text). Insufficient data on $CH_4$. The potential rates of $N_2O$ mitigation were estimated by assuming a 20% improvement in efficiency, and that the corresponding avoided N use reduced $N_2O$ emissions by 0.0125 kg $N_2O$-N per kg N applied. Average N application rates (prior to mitigation) were assumed to be 40, 80, and 160 kg N $ha^{-1}$ $yr^{-1}$ for the 'cool dry', 'cool moist', and 'warm (both dry and moist)' climate regimes, respectively. Derived from Cole et al. 1997; CAST 2004.

6 Soil $CO_2$ figures derived from mixed effects modelling (see text). Figures for $CH_4$ and $N_2O$ for warm (dry and moist) and cool dry conditions are derived from Zou et al. (2003) and Lou et al. (2004). Figures for $CH_4$ and $N_2O$ for cool moist conditions are derived from Li et al. (2003).

7 Soil $CO_2$ figures derived from mixed effects modelling (see text). Insufficient data on $CH_4$ and $N_2O$.

8 Soil $CO_2$ figures derived from mixed effects modelling (see text). Insufficient data on $CH_{4.}$ $N_2O$ figures derived from manure and sewage sludge emission figures used in Smith et al. (2001) based on a number of previous studies

9 Soil $CO_2$ figures derived from mixed effects modelling (see text). $CH_4$ figures for cool-moist and cool-dry climates derived from Qi et al. (2005). Insufficient data on $N_2O$

10 Soil $CO_2$ figures derived from IPCC defaults for drained organic soils in each climate zone. Insufficient data for $CH_4$ and $N_2O$.

11Soil $CO_2$ figures derived from mixed effects modelling (see text). $CH_4$ figures for cool-moist and cool-dry climates derived from Hao et al. (2004). Insufficient data on $N_2O$

12 Same soil C accumulation rate assumed as for natural woodland regeneration reported in Poulton (1996) as used in Smith et al. (1997, 2000). Fossil fuel offsets and $CH_4$ and $N_2O$ emissions from biomass burning are assessed separately (see text)

13 No data yet – (to be completed)

14 No significant impact (see text)

15 No data yet - (to be completed)

***Table 8.4.1.2b*** *Summary of biophysical reduction potential (per animal) for methane emissions due to improved feeding practice* [1]

| | Dairy | | | Other cattle | | | Combined dairy/ other | Sheep | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Default kg $CH_4$ | % reduction | t $CO_2$-eq. reduced | Default kg $CH_4$ | % reduction | t $CO_2$ – eq. reduced | t $CO_2$-eq. reduced | Default kg $CH_4$ | % reduction | t $CO_2$-eq. reduced |
| W. Europe | 100 | 11 | 0.25 | 48 | 9 | 0.10 | 0.14 | 8 | 6 | 0.01 |
| E Europe | 81 | 6.5 | 0.12 | 56 | 4.5 | 0.06 | 0.09 | 5 | 2.5 | 0.00 |
| Oceania | 68 | 6.75 | 0.11 | 53 | 11.5 | 0.14 | 0.13 | 8 | 8.5 | 0.02 |
| N Amer | 118 | 13 | 0.35 | 47 | 9 | 0.10 | 0.13 | 8 | 6 | 0.01 |
| L America | 57 | 11.5 | 0.15 | 49 | 9.5 | 0.11 | 0.11 | 5 | 7.5 | 0.01 |
| Russia | 68 | 11.5 | 0.18 | 50 | 9.5 | 0.11 | 0.14 | 5 | 7.5 | 0.01 |
| Africa | 36 | 10.5 | 0.09 | 32 | 10.5 | 0.08 | 0.08 | 5 | 10 | 0.01 |
| Asia | 56 | 10.8 | 0.14 | 44 | 10.7 | 0.11 | 0.11 | 5 | 10 | 0.01 |
| India | 46 | 10.8 | 0.11 | 25 | 10.7 | 0.06 | 0.07 | 5 | 10 | 0.01 |

[1] Effect on $CO_2$ or $N_2O$ emissions from the farming and related sectors not quantified. Value for $CH_4$ derived from Leng (1991); Johnson and Johnson (1995); McCrabb et al. (1998); Nelson et al. (2001); Johnson et al. (2002); Lovett et al. (2003); O'Mara and Lovett (2003); Jordan et al. (2004); Machmuller et al. (2004); McGinn et al. (2004); Alcock and Hegarty (2005); Beauchemin and McGinn (2005); Jordan et al. (in press); Lovett et al. (in press).

***Table 8.4.1.2c.*** *Summary of biophysical reduction potential (per animal) for methane emissions due to specific agents and dietary additives* [1]

| | Dairy | | | Other cattle | | | Combined dairy/ other | Sheep | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Default kg $CH_4$ | % reduction | t $CO_2$-eq. reduced | Default kg $CH_4$ | % reduction | t $CO_2$-eq. reduced | t $CO_2$-eq. reduced | Default kg $CH_4$ | % reduction | t $CO_2$-eq. reduced |
| W. Europe | 100 | 6 | 0.14 | 48 | 2 | 0.02 | 0.05 | 8 | 0.5 | 0.001 |
| E Europe | 81 | 7.75 | 0.14 | 56 | 6.25 | 0.08 | 0.12 | 5 | 0 | 0.0 |
| Oceania | 68 | 10.5 | 0.16 | 53 | 8.5 | 0.10 | 0.11 | 8 | 3 | 0.006 |
| N Amer | 118 | 14.25 | 0.39 | 47 | 7.25 | 0.08 | 0.12 | 8 | 3 | 0.006 |
| L America | 57 | 7.75 | 0.10 | 49 | 2.25 | 0.03 | 0.03 | 5 | 0 | 0.0 |
| Russia | 68 | 7.75 | 0.12 | 50 | 6.25 | 0.07 | 0.09 | 5 | 0 | 0.0 |
| Africa | 36 | 1 | 0.01 | 32 | 0.75 | 0.01 | 0.01 | 5 | 0 | 0.0 |
| Asia | 56 | 1 | 0.01 | 44 | 0.75 | 0.01 | 0.01 | 5 | 0 | 0.0 |
| India | 46 | 1 | 0.01 | 25 | 0.75 | 0.004 | 0.01 | 5 | 0 | 0.0 |

[1] No impact on soil $CO_2$. Values for $CH_4$ derived from Johnson (1982); Johnson et al. (1991); Johnson and Johnson (1995); Van Nevel and Demeyer (1996); Mathison et al. (1998); Newbold et al. (2002), McGinn et al. (2004); Wallace et al. (2005).

