

Resource Optimisation and the Efficiency Revolution

Introduction

Resource Optimisation is a topic of increasing interest to long term investors given the potential impact on and opportunity for their portfolios. This White Paper is one of a series from Impax Asset Management that provides investors with a framework to incorporate the latest thinking on Resource Optimisation into their overall portfolio strategy.

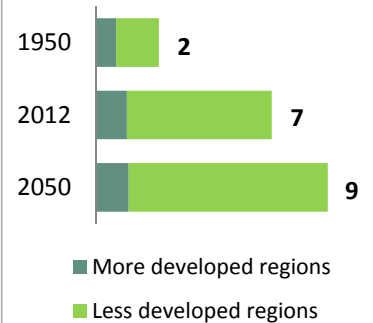
From the time of Malthus¹, concerns that the supply of energy, water, food, materials and other resources would fail to meet the needs of a rising world population (see Figure 1) have been unfounded. However, there is now compelling evidence that we have reached a tipping point beyond which the availability and/or the price of these resources is likely to restrict access unless there are significant improvements in the efficiency of supply and use. Impax Asset Management believes that a revolution in efficiency has already begun and is creating unprecedented opportunities for investors.

Resource demand has reached a new paradigm

In spite of rising demand, commodity prices fell during the 20th century. New technologies facilitated the discovery of mineral resources, while the capital markets attracted and deployed the investment required to exploit them. Similarly, until the second half of the 20th century, there was little concern about the carrying capacity of the natural environment and only limited objection from growing and more prosperous populations about the quality of their surroundings.

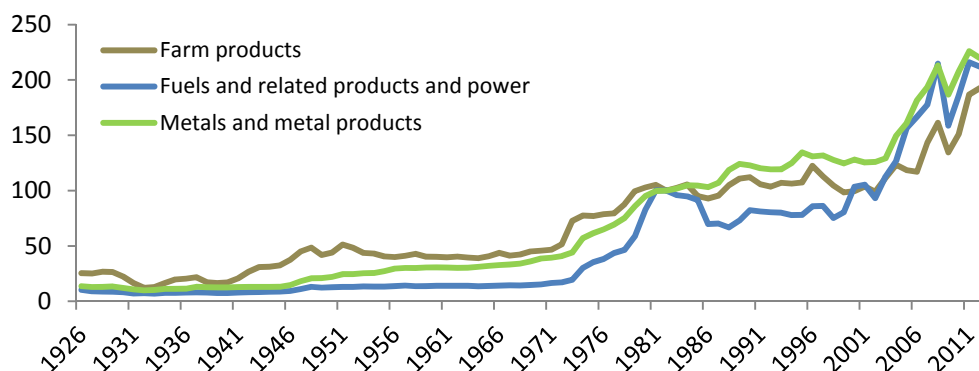
However, in recent years, this situation appears to have reversed dramatically. The price of commodities has jumped significantly since 2000 (Figure 2), and the volatility of prices is at an all-time high.

Figure 1 Global populations are growing - especially in emerging markets (in billions)



Source: Source: 1950 and 2050: United Nations Population Division, "World Population Prospects, The 2008 Revision" taken from the Population Reference Bureau website
http://www.un.org/esa/population/publications/wpp2008/wpp2008_highlights.pdf ;
 2012: Population Reference Bureau 2012
http://www.prb.org/pdf12/2012-population-data-sheet_eng.pdf

