

Projections of Global Meat Production Through 2050

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Summary: Meat production growth is driven by a combination of increases in economic activity that result in increased purchasing power coupled with population growth that increases the number of consumers. Projections of growth in global GDP and population through 2050 strongly suggest that there will be substantial increases in meat production requirements over the next 45 years. The increases are large enough to cause concern over the level of agricultural resources required to produce the projected levels of production.

The Population Factor: The U.N. Population Division publishes historical and projected estimates of global population. The latest revision was made in 2004, and contains four levels of projections through 2050. For purposes of this paper the medium projection was used (Table 1).

Table 1: U.N. Population Estimates and Projections¹
(000's)

<i>Year</i>	<i>Medium</i>	<i>High</i>	<i>Low</i>	<i>Constant-fertility</i>
1950	2,519,470	2,519,470	2,519,470	2,519,470
1955	2,757,399	2,757,399	2,757,399	2,757,399
1960	3,023,812	3,023,812	3,023,812	3,023,812
1965	3,337,974	3,337,974	3,337,974	3,337,974
1970	3,696,588	3,696,588	3,696,588	3,696,588
1975	4,073,740	4,073,740	4,073,740	4,073,740
1980	4,442,295	4,442,295	4,442,295	4,442,295
1985	4,843,947	4,843,947	4,843,947	4,843,947
1990	5,279,519	5,279,519	5,279,519	5,279,519
1995	5,692,353	5,692,353	5,692,353	5,692,353
2000	6,085,572	6,085,572	6,085,572	6,085,572
2005	6,464,750	6,464,750	6,464,750	6,464,750
2010	6,842,923	6,903,276	6,781,431	6,881,529
2015	7,219,431	7,382,434	7,054,584	7,337,041
2020	7,577,889	7,873,172	7,280,148	7,819,287
2025	7,905,239	8,336,867	7,471,426	8,321,838
2030	8,199,104	8,784,155	7,618,083	8,855,299
2035	8,463,265	9,237,907	7,712,423	9,439,779
2040	8,701,319	9,709,446	7,753,745	10,092,723
2045	8,907,417	10,184,739	7,741,810	10,827,058
2050	9,075,903	10,646,311	7,679,714	11,657,999
<i>2005-2050</i>				
<i>%Increase</i>	40.4%	64.7%	18.8%	80.3%

¹ Source: <http://esa.un.org/unpp/p2k0data.asp>

The U.N. estimates are on 5 year intervals, but annual numbers were needed for the meat production estimates. To estimate the years not included in the U.N. medium variant dataset a regression equation, using Year as the independent variable, was fitted to all the available data for 1950-2050. The intervening years were calculated based on the regression. The equation used was:

$$\text{Pop} = A + B(\text{Year}) + C(\text{Year}^2) + D(\text{Year}^3)$$

Using least squares regression the resulting estimate was:

$$\text{Pop} = 46,660,628,985 - 70,374,538(\text{Year}) + 35,343.4(\text{Year}^2) + 5.910(\text{Year}^3)$$

$$R^2 = .99994$$

The Economic Activity Factor: The global level of economic activity is a major factor in the growth of meat production. The best available measure of overall economic activity is Gross Domestic Product, corrected for inflation. The World Bank database, WDI Online², contains estimates of global GDP in constant 2000 U.S. dollars. These estimates for 1965 through 2005, projected through 2050, were used as the independent variable to project per capita meat production through 2050. The total GDP numbers from the World Bank were divided by the U.N. population estimates to yield per capita GDP.

Table 2: GDP, Population and Per Capita GDP, Selected Years, 1965-2050
Population and GDP in 000's, 2006-2050 Projected

Year	Per Capita		
	GDP \$2000	Population	GDP \$2000
1965	\$2,825	3,337,974	\$9,429,556
1970	\$3,299	3,696,588	\$12,194,430
1975	\$3,581	4,073,740	\$14,587,570
1980	\$3,966	4,442,295	\$17,616,910
1985	\$4,136	4,843,947	\$20,032,840
1990	\$4,535	5,279,519	\$23,944,060
1995	\$4,727	5,692,353	\$26,910,310
2000	\$5,217	6,085,572	\$31,745,760
2005	\$5,654	6,464,750	\$36,554,731
2010	\$6,103	6,842,923	\$41,765,656
2015	\$6,588	7,219,431	\$47,562,691
2020	\$7,111	7,577,889	\$53,888,672
2025	\$7,676	7,905,239	\$60,680,624
2030	\$8,286	8,199,104	\$67,934,006
2035	\$8,943	8,463,265	\$75,691,056
2040	\$9,654	8,701,319	\$83,999,657
2045	\$10,420	8,907,417	\$92,817,529
2050	\$11,248	9,075,903	\$102,083,102

² <http://publications.worldbank.org/WDI/>

To project GDP from 2005 to 2050 the available data for 1965 through 2005 were regressed on Year. The equation was estimated in logarithms, and regression gives average annual growth rate of GDP. The regression result was:

$$\text{Per Capita GDP} = 2995.3 * e^{0.0154}$$

$$R^2 = 0.98$$

The exponent of 0.0154 is the estimate of the average annual growth rate of 1.54% per year. This growth rate was applied to the current level of per capita GDP to estimate 2006-2050 per capita GDP. The resulting 2006-2050 per capita GDP projections were multiplied by the U.N. population numbers to yield the total 2006-2050 GDP estimates in the last column of Table 2.