***Table 8.4.1.2d.*** *Summary of biophysical reduction potential (per animal) for methane emissions due to longer term structural and management changes and breeding* [1]

| | Dairy | | | Other cattle | | | Combined dairy/ other | Sheep | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Default kg $CH_4$ | % reduction | t $CO_2$-eq. reduced | Default kg $CH_4$ | % reduction | t $CO_2$-eq. reduced | t $CO_2$-eq. reduced | Default kg $CH_4$ | % reduction | t $CO_2$-eq. reduced |
| W. Europe | 100 | 5 | 0.12 | 48 | 17.5 | 0.19 | 0.17 | 8 | 1.5 | 0.002 |
| E Europe | 81 | 5 | 0.09 | 56 | 17.5 | 0.23 | 0.15 | 5 | 1.5 | 0.003 |
| Oceania | 68 | 5 | 0.08 | 53 | 17.5 | 0.21 | 0.19 | 8 | 1.5 | 0.003 |
| N Amer | 118 | 5 | 0.14 | 47 | 17.5 | 0.19 | 0.18 | 8 | 1.5 | 0.002 |
| L America | 57 | 5 | 0.07 | 49 | 17.5 | 0.20 | 0.19 | 5 | 1.5 | 0.002 |
| Russia | 68 | 5 | 0.08 | 50 | 17.5 | 0.20 | 0.15 | 5 | 1.5 | 0.002 |
| Africa | 36 | 5 | 0.04 | 32 | 12.5 | 0.09 | 0.09 | 5 | 1.5 | 0.002 |
| Asia | 56 | 5 | 0.06 | 44 | 12.5 | 0.13 | 0.12 | 5 | 1.5 | 0.002 |
| India | 46 | 5 | 0.05 | 25 | 12.5 | 0.07 | 0.07 | 5 | 1.5 | 0.002 |

[1] Effect on $CO_2$ or $N_2O$ emissions from the farming and related sectors not quantified. Value for $CH_4$ derived from Martin and Seeland (1999); Herd et al. (2002); Johnson et al. (2002); Lovett and O'Mara (2002); Berry et al. (2003); O'Mara and Lovett (2003); Garnsworthy (2004); Lovett et al. (2005).

## *Table 8.4.3a* *Estimated costs (USD per t $CO_2$-eq.) of each mitigation option*

| | **Costs for socio-economic potential (USD per t $CO_2$eq.) - range** | **Notes (cost basis listed here)** |
|---|---|---|
| 1. land cover (use) change | -20 to -60 | Converted from Euro value in ECCP WG7 report. The 50cm strip would seem difficult to achieve in practise; a more workable width is required. The yield penalty would severely hamper uptake of this measure by the industry (ECCP, WG7). |
| 2. agroforestry | n/d | |
| 3. crop management | n/d | |
| 4. tillage/residue management | n/d | |
| 5. nutrient management | -3 to -340 | Converted from Euro value in ECCP WG7 report. This option is only feasible provided there is an incentive to do so [fertilizer is relatively cheap] and that sufficiently trained farmers/ specialist rural contractors are available. This could be achieved by making such maintenance a factor in agri-environment schemes [other CAP or rural development regulation to incentivise] and paying a further premium for good maintenance. There are also opportunities for rural development within the agricultural industry through subsidised training, perhaps diversity of activities for farmers. Measures of these types can (or should) to variable extents be found in action programmes for nitrate vulnerable zones. Largest figure is for contractors for precision farming. Optimised timeing is cost neutral. |
| 6. rice management | n/d | |
| 7. water management | 2500-37500 | (Mean irrigation rate 10500 t per ha, pumping cost 0.25 USD per ton as in China). The range given assumes all irrigated water is pumped. When pumping offers 30% of the irrigation water, then the cost would be 2500 - 37500 per ton $CO_2$ (Ref). |
| 8. manure/biosolid management | n/d | |
| 9. grazing land management / pasture improvement | n/d | |
| 10. management of organic soils | n/d | |
| 11. land restoration | n/d | |
| 12. bioenergy | n/d | |
| 13. enhanced energy efficiency | n/d | Uwe and Bruce to provide |
| 14. livestock management – improved feeding practices | 0 to 100 | |
| 15. livestock management – additives, inocula, vaccine | 0 (most options) - 4500 (propioante precursors) | High - very high according to ECCP, WG7. It could be $4,500/tonne of CO2 eq, using synthetic organic acids. Selecting or breeding forage plants with higher contents of organic acids would give a cheaper source, but feasibility still unproven. Based on figures for cost of $2.1/kg and potential reduction of 0.12 if fed at 0.1 of diet. Costs based on using synthetic organic acids. Costs much lower (close to zero or neagitive) for other methods such as BSt and ionophores. |
| 16. livestock management –breeding, improved systems | -60 to 0 | Converted from value of -43 Euro per t $CO_2$ eq. given in ECCP, WG7. 0 value if improved breeding leads to an actual increase in emissions |
| 17. increase C storage in agricultural products | n/d | |
| 18. Manure management | -60 to 180 | For anaerobic digestion and energy production (CHP). Converted from Euro values in ECCP, WG7 report. Cost vary with scale and whether heat and power or heat only. Subsidies of some form or another operate in several countries to encourage development of these facilities. A study by the European Commission (EC, 1998) showed that CO2 abatement can be achieved at no additional cost in the case of the combustion of forestry residues in circulating fluidised bed boilers for CHP power generation in Sweden compared to a reference coal combustion case. This may also be the case where biomass is used for heat generation in small scale plants for substituting stoves fired with coal or light oil. Heat and electricity generation from gasification-based combined cycle systems possess positive abatement costs, up to about 80 US$/t CO2 for the current state of the technology. Slurry cooling is prohibitively expensive (AEA, 2001) |