Figure 2 Prices have risen and become more volatile

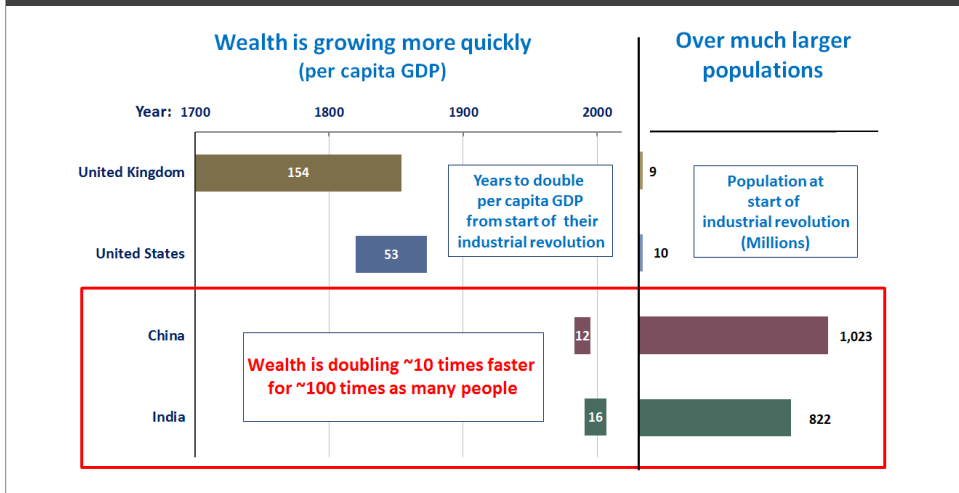


Source: United States Department of Labor, Bureau of Labor Statistics commodity data (Producer Price Index – PPI 1926-2012):
<http://www.bls.gov/data/>

Two factors appear to explain this transformation:

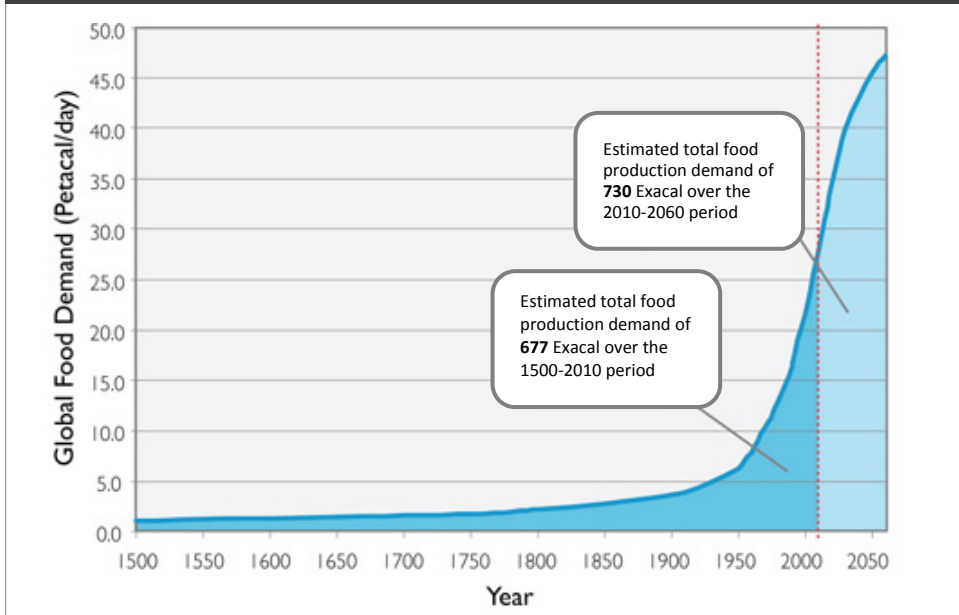
- 1 Demand Shock:** The expansion of multiple emerging markets is unprecedented, particularly in China and India, where wealth is increasing far faster than in the UK and US during their industrial revolutions (Figure 3) and whose combined middle class now exceeds 200 million peopleⁱⁱ.
- 2 Growing populations and increasing consumption create the perfect storm.** Population growth and a parallel growth in calorie intake place a ‘multiplying’ effect on food demand (Figure 4).

