FEEDING THE WORLD: TECHNOLOGY IS NOT ENOUGH

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In 2015 the world is facing significant challenges, social, political and environmental, that threaten to disturb the equilibrium of our "Western" way of life. Many of the challenges are inter-related, none more so than how we are to feed the additional 2.4 billion mouths that are expected to arrive on this planet in the next 35 years or so.

Consider some numbers taken from UN agencies. In 2011 the world's population passed 7 billion and was growing at a rate of approximately 66 million a year—that is two Canadas or one UK a year, with the expectation that it will reach 9.6 billion by 2050. Since you started to read this essay the world's population will have grown by about 90 people (136 in each minute). It is estimated that today there are between 800 million and 1 billion people who do not have enough to eat and that many more, whom may have sufficient calories, have diets that lack some essential nutrient or other. By 2080, one third of the world's population will be in sub-Saharan Africa: in the last two decades of the twentieth century agricultural productivity in sub-Saharan Africa declined by 20%. Across the globe, for the first time in history, more than half of all people live in cities and that proportion is rising, so small scale farming and local food production will become much less relevant, especially in the mega-cities with populations exceeding 10 million, as most of the new arrivals on this planet will be born in cities. By 2050 the UN predicts that there will be two urban dwellers for each rural dweller. According to the *United Nations, Department of Economic and Social Affairs, Population Division of 2014, World Urbanization Prospects: The 2014 Revision (custom data acquired via website), the 2014 world population of 7.24 billion is slightly more than half urban and just under half rural. By 2050 they estimate there will be 6.34 billion urban and only 3.21 billion rural inhabitants, less rural dwellers than there were in 2014 (3.36 billion).*

If feeding the growing population is the major, and I would contend the only really significant, issue facing this world in the future, how do we challenge it? What must we do and how should we focus our resources? Which of our present ways of "doing" obstruct sensible solutions? This is not an essay based on pure academic research, rather it is a scientist's perspective, a critical analysis, on how science and technology have sought in the past to challenge the future, why this has often led to unintended consequences, and a hypothesis as to how we might fare better in the future.

At issue then is the problem of how we could feed another 2.4 billion people on this earth by 2050—only 35 years away, when we cannot even now adequately feed 1 billion of our present population of 7.2 billion. In reality we need to find a way to feed an additional 3–3.4 billion people to provide for both future growth in population and demand, and also make up the present deficit. Not only do the numbers seem so large, the timeframe seems so short. As we explore the known limits to agriculturally productive land and ever increasing competition to use that land to produce non-food stuffs, the depleted fish stocks in our oceans, the destruction of habitats and the degradation of those resources that we do have, we will realize that likely increases in agricultural productivity will, on their own, be insufficient to meet this goal. For example in the year 2000, when the world population was 6.1 billion, global grain production was around 1.86 billion tons, which if evenly distributed would leave each person with 305 kg of grains a year. The FAO predicts that in 2030 globally 2.8 billion tons of grain will be required for a world population of 8.3 billion (or 340 kg/person). But grain consumption in developed countries is presently of the order of 612 kg annually per person, most of which is used as animal feed to satisfy the demand for animal protein. Globally, about one third of grain production is used as animal feed (but a substantial proportion of that grain is anyway only suitable for animal feed). As incomes have risen in developing countries the demand for meat has increased and will continue to do so. If the whole world had the same demand for grain as Europe, the total global grain demand by 2030 would amount to 5.1 billion tons. Simple arithmetic tells us that if nothing changes by 2030 the world could face a grain shortage of 2.3 billion tons. To make up this deficit requires grain production to increase by +3.5% p.a. on average, but historically, since the "green revolution" production has increased by less than 1.3% p.a. These estimates assume no impact on grain production, or available land, from biofuel and biomaterial production, desertification or soil erosion, or the effects of a changing climate, and it is likely, therefore, that food production will fall below food demand sometime during the next decade (data taken from *The Bioeconomy to 2030: Designing a Policy Agenda,* OECD 2009, accessed: November 22, 2011).

There are a number of factors that will alleviate these worrying projections. For example, a future rise in grain productivity to 2030 will be augmented in part by an estimated increase in available arable land (in South-America and sub-Saharan Africa) of 13%. Demand will not reach 5.1 billion tons, because poverty will prevent everybody adopting European meat eating habits. And, although generally the quantity of meat eaten increases with disposable income, income eventually rises to the point where, as is the case in the US, income and meat consumption become decoupled, that is consumption becomes independent of income. However, we cannot be complacent, because unforeseen natural or manmade circumstances will derail progress.