***Table 8.4.3b.*** *Estimates of the global agricultural GHG mitigation potential (Mt $CO_2$-eq. $yr^{-1}$) under different assumptions on the price of $CO_2$-equaivalents and the level of implementation possible by 2025*

| | Global agricultural GHG mitigation potential (Mt $CO_2$-eq. $yr^{-1}$) | | |
|---|---|---|---|
| Price of $CO_2$-eq. (US$ t $CO_2$-eq. $^{-1}$) | Full implementation | 20% implementation | 10% implementation |
| 16.67 | ~2000 | ~400 | ~200 |
| 33.33 | ~4100 | ~800 | ~400 |
| 50.00 | ~6000 | ~1200 | ~600 |
| 5000 | ~7400 | ~1500 | ~740 |

## *Table 8.4.4 Potential sustainable development consequences of mitigation options*

| Activity category | Sustainable development<br>Social | Economic | Environmental | Notes |
|---|---|---|---|---|
| 1. land cover (use) change | Positive as it enhances the ecological services by increasing the biomass and watershed functions | Farmers will loss their income from cropland | Positive | 1 |
| 2. agroforestry | Uncertain | Uncertain | Positive | |
| 3. crop management | Uncertain | Uncertain | Positive | 2 |
| 4. tillage/residue management | Uncertain | Uncertain | Positive | 3 |
| 5. nutrient management | Uncertain | Overall efficient use of nutrients will yield cost reduction and productivity improvement | positive | 4 |
| 6. rice management | Positive | Positive | Might result in less pollution | 5 |
| 7. water management | Positive | Positive (even if the farmers are supposed to pay for water!) | Positive | 6 |
| 8. manure/biosolid management | Positive | Could be adverse due to higher cost structure under new scheme of biosolid management | Positive | 7 |
| 9. grazing land management / pasture improvement | Positive | Positive | Positive | 8 |
| 10. management of organic soils | Uncertain | Uncertain | | |
| 11. land restoration | Positive | Likely to be positive | Positive | 9 |
| 12. bioenergy | Positive | Uncertain | Positive | 10 |
| 13. enhanced energy efficiency | Positive | Positive | Uncertain | |
| 14. livestock management – improved feeding practices | Uncertain to negative as these practices may not be acceptable due to prevailing cultural practices especially in developing and underdeveloped society | Positive | Uncertain | |
| 15. livestock management – additives, inocula, vaccine | Same as above | n/d | n/d | n/d |
| 16. livestock management –breeding, improved systems | Same as above | n/d | n/d | n/d |
| 17. increase C storage in agricultural products | Positive | Positive | Positive | |
| 18. manure management | n/d | n/d | n/d | n/d |

Footnotes for Table 8.4.4:

[1] Economic benefits might decline but other benefits would increase.
[2] Technology-based production increase fertilizer efficiency, which leads to decrease of demands on arable lands.
[3] Improves fertility of the land
[4] Overall reduction in fertiliser use
[5] Favourable
[6] All efficiency improvements are positive for sustainability goals
[7] Green industrial development becomes feasible and hence positive
[8] Positive
[9] Favourable
[10] Positive

**Figures**

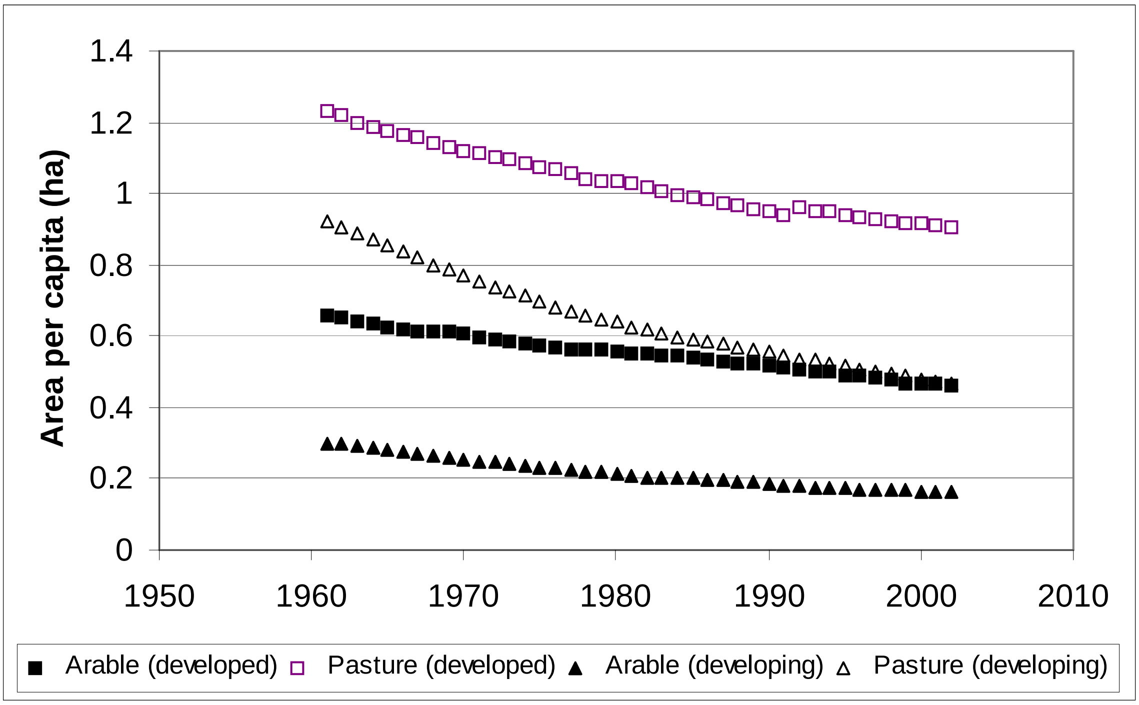



***Figure 8.2.1*** *Evolution of per capita area of arable land and pasture, in developed and developing countries. (Source FAOSTAT, 2005)*