Projected Meat Production: Global meat production data for 1965-2005 were obtained from the U.N. Food and Agricultural Organization FAOSTAT livestock database³. The numbers represent total meat produced from all significant farmed species for all U.N. member nations. The total production numbers were divided by the U.N. population estimates to obtain per capita production.

To project per capita meat production the following model was used:

$$\text{Per Capita Meat Production} = A + B(\text{Per Capita GDP})$$

Both variables were converted to logarithms before the regression was run. The resulting estimated equation for 1965-2005 was:

$$\text{Per Capita Meat Production} = -2.842 + 0.758313(\text{Per Capita GDP})$$

$$R^2 = 0.976$$

By estimating the regression using logs of the data the B coefficient can be interpreted as the % change in per capita meat production for a 1% change in per capita GDP. The equation implies that on a global basis a 1% increase in per capita GDP is associated with a 0.76% increase in per capita meat production. This coefficient, being a global average, and is likely different for different regions. In particular, the responsiveness of production to GDP is likely higher in lower income countries than is the case in high income countries.

The equation above was used to project per capita meat production from 2006 through 2050. The per capita numbers were multiplied by the U.N. population projections to obtain total meat production. All numbers were then converted back from logarithms for purposes of Table 3.

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The 135.5% increase in total meat production is driven by both population growth and increases in GDP. While both population and GDP are important, the near doubling of per capita GDP is a more important factor than the 40.4% increase in population.

Table 3: Per Capita and Total Meat Production
2006-2050 Projected

Year	Per Capita		GDP \$2000	Total Meat, 000 Tons	Per Capita Meat, kg
	GDP \$2000	Population			
1965	\$2,825	3,337,974	\$9,429,556	84,437	25.3
1970	\$3,299	3,696,588	\$12,194,430	100,624	27.2
1975	\$3,581	4,073,740	\$14,587,570	115,765	28.4
1980	\$3,966	4,442,295	\$17,616,910	136,682	30.8
1985	\$4,136	4,843,947	\$20,032,840	154,421	31.9
1990	\$4,535	5,279,519	\$23,944,060	179,958	34.1
1995	\$4,727	5,692,353	\$26,910,310	206,755	36.3
2000	\$5,217	6,085,572	\$31,745,760	235,121	38.6
2005	\$5,654	6,464,750	\$36,554,731	265,236	41.0
2010	\$6,103	6,842,923	\$41,765,656	296,199	43.3
2015	\$6,588	7,219,431	\$47,562,691	331,138	45.9
2020	\$7,111	7,577,889	\$53,888,672	368,316	48.6
2025	\$7,676	7,905,239	\$60,680,624	407,148	51.5
2030	\$8,286	8,199,104	\$67,934,006	447,475	54.6
2035	\$8,943	8,463,265	\$75,691,056	489,447	57.8
2040	\$9,654	8,701,319	\$83,999,657	533,234	61.3
2045	\$10,420	8,907,417	\$92,817,529	578,429	64.9
2050	\$11,248	9,075,903	\$102,083,102	624,530	68.8
1965-2005					
Increase	100.2%	93.7%	287.7%	214.1%	62.2%
2005-2050					
Increase	98.9%	40.4%	179.3%	135.5%	67.7%

Summary: On a global scale the world's meat production is poised to more than double over the next 45 years as compared to a near-tripling over the past 40. The decline in projected growth rate is due entirely to a sharp drop in population growth rates in the U.N. medium growth population projections. From 2005 to 2050 global population is estimated to increase 40.4%, well under half the increase of 1965-2005. Per capita meat production growth from 2005-2050 is projected to about match the 1965-2005 growth.

Production growth will be primarily driven by a near-doubling of per capita GDP in constant dollar purchasing power. A more affluent world will, as it has in the past, want the variety and nutrition offered by more meat in the diet.

The good news is that the rate of growth is slowing. **The bad news is that, even with a slower rate, the absolute growth of 359.3 million tons of meat**

production is substantially more than we can produce today using essentially all of our productive farmland.

Implications: With no more, and perhaps less, productive farmland available over the next 50 years this projected growth in meat production represents a major challenge to both farmers and the environment. More meat means more feed and forage will need to be produced, and more land will be required for housing the additional animals that will be on farms. In addition, more production of all crops will be needed, including those used for direct human consumption and for industrial uses.