If we are, therefore, to meet this goal and ensure the sustainable and just distribution of available food to the predicted 9.6 billion inhabitants of this planet, we have to do so in a way that is significantly different to the present day's single issue, piecemeal, reactive approach that we take to the social and scientific challenges that confront us both now and in the future.

One major problem that we face when preparing to challenge this future is that we actually have little idea of what the future *is*: we are facing the unknown! There is only one certainty, and that is that at some point each one of us will die. But having no certain knowledge of what the future might bring seems to leave us uncomfortable, so we try to predict what may happen based upon our limited experience. Sometimes governments ask the experts for an opinion. In the early 1990's the UK government set up a series of expert panels to look into possible futures, so that limited resources for research and development could be targeted towards potentially useful ends. Broadly, this foresight exercise was successful in predicting the technological developments that could be foreseen relatively easily, for example the decoding of the human genome. In this case the methodology for analysing the sequence of bases in a small piece of DNA had been available for two decades. Each successive year technological development had speeded up the process of analysis so that what had taken several days to accomplish last year would take only several minutes next year. In reality, then, the idea of sequencing the human genome was not visionary, rather it was an exercise in amassing the effort to apply to a huge, but at the time relatively mundane, scientific exercise. And the full sequence was obtained through multi-national public-private partnerships within just a few years. Has the sequencing of the human genome brought the benefits to human health that were predicted at the outset? Probably not, but then maybe we are impatient, or perhaps more likely we did not consider what else we needed to know, or be able to do, in order to capitalize on our knowledge of the sequence: the sequence itself became the end, rather than the means to an end. And there are any number of other examples of "foreseeable" future science that came from this foresight exercise. But this exercise failed to predict two very significant developments, the Internet, and nanotechnology, both of which emerged upon the scene within just a couple of years. Looking back now it is relatively easy to see the scientific and technical foundations of both the Internet and nanotechnology, but the point is that the various foundations occurred in different and unrelated fields of academic endeavour: no one it seems set out to "invent" the internet or nanotechnology. An excellent example of this unintended route from basic science to technology occurred some 20 years earlier when two biologists, an Argentinian and a Swiss, working together in a UK government agricultural research station in Cambridge, managed, for the first time, to fuse a single white blood cell or lymphocyte, with a myeloma cell from a woman called Helen Lane (who had died of a myeloma cancer). The myeloma cells, known as HeLa cells after their origin, were typical of cancer cells in that they could be grown in culture more or less in perpetuity, generation after generation. Lymphocytes are the cells in our blood that produce antibodies. What César Milstein and Georges J. F. Köhler had achieved was to produce a continually growing culture of hybrid cells where each was not only genetically identical, but where each produced the same molecularly identical a so called monoclonal antibody. Why was this significant? Well, at the time no one knew, not even Milstein and Köhler, nor the British Technology Group (BTG) the government body of experts who were supposed to identify patentable ideas coming out of publicly funded research laboratories. In fact not only did no one suspect that this piece of science might have some practical application (it was just interesting basic science of cell biology) there were a number of senior scientists who doubted that the monoclonal hybridomas could actually be produced (information based on a conversation between two notable British biochemists ove heard at a meeting of the (UK) Biochemical Society Cambridge in 1995): for a time it seemed that only Milstein and Köhler could get this to work. Yet within 5 years the first commercial application of monoclonal antibodies, a kit for detecting the presence of kangaroo meat in what was meant to be oxtail soup produced in Australia was on sale, and countless other analytical and therapeutic applications followed. As an aside the incredible commercial success of this unintended invention was in part the result of it never having been patented!

Sometimes governments, for good and pressing reasons, take actions that have unintended, or at least unconsidered, consequences in the future. When the Chinese government some decades ago put in place its one child per family policy, a policy designed to slow and cap China's rapidly growing population, how much thought was given to the consequences that we now see of an unbalanced, elderly demographic, and a population with an increasing majority of males amongst the young?