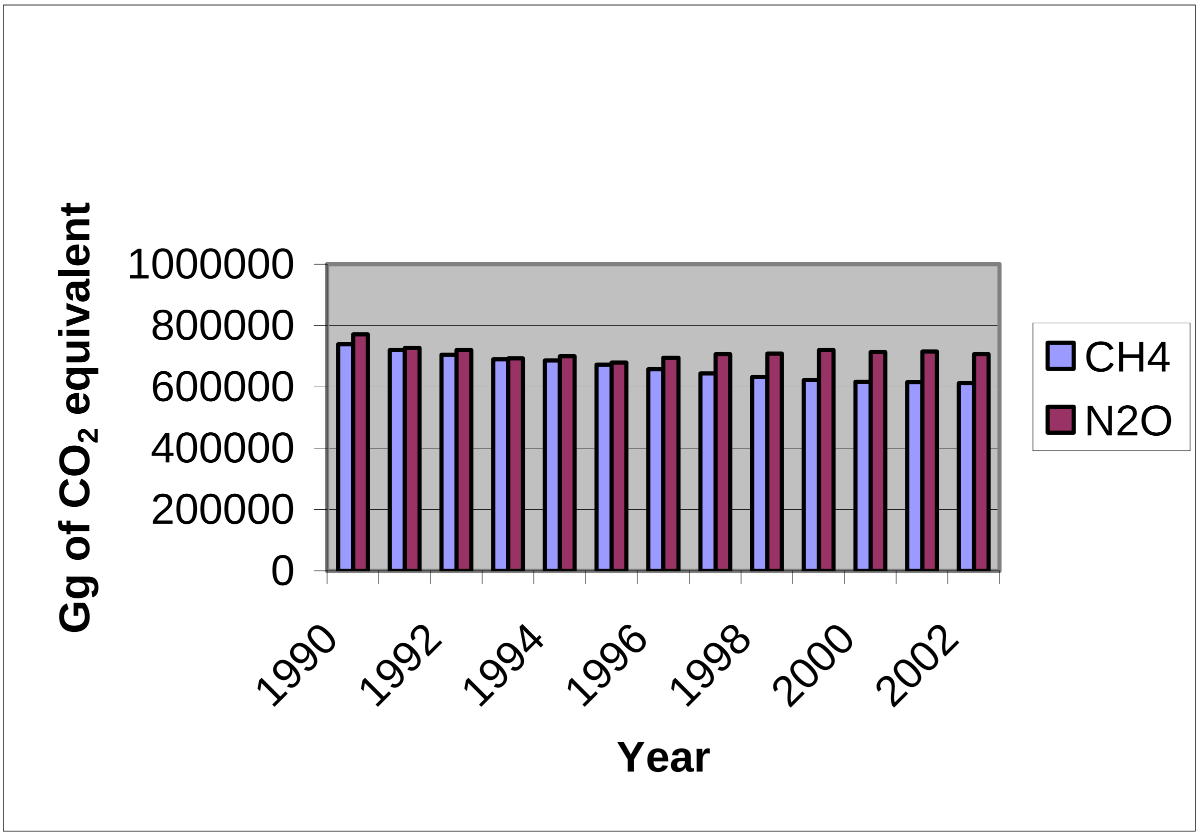



***Figure 8.3.1*** *Methane and nitrous oxide emissions from agriculture.*

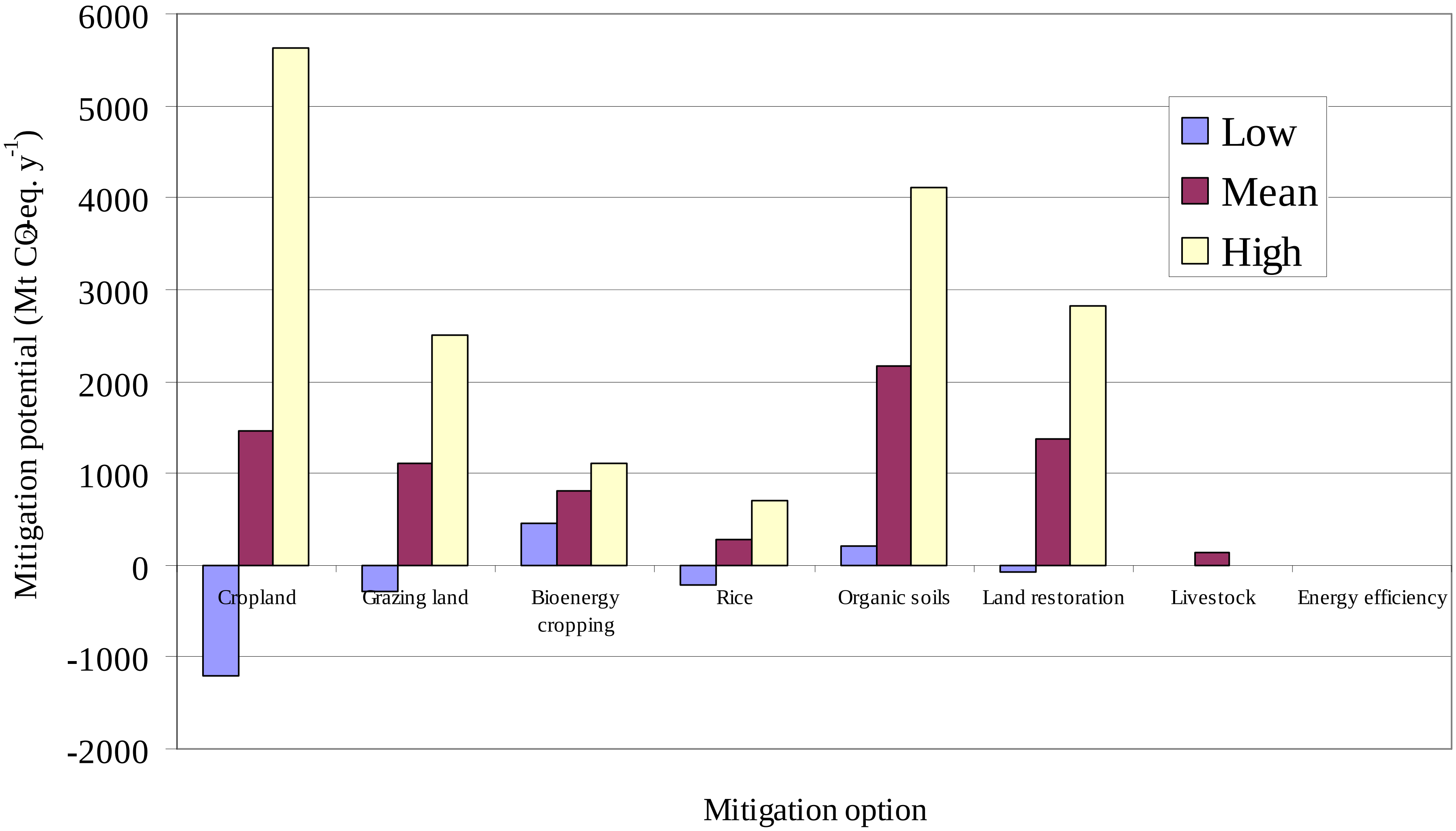
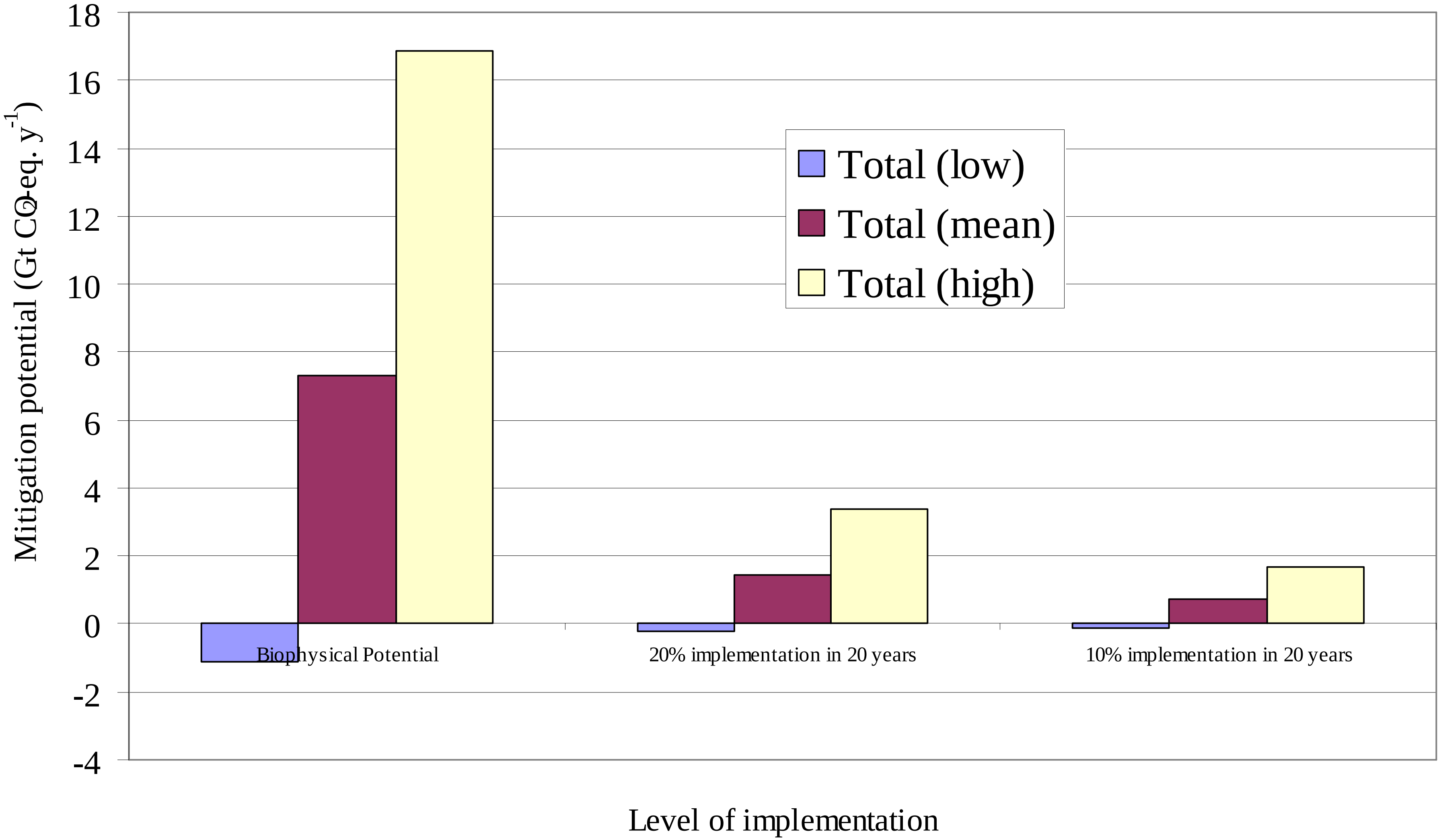



***Figure 8.4.2a*** *Global biophysical mitigation potential of each agricultural management practice (showing the low, mean and high estimates.)*



18
16
14
12
10
8
6
4
2
0
-2
-4
Mitigation potential (Gt CO2-eq. y-1)
Total (low)
Total (mean)
Total (high)
Biophysical Potential
20% implementation in 20 years
10% implementation in 20 years
Level of implementation

***Figure 8.4.2b*** *Global mitigation potentials, comparing the total biophysical potential with the realistically achievable potentials under assumptions of 10 and 20% implementation over the next twenty years.*

