The Earth's Population Carrying Capacity

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The Author is a member of the "Port Charlotte Junta" - a group of concerned individuals who meet regularly with an old and valued member of CACOR, Ken Hammond, during their annual hibernation in Florida. In the course of voluntary studies for the Junta, Andy Clarke came across a book entitled Full House *by Lester Brown and Hal Kane which he summarizes the essential arguments below. He also re-examines a 1994 article in* US News and World Report *in the light of the contents of* Full House.

Following a review of the population growth numbers that .we are all familiar with, e.g. world population now about 5.7 billion and increasing at 90 million, a year, U.N. medium-range projection of 8.9 billion by 2030, etc., *Full House*, by Lester Brown and Hal Kane argues that the most immediate constraint on population growth is the food supply. Other potential population limiting factors are mentioned including the buildup of environmental pollutants and fresh water scarcity but it appears that food supply will be the most immediate controlling determinant of how many people the earth can support.

If food supply is the limiting factor which will determine the earth's carrying capacity, at least in the short term, what are the prospects of increasing the production of food to maintain both today's inadequate level of nutrition for much of the world (the UN estimates that 900 million people now go to bed hungry each night) and feeding the additional 3.2 billion increase projected for 2030? Most of the book focuses on the answer to this question.

Brown and Kane explore in considerable detail the main determinants of food production which they identify as **land area**, **yield** and **irrigation**. Lesser determinants include various environmental factors (air pollution, global warming, etc.), waterlogging, salting, and increasing ultraviolet radiation. I will review each of the three main determinants in brief.

Land Area.

Grainland area peaked in 1981 when 735 million hectares were under the plough; by 1993 grainland area had dropped about 5% to 695 million hectares. While an expansion in cropland area is possible in a few countries, losses through non-farm uses and abandonment because of severe degradation (soil erosion) will offset the increases. The loss through non farm use in China is expected to be particularly severe, amounting at the present time to a drop of 850,000 hectares or 1%, of its cropland area annually. If total grainland area does not change the increase in world population will mean close to a 40% shrinkage in grainland area per person from 1990 to 2030, i.e. 0.13 to 0.08 hectares.

Yield

The enormous increase in world grain production between 1950 and 1984 (631 million tons to 1664 million tons or 260%) was achieved largely through agriculture research leading to new plant varieties and the application of increasing amounts of fertilizer. The increase in grain output during this 34 year period equaled *3%* annually, easily surpassing the world population increase during the same period. Since 1984, however, grain production grew at less than 1% a year, well below the present annual population increase of about 1.6%. The authors argue that no major technological breakthroughs in agriculture have occurred since 1940 and the very large increases in yields described above were the result of the application of basic knowledge of agriculture acquired during the 100-year period 1840 to 1940. While some improvement may be achieved in particular areas, plant varieties are now approaching their biological limits and any further improvement in yields on the scale achieved prior to 1984 appears remote. In fact, recognition of plant-yield limits has led to a reduction of fertilizer use during very recent years.

(The above view on crop yields accounts in large part for the wide difference of opinion between the Worldwatch Institute and population/food output optimists like the Fraser Institute. Brown and Kane mention cultural experts at the FAO and the World Bank, who simply project the very favourable 1950-84 experience into the future, ignoring both the factual data of the last 10 years and in-depth analysis of plant biological limits.)

Irrigation

Very rapid growth in irrigated cropland occurred between 1950 and 1978. During this 28 year period irrigation throughout the world expanded from 94 million hectares to 206 million hectares representing an increase of 119%. Since 1978 growth has been very much less rapid, increasing by only an additional 38 hectares to 244 million hectares. During this 13 year

period growth in irrigation fell behind that of population for a loss of 6% of irrigated land per person.

The large increase in irrigated land since mid century was closely linked to the introduction of high-yield varieties of wheat and rice as well as the increase in the use of fertilizer (the Green Revolution). Unfortunately, the two main sources of irrigation water, the diversion of rivers and the pumping of aquifers, appear unlikely to be able to provide any major increase in water supply in the future. Growing competition from non-farm sources, the silting of irrigation reservoirs and falling water tables indicate that the decline in irrigated land per person since 1978 will continue as far as we can see into the future.

Another main source of world food is the oceans of the world. World consumption of fish exceeds that of beef and chicken combined and, in some countries, it provides most of the animal protein consumed. The world's fisheries are now experiencing serious difficulties and all of the world's 17 major fishing regions are currently harvested at or beyond their capacity. Total world fish catch increased rapidly from 22 million tons in 1950 to 100 million tons (includes about 13 million tons from aquaculture) in 1989. However, no significant additional increase has occurred in the last five years and it now seems unlikely that world fish harvest will exceed 100 million tons on a sustainable basis. Because of the growth in world population the 1993 per capita seafood catch was 9% below that of 1988.

If the above analysis by Brown and Kane is approximately correct the world faces a steadily widening gap between population and food availability. Based upon the authors projections through to 2030 the discrepancy between world grain supplies and consumption needs will equal 526 million tons – an amount approaching the current grain consumption of the United States and China combined. Of course in the real world such an imbalance between supply and need is impossible. To quote Brown and Kane directly:

"Will these projections fail to materialize because production actually expands much faster than we have assumed? Or because population grows slower than projected as governments work to fill the family planning gap and to eliminate the social conditions that foster high fertility? Or because population growth slows as malnutrition raises mortality rates, which is already happening in some African countries?"