Another example is the interaction of agriculture and one of the world's largest lakes. In 1960 the Aral Sea that lay between Uzbekistan and Kazakhstan was the fourth largest body of inland water in the world, a salt water lake fed by two rivers, but with no outlet. The sea's level and area of 68,000 square kilometers remained in a balanced equilibrium between inflow and evaporation. The then Soviet Government decided to divert the two rivers that supplied the lake to irrigate the desert to grow cotton and rice, in order to become self-sufficient and provide excess crops for export. The consequence of the poorly executed irrigation projects was that most of the river water was diverted from the Aral Sea, but as little as 15% actually reached the fields. By 2008 the sea had shrunk to one tenth of its original size, salinity had increased to 3 times the level of normal sea water, the fish had died and the once thriving fishing industry died with them, and the dried out salt bottom of the original sea had become highly polluted with chemicals used in the production of the cotton and rice (and possibly biological weapons). Once thriving fishing ports now lie 100 kilometers from the nearest water, and fishing boats slump abandoned on the lake bed. Even in the 1960s there were Soviet scientists who warned of the impending disaster, but the greater good it seems was to make the dessert bloom. Social and economic policy was paramount, science was ignored. Major wind-borne pollution exists: local cases of throat cancers are significantly above "normal" levels. And the microclimate around the lake changed as the moderating water body dried up, with summers becoming hotter and drier and winters colder and longer.

Which leads me on to our belief that the climate is changing. We know this as a fact from our knowledge of the past. 10,000 years ago in what is now Manitoba in Canada, any local inhabitants would have been standing on top of 1 km of ice. In my view we cannot be certain what is causing this change: we are told that it is human activities since the industrial revolution, but the lichen clinging to the rocks on Baffin Island that recently emerged from their cover of permanent ice last saw, we are told, the sun's rays over 1600 years ago, which of course means that those rocks were as warm 1600 years ago as they are today. Similarly the foot of the Athabasca glacier in the Rockies has been retreating since (and probably before) it was first discovered by Europeans in the early 19th century. In 1830 it covered what is now the parking lot of the visitor center on the opposite side of the valley to the main body of the glacier: signs in the parking lot show that over the following 10 years it retreated by well over 15 meters, and that it has been retreating ever since. The point here is that the Athabasca glacier began its retreat before there was any significant rise in greenhouse gases in the atmosphere, and before there was any detectable effect of the industrial revolution on the global environment. Incidentally, there are two possible reasons why the

Athabasca (or any other) glacier might be retreating: either the atmosphere around the glacier is warming, thus causing the ice to melt; or the ice is melting faster than it is being replaced by precipitation on the mountain top, or, of course both! The global environment has always changed. 9,000 years ago after Lake Agassiz (that formed from the melting ice-cap that covered much of what is now Manitoba) had drained for the second time into the St. Laurence channel, central Manitoba was a sandy dessert of over 60,000 square km. What is left is the 4 square km of Spirit Sands. 8000 years of temperate climate, adequate rainfall and creeping vegetation has made that desert bloom.

By contrast, in the Middle East the Gulf States are now mostly arid, hot desert. Not long after Agassiz was draining, the region that is now the Emirates was developing into an advanced agrarian civilization that at least 5000 years ago was capable of producing harnesses for horses and gold jewelry (see Sharjah Archaeological Museum). Changing climate has turned that once fertile region into desert.

My point is this: over geological time scales man has never been able to control or reverse natural changes, but has nonetheless survived because of the ability to adapt. If forests died or land became uncultivable, man moved, adopted new strategies for example irrigation, or died. But is adaptation now enough? In the face of what many believe is catastrophic climate change caused by anthropogenic activities there is the rallying call to change, to reverse the trend. Carbon is traded between countries and doubtless some privileged few are making their fortunes through this; we are exhorted to consume less, to donate our air miles to carbon offsets (what marketing genius thought of that one); governments mandate the use of a percentage of biofuels in an attempt to make our driving habits more environmentally friendly, instead of outlawing fuel inefficient large engines. And odder still they dream up unworkable policies. A classic case of the latter is the UK's policy (around 2010) to reduce GHG emissions by 80% across all sectors of society by 2050. At a meeting of the Royal Society of London in March 2011, it was concluded by the considerable and thoughtful intellect present that this policy would mean that the UK would have to ban dairy cattle and beef production, give up on sheep farming, produce a few pigs and chickens, and turn half the present arable land over to the production of energy crops! What is even more bizarre about this policy, apart from the fact that it is being copied more or less across Europe, is that it is the Northern temperate zones such as the UK that will be required to produce more, not less, food if the worst predictions of the climate change modelers turn out to be true and southern Europe becomes arid.