Figure 3 Unprecedented wealth creation is accelerating resource demand



Source: Reproduced from McKinsey & Company report, “Resource Revolution: Meeting the world’s energy, materials, food and water needs”, November 2011, p24

Figure 4 Food Production Over the Next 50 Years Will Need to Exceed that Produced to Date



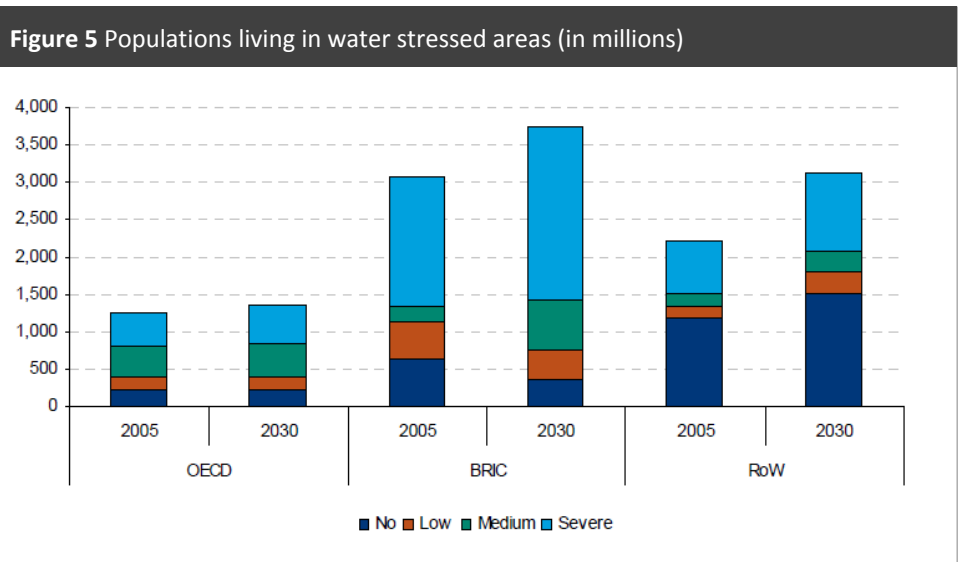
Source: Commonwealth Scientific and Industrial Research Organisation (CSIRO). Based on data from FAOSTAT (Food and Agriculture Organization of the United Nations) and UN Population Division, with simple scenario modelling from CSIRO 2009 (BA Keating, unpublished). Assumptions: growth trends in per capita food consumption growth in developing countries (currently 2668 kcal per capita per day) are maintained such that current developed country food consumption levels (3331 kcal per capita per day) are reached by 2050; diversion of food products (or production resources) to biofuels grows from current levels to 15 per cent by 2050; no food wastage prior to 1920 ramping up to current estimates of food wastage of 30 per cent and these are not reduced going forward. A Petacal is 10^{15} calories, an Exacal 10^{18} calories.

<http://www.csiro.au/Portals/Multimedia/On-the-record/Sustainable-Agriculture-Feeding-the-World.aspx>

China and India doubled per capita GDP in less than a fifth of the time taken by the UK after the Industrial Revolution

There is now strong evidence highlighting that depleted environmental resources such as clean water, clean air and arable land limit the potential for economic growth in many countries. At the same time, losses from weather related events have increased sharply. In 2012, there were 11 weather and climate disaster events with losses exceeding \$1 billion each across the United States. These 11 disaster events cumulatively caused over \$110 billion in damages and 377 deathsⁱⁱⁱ.

Water shortage: While fresh water supplies are relatively static, global populations continue to increase especially in developing economies where access to fresh water is much more limited. Under a current 'business as usual' scenario, i.e. if nothing is done, by 2030 water demand will outstrip supply by 40%^{iv}. And water stress is forecast to increase, particularly in BRIC nations (Figure 5).