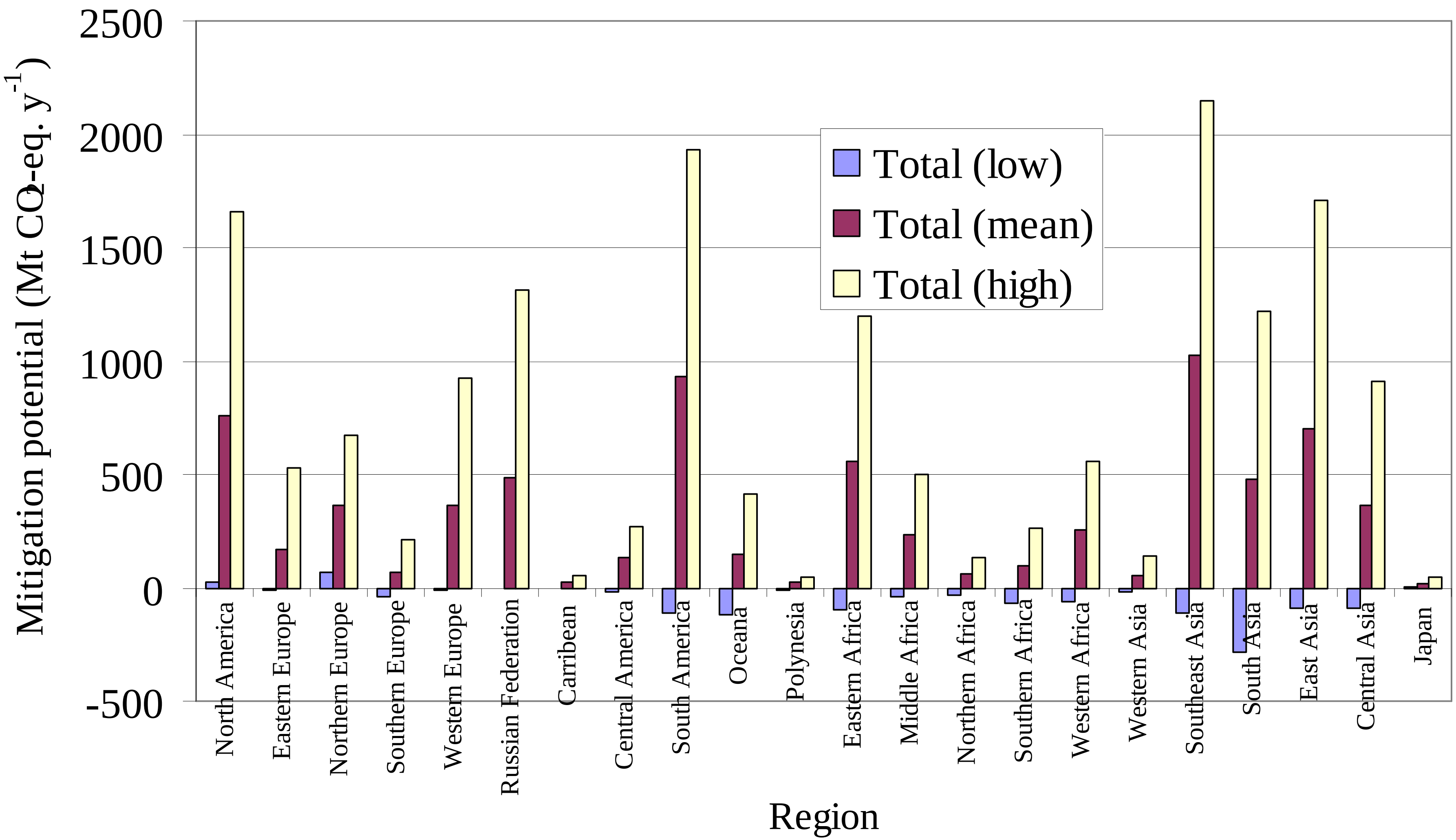



***Figure 8.4.2c*** *Regional estimates of the biophysical mitigation potential (low, mean and high) for all practices and GHGs considered together*