So my fundamental question is how does one challenge the future if one is uncertain what the future will bring? Soothsayers and fortune tellers will confidently prescribe future events: Malthus predicted that long ago civilization would die through outgrowing the available resources to feed itself: Norman Borlaug the "father" of the green revolution proved Malthus wrong, or at least not right yet! But if one is going to challenge the future, you need to know which possible future it is that you need to challenge as a priority. So I will be direct here—as far as I am concerned climate change can take a bath in a bucket. If what we perceive as a change in the climate is really caused by man's activity - and as you will probably have realized by now I have my doubts, (I immediately become suspicious when I am told "the science is certain there is no more debate"— science is never certain, it is always open to challenge, and those that would deny this are not promoting science, they are pedaling dogma) then, given the growth in the economies of just China and India, economies that represent over 1/3rd of the world's population, and the demand that this growth creates for more consumption of all of those things that are predicated to advance climate change (e.g. meat and gasoline), I simply do not believe that donating your Airmiles to offset your airlines emissions is going to have any effect on humankind's future prospects.

What we have to do is do what people have always done in order to survive, and that is adapt to the challenge. So what do I see as the greatest challenge we face both now and in the future? It has to be how to feed a growing world population in a sustainable manner. If feeding the growing population is the major and only really significant issue facing this world in the future, how do we challenge it? What must we do and how should we focus our resources? Which of our present ways of "doing" obstruct sensible solutions?

Fundamental amongst our inability to challenge this future, is our insatiable penchant to work in unconnected silos. We deal with complex problems as though there are no connecting themes. We place single issues into closed boxes and worse still try to solve those issues without reference to anything else, ignoring the fact that nature is essentially a balanced relationship between what might appear to be unconnected factors. For example, one suggestion that has been widely suggested to increase food production, is breeding plants to be more productive. A reasonable enough suggestion, except that for a plant to produce more seed it will almost invariably need more water, which on drier lands will mean more irrigation, which in turn, as the Soviets discovered in central Asia and the Chinese are discovering in Inner Mongolia, leads over time to increasing salinity of the soil: and in any event agriculture already accounts for some 70% of the world's use of fresh water. High productivity crops will also need more fertilizer. We cannot get around this problem by simply increasing the land area for agriculture: we are using 37% of the earth's land surface as it is, and the rest is too cold, too hot, too wet, too dry, or to valuable as forest and savannah. Much of this agricultural land, about two thirds, is pasture, not suitable for growing more than grass. Fortunately we have animals that can process the grass and turn it into protein. Mostly these animals are ruminants: cows, sheep, goats that belch the potent greenhouse gas methane and contribute to climate change; but, in forage based or pasture systems they also efficiently recycle nutrients back to the soil. Were we to abandon our cattle and sheep and plough the pasture, we would however release more carbon dioxide into the atmosphere, and potentially, through the use of nitrogen fertilizers, more nitrous oxide another potent GHG. There are no simple answers.

In June, 2011 at NABC's annual meeting entitled "Food Security: The Interrelationship of Sustainability, Safety and Defense" at the University of Minnesota, Professor Jonathan A. Foley proposed in his talk on "Simultaneously addressing food security and global sustainability" four core strategies which would both increase food production and reduce impact on the environment, and they are linked. The first, somewhat counterintuitively is to slow drastically the conversion of forest into agricultural land in order to protect biodiversity. The second is to close the yield gap. Yields of the same crop can vary by 100 fold depending upon where and how it is grown. By raising the lowest yielding land to the productivity of the greatest we could produce an additional 50–60% more food. The barrier to this is not science and technology, we know what to do and how to do it, the barrier is politics and poverty. Third we need to increase the efficiency of agriculture by using fewer inputs of water, fertilizer, and pesticides etc. Critically, China and India vastly over apply fertilizer and pesticides for reasons that are due to lack of education of many farmers, and government and industry practices that encourage sales of inputs to farmers. Fourth, and controversially, we need to change eating habits. At present agriculture produces globally food for people (60%), feed for animals (35%) and biofuels (5%). Eating less meat would theoretically leave more grain for human consumption; a return to the average medieval diet. Ironically, this suggestion comes at a time when the growing and economically prospering peoples of India and China are adding more and more meat to their diets! But it is estimated that an increase in food supply of up to 50% could be achieved if the world went mostly vegetarian. However, there would be no point in abandoning otherwise unproductive pastures by totally eliminating animal agriculture. As demand for meat grows, but the supply does not, economics rather than policy will probably push us in this direction. Or we could intensify animal production further, as studies show that intensive livestock rearing can generate less by way of greenhouse gases than traditional "extensive" methods.