Source: Bank of America Merrill Lynch: "A Blue Revolution – Global Water", December 2012

Resource Optimisation – Much achieved: much more to go for

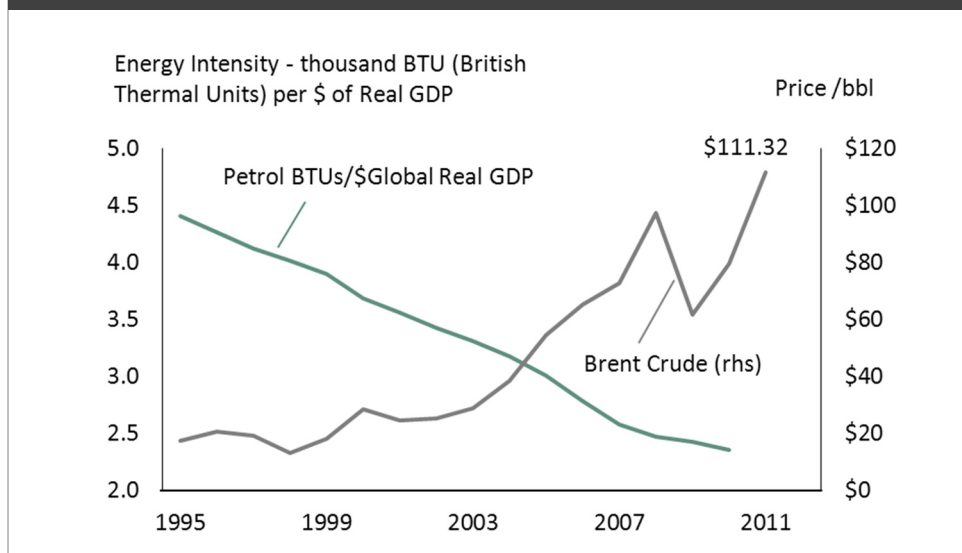
A natural consequence of rising prices, improved resource optimisation and efficiency has historically underpinned improvements in productivity and thus contributed to economic growth. Given the new resource demand paradigm, we believe that a revolution in efficiency is underway that is creating unprecedented opportunities for the private sector. We focus on four fundamentally important areas below:

1) Energy

The energy sector is set for transformation and energy prices for most of the world's population are set to rise. Over the next two decades annual investment in the energy sector will average US\$1.5T, of which 50% will be in the power sector^v. By 2035 China will consume 70% more energy in total than the US; yet per capita consumption will still only be 50% of US levels. One of the primary uses of energy is in transportation. By 2030, there will be 1.7 billion passenger vehicles on the road globally, twice the number today^{vi}.

Efficiency improvements in the energy sector are well established. Since 1995 rising oil prices have been accompanied by a steady fall in the petroleum intensity of the world economy, as the adoption of more fuel efficient vehicles has more than offset the increase in the aggregate vehicle numbers (Figure 6).

Figure 6 Declining petroleum share of global GDP with rising oil prices



Source: Energy Information Administration, Financial Times and Nomura Global Economics Research: Americas Chart Alert, 28 February 2012

Our trends are expected to lead to substantial investment opportunities:

- **Incremental efficiency improvements:** Across the built environment, industry and transportation, the energy efficiency of current products and services is set to increase. For example, today's gasoline and diesel engines are capable of delivering 80 miles per gallon^{vii}, a figure that should rise to 100 mpg within 15 years^{viii}, bringing the US fleet average up from the current level of ~26 mpg^{ix}.
- **Rapid adoption of breakthrough technologies:** Light emitting diodes consume 15% of the power of equivalent incandescent bulbs and last 50 times as long^x. The LED market is expected to grow 25% per year to 2020, reaching US\$100B^{xi}.
- **Leapfrogging by developing countries:** Emerging economies faced with limited availability of fossil fuels are likely to encourage the adoption of the most energy efficient technologies. China's Ministry of Construction recently called for 65% energy savings targets for buildings in major cities.^{xii}

“The payoff for our energy efficiency work has been significant. Since 1990, DuPont's energy use has declined over 18% while production has grown over 47%. This improvement has enabled us to avoid over \$3 billion in energy purchases.”