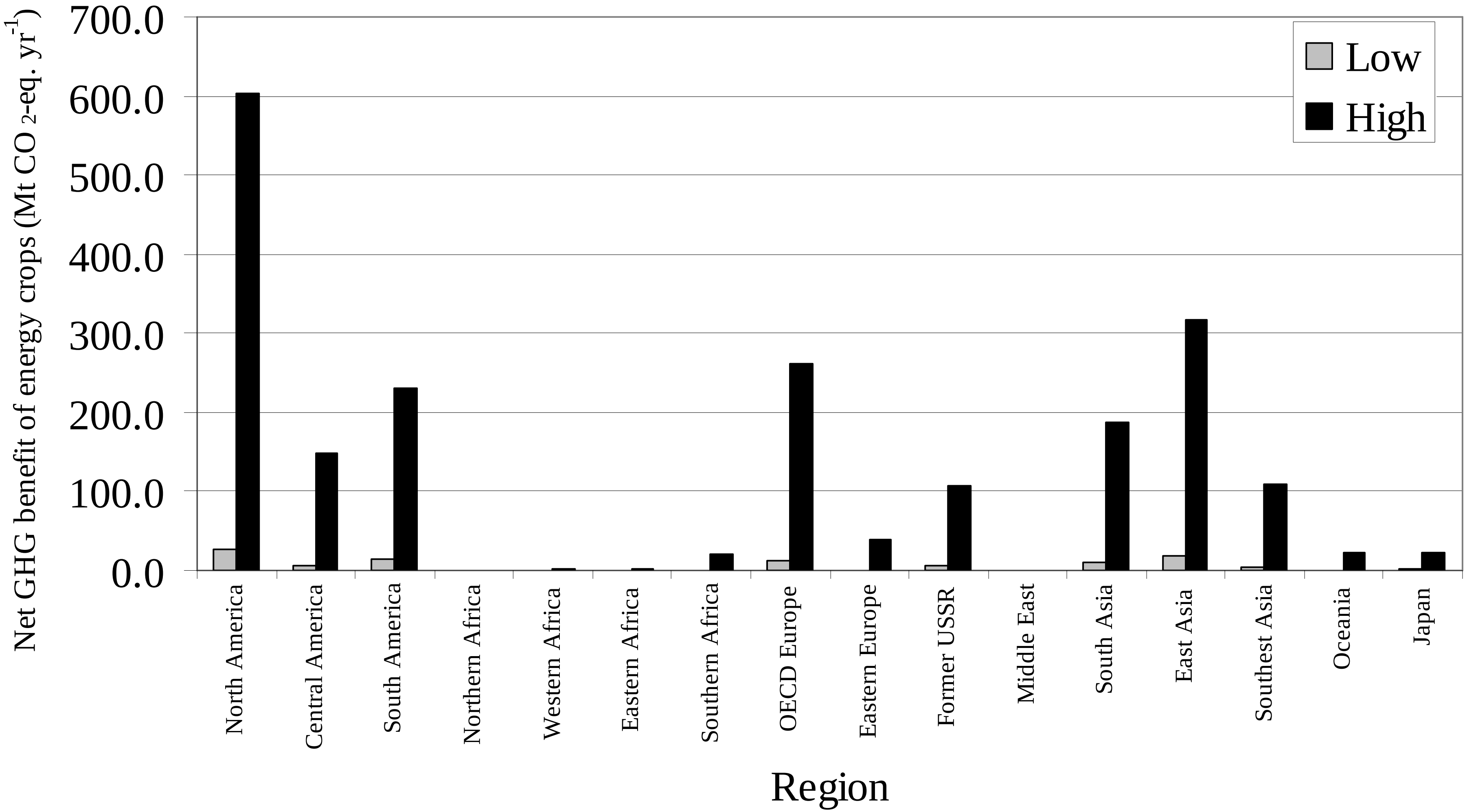



***Figure 8.4.2d*** *Low and high regional estimates of net GHG benefit of bioenergy crops*

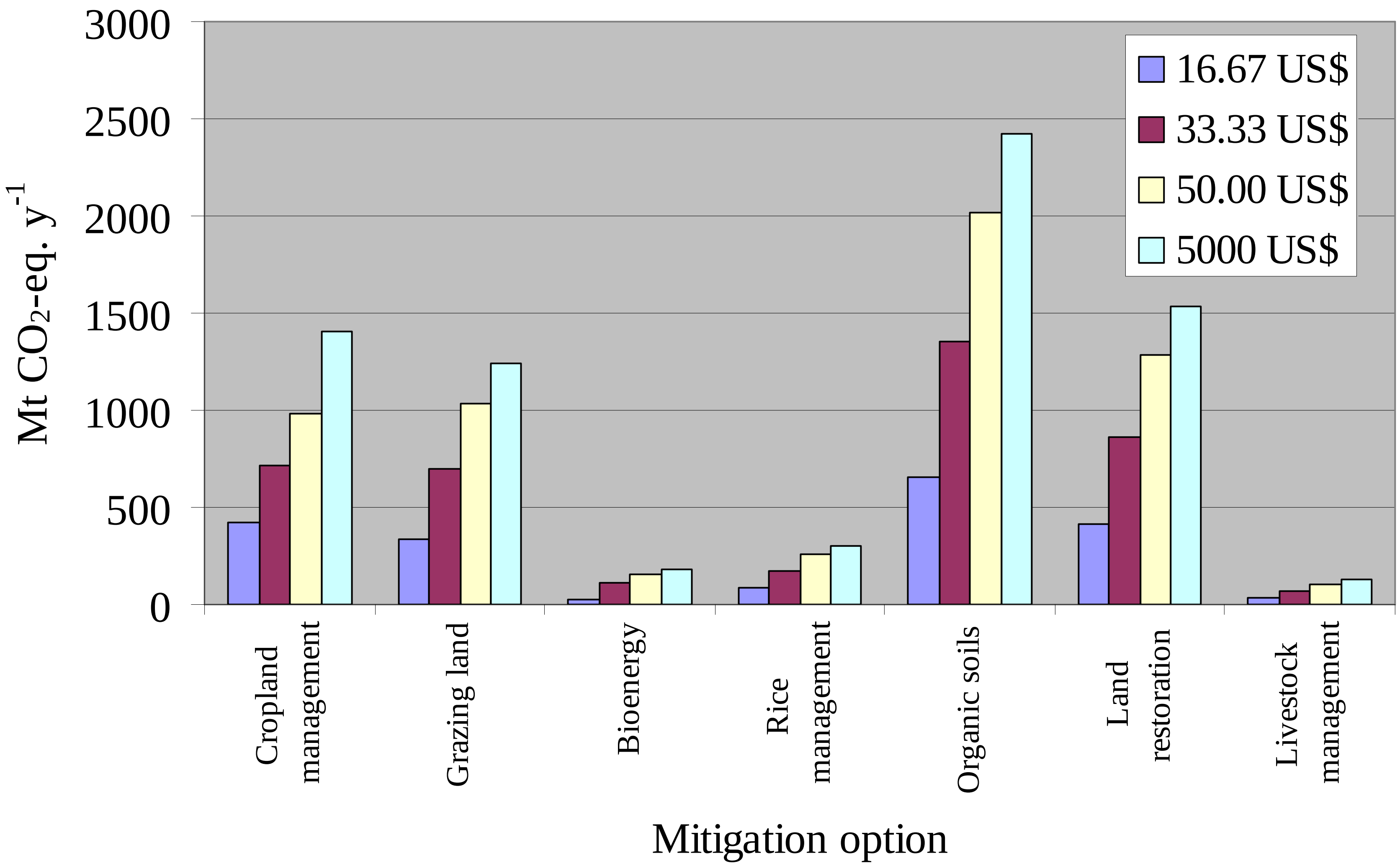



***Figure 8.4.3a*** *Effect of price of $CO_2$-eq. (US\$ t $CO_2$-eq. $^{-1}$) on the global mitigation potential of each group of agricultural GHG mitigation activities*