But to me all these strategies miss one key element, the elimination of waste (interestingly, by 2011 in the November edition of Scientific American, on pages 60–120, Foley had added a fifth issue and that is to reduce waste). For each man, woman and child in North America, the agriculture-food system produces 4,400 calories each day. Approximately half of the food that is bought on that continent is wasted: on average only half of every bag of pre-prepared lettuce is eaten, the other half is thrown in the garbage bin. If we could capture that wasted half of all our food we could feed another half a billion people. Similarly India, with a population of over 1 billion, is self-sufficient in food. However, nearly half the food produced never even reaches market: 10% of grain produced (that is more than the grain produced by the whole of Australia) is eaten by rats and mice in the field. So now we could potentially feed another billion.

Whatever strategies we adopt in order to provide a secure food supply, or rather nutritional security, they must be integrated and work synergistically. In particular, we must recognize that providing adequate food for all is not just a scientific or technological problem, it is a social, ethical and economic problem. Cultural and belief factors must be included in the decision making process. For example, India, a country where in Maharashtra even owning a piece of beef is a criminal offence that attracts fine and up to 5 years in jail—the Legislation passed 2nd March 2015 by Haryana government plans to introduce similar legislation (see India Today at www.indiatoday.in, accessed 12th March 2015)—and where the Hindu religion regards cows as sacred there are, according to FAO estimates, over 310 million cattle and buffalo. Providing additional nutrition by enhancing milk supply is pointless if target populations do not culturally accept milk as a food (e.g. Inuit populations) or cannot eat it for physiological reasons (most Asians who are lactose intolerant). In addition, food security is not just a matter of sufficient supply, but of the ability of those at the bottom of the economic pile to afford the food in their market place. Over the last few years we have seen the consequence of rising food prices—they are now two times higher than in 2000—with the sharp rise in 2007/08 causing riots leading to changing governments in North Africa. Zimbabwe used to feed much of Southern Africa, now it cannot even feed itself. In 2012 scientists from the Kerala Agricultural University reported that rice paddy cultivation had declined significantly over the last few years (information based on personal communication): they were concerned with food security as, of course, rice is the staple food. It appeared that the reason for the decline was a mix of social, natural and economic forces. People were leaving rural areas to migrate to towns because there they could earn a better income. In certain areas water flow in rivers had diminished leaving too little for rice paddy irrigation. Aiding this was the increasing use of agricultural land for residential and lifestyle development. At first this might seem to be a combination of factors that acts against food security: less people working less land. But in fact hunger in India is almost entirely caused by poverty. India produces enough food to feed adequately its 1.25 billion population, but a significant proportion of the population do not have enough money to buy the nutritional essentials. The answer here is therefore not more production, even though this might drive prices down, because this would reduce income for rural farmers who with their workforce form the majoaity of the population, but rather more money. So, the somewhat counterintuitive conclusion is that sacrificing agricultural land for economy stimulating development in peri-urban regions might be in the best interests of the presently underfed. However, consider this interesting piece of data (provided by M. Gopalakrishnan, Secretary General of the International Commission on Irrigation and Drainage), and that is that there is a positive association between irrigation of farmland in India and economic affluence: the more there is irrigation the less the proportion of the population in poverty. Where there is less than 10% irrigation the population living below the poverty line approaches 70%; when irrigation exceeds 50% then the population living below the poverty line is less than 20%. Increasing both agricultural productivity and economic wealth to lift more of the population out of poverty by increasing the use of irrigation is not simple and may have consequences as the Soviet authorities eventually discovered around the Aral Sea. Even when a suitable water supply is available access to that water can become the limiting factor. This in turn may raise intractable social and political difficulties. For example, the disputes and social unrest that have occurred and continue between Tamil Nadu and Kerala in southern India about who has the right to the water in the Bharathapuzha (or Nila) River that flows from Tamil Nadu into Kerala and is the sole source of water to supply the rice paddies of Kerala. As an aside it is worth noting that the case of poor nutrition in India is quite different to the problem with poor nutrition amongst North American indigenous peoples. In India the appropriate foods are present in the market, and culturally individuals will know how to cook from raw produce. Simplistically, the issue with North American aboriginals is that the wrong foods are supplied to their market place. And not only must the world's food supply be secure, it must also be safe.