In the book's final chapter, the impending population/food crisis is expressed in these words:

"The food sector is the first where our demands are colliding with some of the earth's limits – the capacity of oceanic fisheries to supply fish, of the hydrological cycle to supply fresh water, and of crop varieties to respond to fertilizer. The impact of these collisions will reverberate throughout the economy in ways we cannot now even imagine. In these circumstances, the need to address directly the carrying capacity question – How many people can the earth support and at what level of consumption? – is obvious."

The above review of *Full House* is of course simply a brief overview and does not do justice to much of the subject matter of the text. Following my study of the book I had a further look at the US News and world Report article, *10 Billion for Dinner, Please*, of September 12, 1994,. I was even less impressed with the US News and World Report article than I was last March for the reasons which follow.

One difficulty in responding to the US N & WR piece based upon information and argument contained in *Full House* (as well as other sources) is that the former presents its case based largely upon rather sweeping generalities while the latter employs specific population/food data. Nevertheless let us look at a few key items in the US N & WR statement.

a) "The real threat is not that the Earth will run out of land, topsoil or water but that nations will fail to pursue the economic, trade and research policies that can increase the production of food

***Full House* Response**

As stated above, grainland area peaked some 14 years ago and is now in decline with almost no prospect of reversal. True, grainland has been taken out of production in the US and Europe but, even if it were all brought back it would "expand grain area by only 1.6%, not half enough to get back to the historical high reached in 1981." It is also true that extensive areas of land in Latin America may be available in the future but much of this land is "marginal" and in no way comparable to land which is now being lost through erosion and industrialization in China and elsewhere.

One reason some 900 million persons in the Third World are now hungry and some starving is related to their limited purchasing power. This situation is worsening daily but no one seems able to suggest any practical economic or trade policies which will ease the

situation. Certainly to grow no more wheat in Kansas or corn in Iowa is not a sustainable response to the widening gap between food production and food consumption in Africa south of the Sahara. It is not a coincidence that malnourishment is at its worst where population growth is greatest. The US N & WR's several references to economic and trade policies are essentially pious nonsense as seen through an American prism.

b) "Total food production meanwhile, continues to grow much faster than population".

***Full House* Response**

Per capita world grain production peaked at 346 kilograms in 1984 and during the three year period 1992-1994 averaged 311 kilograms for a decline of 10%. Per capita fish catch (includes aquaculture) peaked in 1988 and has since declined by 7%.

c) Worldwide yields depend on "money to fund continuing research and development of new technologies."

***Full House* Response**

"Between 1950 and 1984, the world grain yield per hectare more than doubled, rising 118% or 2.3% a year. But from 1984 until 1993, yields rose only 1% a year. This slowdown is a worldwide phenomenon afflicting industrial and developing countries alike". " Rising grain yield per hectare, like any other biological growth process in a finite environment, must eventually give way to physical constraints. Where farmers supply all the nutrients and water that advanced varieties can use, cereal yields may now be pushing against various physiological limits, such as nutrient absorption capacity or photosynthetic efficiency." "Contrary to popular opinion, biotechnology is not an agricultural panacea that will end hunger."

d) "Most telling is the fact that the world price of food has been declining for the last 50 years"

***Full House* Response**

Food prices have indeed been declining for some four decades. This decline has continued despite the fall in grain production per person since 1984 for two important reasons:

- the deteriorating economic position of the poorest one fifth of humanity who spend most of their income on food.
- the collapse in purchasing power in the former Soviet Union.

But after four decades of declining real prices of food, the world may now be on the edge of a period of rising real prices. This has already begun for seafood where prices have jumped by 33% since 1970. As the politics of surplus is replaced by a politics of scarcity, higher food prices and inflation threats in exporting countries could lead to grain export restrictions or even outright embargoes, as happened in the mid 70s after grain prices doubled.

One final comment.

For many years demographic theorists spoke confidently of the three stages of population growth. The first stage was characteristic of primitive societies where both birth rates and death rates were high and population grew slowly if at all. In the second stage, living conditions improve as public health measures, including mass immunizations, are introduced and food production expands. Birth rates remain high, but death rates fall and population grows rapidly. The third stage follows when economic and social gains, combined with lower mortality rates, reduce the desire for large families. As in the first stage, birth rates and death rates are in equilibrium, but at a much lower level.

While the above stages of demographic transition have indeed been the historical experience in Europe, North America, Japan and a few other countries, as we approach the end of the 20th century there is growing evidence that a gap has emerged in the analysis. The theorists did not say what happens when second ;stage population growth rates overwhelm local life support systems, making it impossible to sustain the economic and social gains that are counted on to reduce births.

As is now happening in much of Africa and other parts of the Third World, populations have expanded in stage two to the point where their demands exceed sustainable yields of local forests, grasslands, croplands, or aquifers, and they begin to consume the resource base itself. Food production and incomes are then reduced in a downward spiral with .the risk that death rates will resume their historical high levels, pushing countries from the second stage back into the first stage. Close to half the world's people now live in countries where the spectre of social and economic bankruptcy or disintegration threatens a return to stage one. Unless external intervention occurs, a return to stage one will also mean a reduction in population (through famine?) to the former historical levels of primitive societies.