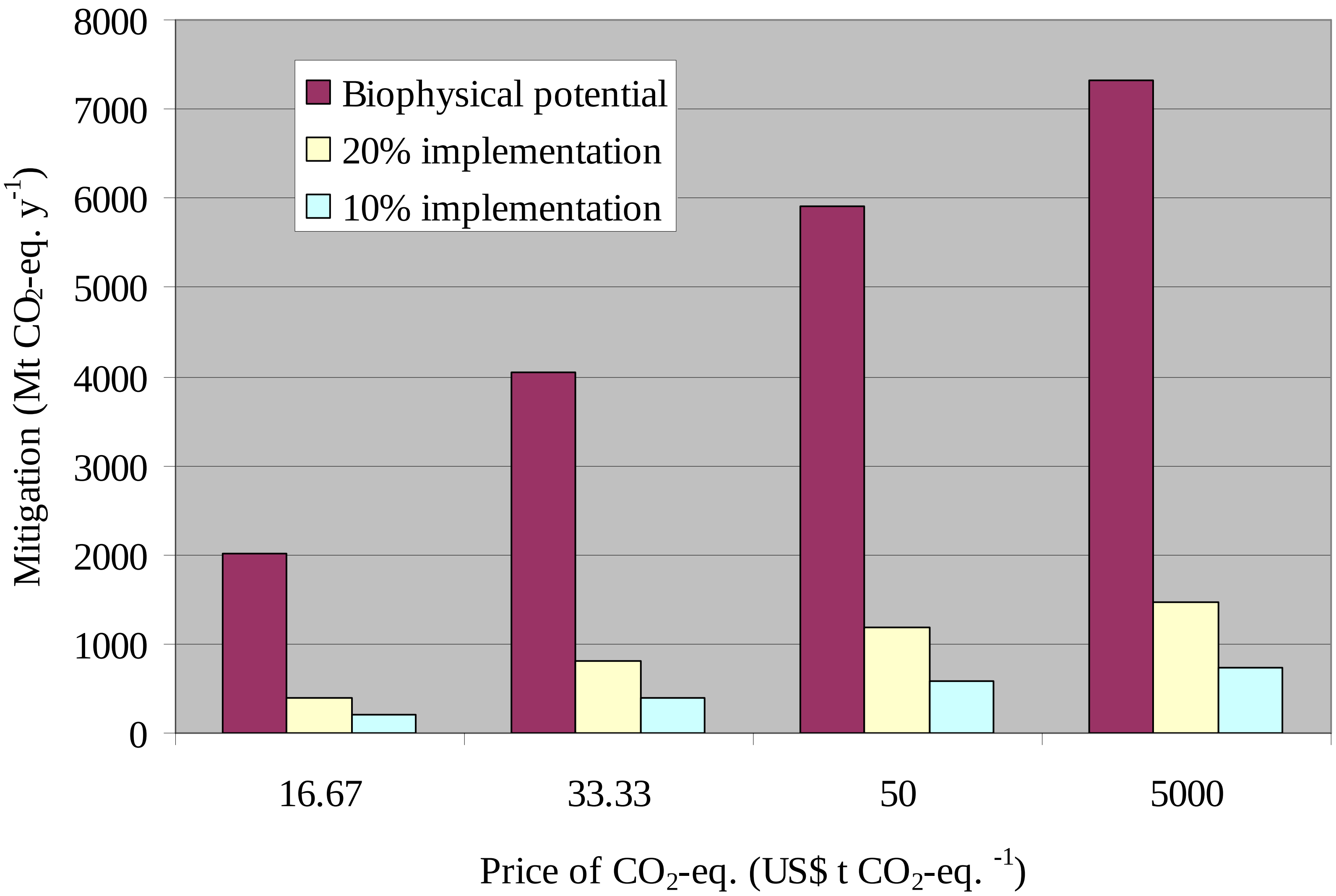



***Figure 8.4.3b*** *Effect of price of $CO_2$-eq. (US$ t$CO_2$-eq. $^{-1}$) on the total global mitigation potential assuming full implementation (biophysical potential), 20% or 10% implementation by 2025*

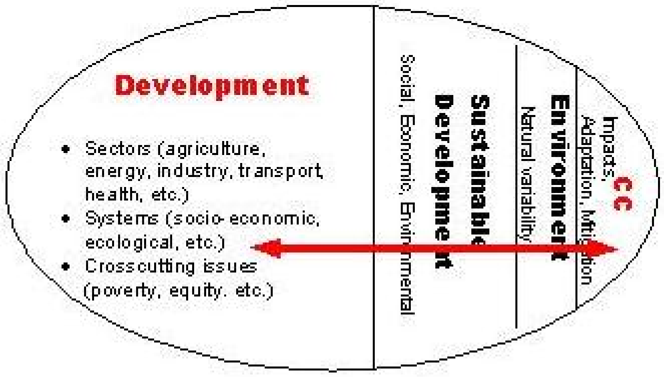



***Figure 8.4.4***. *Linking CC response to Sustainable Development*

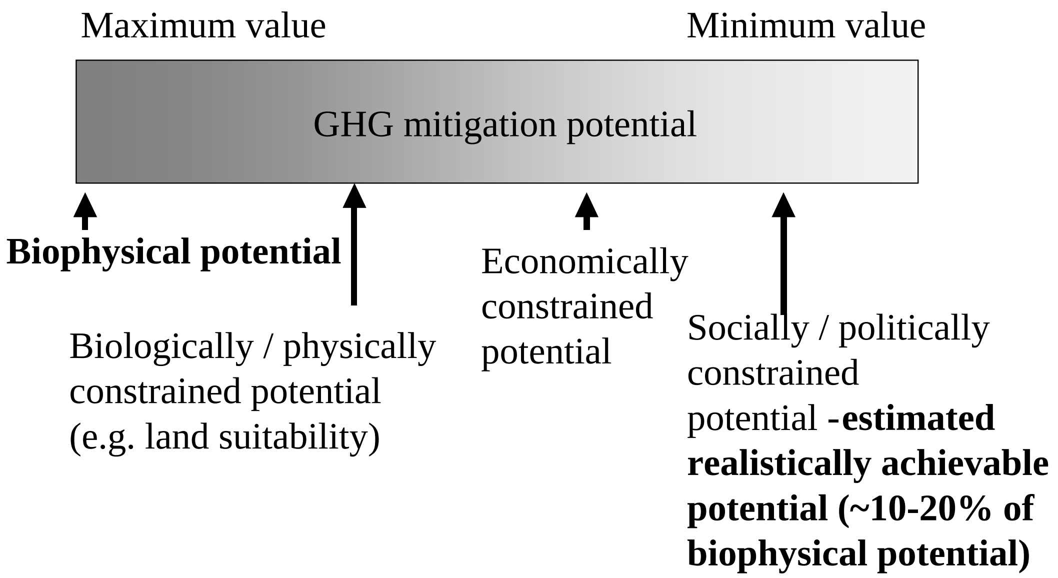



***Figure 8.6*** *Impact of different constraints on reducing the GHG mitigation potential from its theoretical biological maximum to lower, realistically achievable potentials (after Smith, 2004b)*