Am I optimistic about our future? Will we succeed in bridging the gap between sustainably produced, available food and demand? History tells me that we can. Between 1969 and 2012 the world population almost doubled (from 3.6 to 7 billion), yet due to falling food prices and increases in agricultural production (the two are of course linked) the global number of underfed remained relatively constant fluctuating between 0.75 and 1.0 billion (based on Food and Agriculture Organization of the United Nations statistics). In 2005 food prices were 60% lower than they had been in 1969, and even following the dramatic rises from 2008, by 2012 global food prices were still 36% lower than in 1969. Looked at another way these statistics show that in 1969 the global food supply fed adequately only 2.7 billion people, but by 2012 the number fed had more than doubled to over 6.2 billion. Whilst these figures may seem reassuring, there remains a very significant question, from where will we obtain the extra food? At present globally farms that can provide excess produce for sale range in size from a one or two to over one hundred thousand acres and effective farming methods change with scale. Globally, 600 million small scale farmers each with less than 10 acres (2.5 ha) feed approximately 3.5 billion people, that is roughly half the world's present population. By its very nature farming is a rural activity, and most of those fed in this way will be rural inhabitants or those living in small (rural) towns or villages. The projections of future population growth show that the global rural population will actually decrease slightly over the next 35 years. Scientists at the University of Agricultural Sciences in Bangalore have demonstrated that, properly designed, even a farm of only 1 ha can support a farm family and provide sufficient excess produce to provide an income, and this on relatively poor, drought affected soil. Applying the principles of agro-ecology to small farms can have a very significant positive effect upon their productivity, potentially raising farm income. Of course, extra production has to be sold otherwise it can actually reduce income, and sale means having a distribution network suitable for the local conditions. In Karnataka, farmers who are bringing produce into the markets of the city of Coimbatore can do so for nothing on the local bus network. Cooperatives can bring the economies of scale and wider distribution networks to small farmers anywhere in the world. As we have seen, by 2050 the number of people living in cities will have doubled to 7 billion, and many of these cities will have more than 10 million inhabitants. For these people the notion of eating "locally" will not only be impractical it will be irrelevant. Although some local produce will be available, the vast majority of the food will have to be supplied on an industrial scale, and will come from "industrial scale" farms. On the Canadian Prairies where the average farm size is now over 1000 acres, 80% or more of what is produced is exported from Canada, and relatively little as a proportion will appear in the local food market.

If the aim is universally available safe and healthy food the journey from farm to fork will need to be sophisticated and multifaceted. Even today in many of the developed world's city centers the poor have inadequate access to healthy, safe food: the wealthy at least have the option of driving to the supermarket on the outskirts. As the size of cities increase so does the complexity of the problem of supply and sale of food, especially "fresh" food, but increasing population density will bring new marketing opportunities. Secure refrigerated transport chains, appropriate retail storage space (e.g. freezers that operate all 24 hours in a day), enhanced preservation technologies will become increasingly important. These are the same essential challenges that faced 19th century European countries as they became industrialized and the population moved from the rural space into cities in search of work. Inner city dairies were established to provide a supply of fresh milk, butter and cheese in places like London eventually using the growing network of railways for bulk transport. Canning, an industry originally established in what is now Bermondsey in south London in 1813 to supply the British Navy with fresh rather than salted meat, eventually became an important method for the supply of meats and other foods from the growing agricultural production in the US and Brazil to the inner cities of Europe.

So given coordinated efforts to challenge the future, yes I am optimistic that we can feed at least the vast majority of the world's population of over 9 billion by 2050, and anyway the alternative would be just too depressing. It is, however, also likely that there will remain a significant number who will be underfed, maybe as many as today's figure of about 800,000 but, like today, this will have more to do with war, repression and poverty than a lack of agricultural productivity or distribution.

I remain optimistic therefore for the same reason given by Peter Ustinov, in the film "Romanov and Juliet" where he plays the part of the President of a Ruritainian state, and has a conversation with his care-worn Prime Minister. He says, "The trouble with you, Otto, is that you are a pessimist because you are continually finding out what a rotten place the world is, I, on the other hand am an optimist because I already know!"