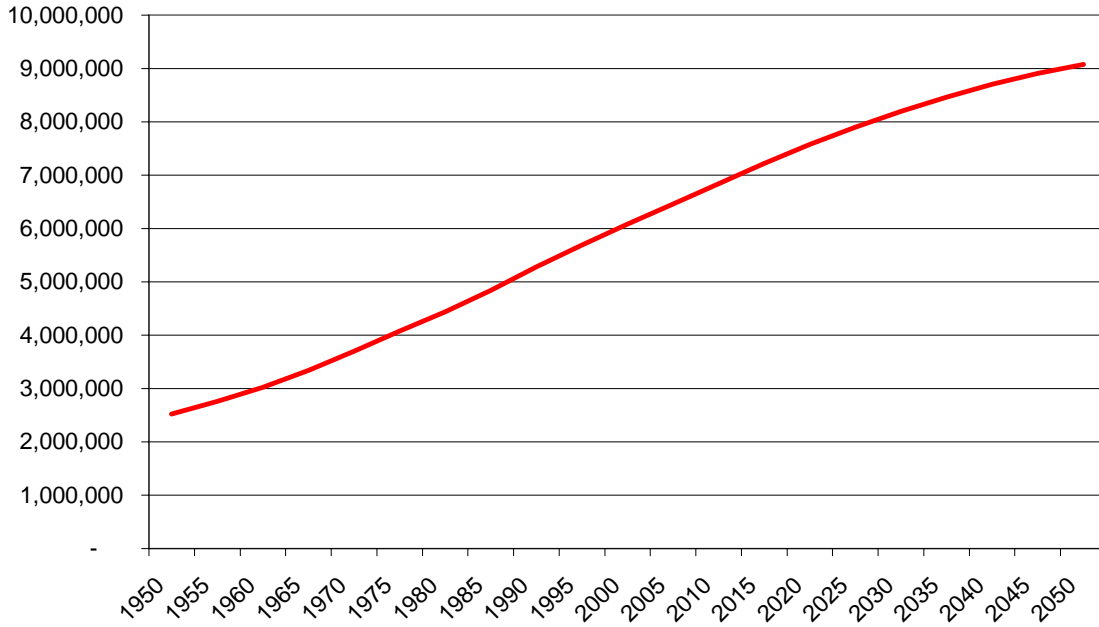
To support the higher animal product production level of 2050 it is required that feed crop yields will need to more than double if we are to increase meat production in line with increases in GDP and population that will almost certainly happen over the next 45 years. To achieve this level of yield increases implies that agricultural research aimed at increasing feed crop yields should be a high priority.

Failure to substantially increase crop yields in line with the meat production projections will result in increased pressure to push crop production onto more of the world's fragile lands that are not being farmed today. If feed crops production is pushed onto marginal land the result will be a degraded environment, increased soil erosion, increase water pollution, reduced wildlife habitat, and increased use of chemical and fertilizer inputs.

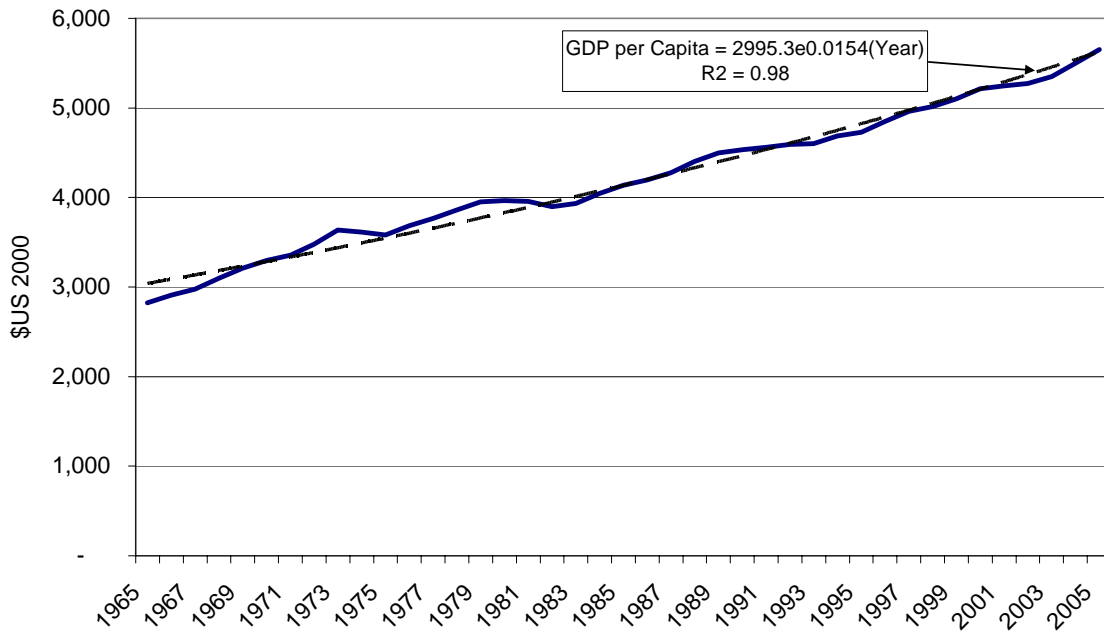
The only environmentally responsible way to accommodate the world's increasing demand for meat is to produce increased amounts feed crops without using more land. The only way to accomplish that is to substantially increase yields.

Appendix:

Appendix Figure 1: Global Population (000)
U.N. Medium Estimate, 2005-2050



Appendix Figure 2: Per Capita Global GDP
\$US 2000



Appendix Figure 3: Total and Per Capita Meat Production
2006-2050 Projected