– William F. Bailey,
principal consultant,
DuPont Engineering

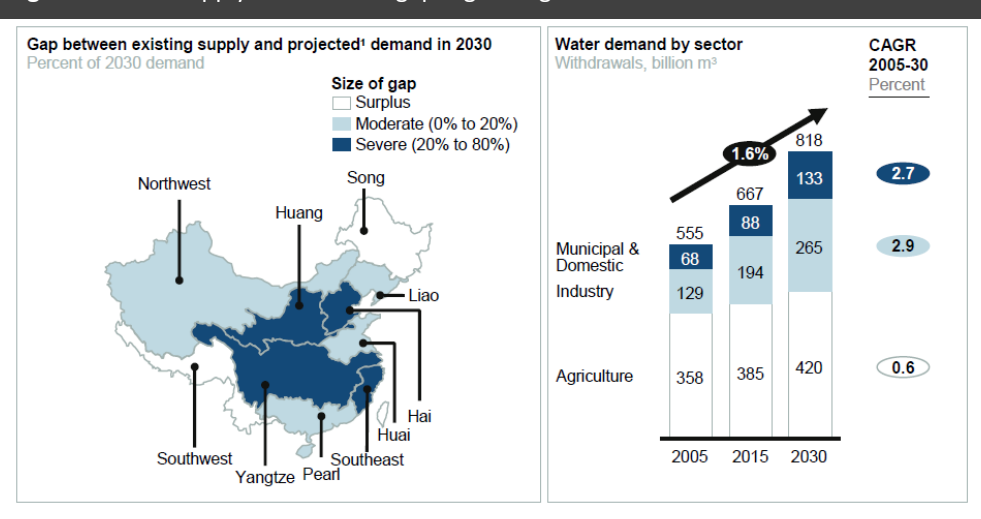
Rising oil prices have provided a strong impetus for efficiency

- **Move to lower carbon energy:** Faced with concerns about rising CO2 emissions and their impact on climate change, as well as the availability of low cost, low carbon natural gas, many countries are increasing their use of renewable energy and reducing their reliance on high carbon fuels such as coal.

2) Water

The prevalence of water stress has increased sharply in recent years. Several countries, for example Israel, have built advanced economies while coping with limited water supplies. However, sustained droughts elsewhere, for example in Australia, the US, and China have taken governments by surprise. The problems arising from a shortage of supply have been compounded by rising demand. By 2030, the UN estimates that 47% of the world’s population will live in areas of high water stress^{xiii}. As shown in Figure 7, severe supply gaps are expected in central China by 2030, with increasing demand across all sectors. Rising urban populations in developing countries are creating sanitation problems, with only 20% of Indian urban water supply meeting World Health Organisation (“WHO”) standards^{xiv}. Indeed, India’s National Urban Renewal Mission has allocated 70% of spending for water^{xv}.

Figure 7 Water supply and demand gap is growing in china



¹The unconstrained projection of water requirements under a static policy regime and at existing levels of productivity and efficiency. Source: 2030 Water Resources Group: “Charting Our Water Future”. China Environment Situation Fact Book; China Agriculture Annual book; Study of China water resources strategy; China grain security planning; basin annual bulletin; press search; 2030 Water Resources Group

In many parts of the world, efficient use of water is a relatively new phenomenon. In the United States, public ownership dominates and the 50,000+ public utilities struggle to raise the capital to repair and upgrade their water supply and sewerage systems. In the UK, a leakage rate of 32%^{xvi} between the reservoirs and the points of use in London has prompted a £5B investment programme over 2010-2015 by the (privately owned) utility Thames Water^{xvii}.

Accordingly, investment opportunities in the water sector are likely to arise in three areas:

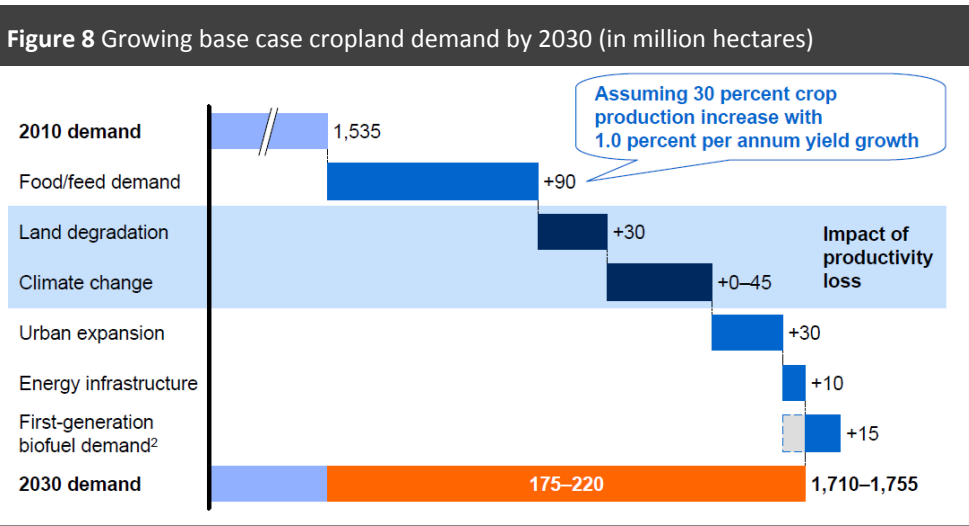
- **New asset creation:** The construction of new water supply and treatment infrastructure in emerging economies is set to be a dominant theme over the next decade. The Chinese government has earmarked US\$780B^{xviii} of investment in water assets by 2020, in part to cope with rapid urbanisation, as ~100 million additional people move from the countryside to urban areas over the next ten years^{xix}.
- **Asset upgrading:** Notwithstanding constraints on public sector expenditure, OECD countries will continue to improve and extend their water infrastructure, particularly in areas of drought and/or flood risk.

Water resources
in China are
declining

- **Roll out of new technology:** Faced with an expanding range of contaminants in the water supply, regulators have mandated the adoption of new technologies, such as membrane filtration, ultra violet light disinfection or using activated carbon.

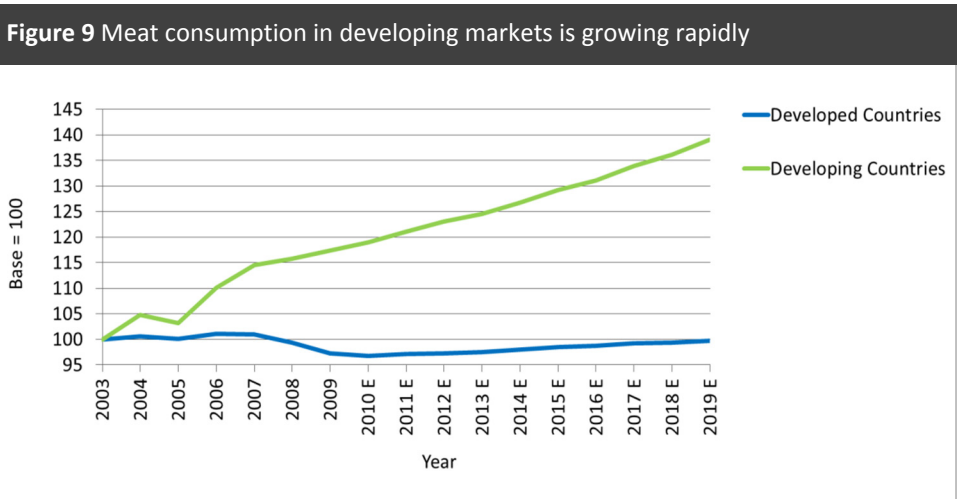
3) Food

With populations growing to nine billion people by 2050, (Figure 1), there will be 80 million new mouths to feed each year, and two thirds of the world’s population will live in urban areas. As a result, global food production needs to rise by 70% (Figure 8), requiring not only additional land, (an estimated 430-550 million acres by 2030) but also other vital inputs such as agri-chemicals, energy and water.



Source: McKinsey & Company report, “Resource Revolution”, November 2011, p39 **Note:** 1 Hectare = 2.47 Acres.

The pressure from an increased population is further exacerbated by rising affluence and changing appetites. In developing countries meat consumption is growing, which requires more inputs than simple, basic foods; indeed, a chicken could be described as a “bag of grain on two legs”.



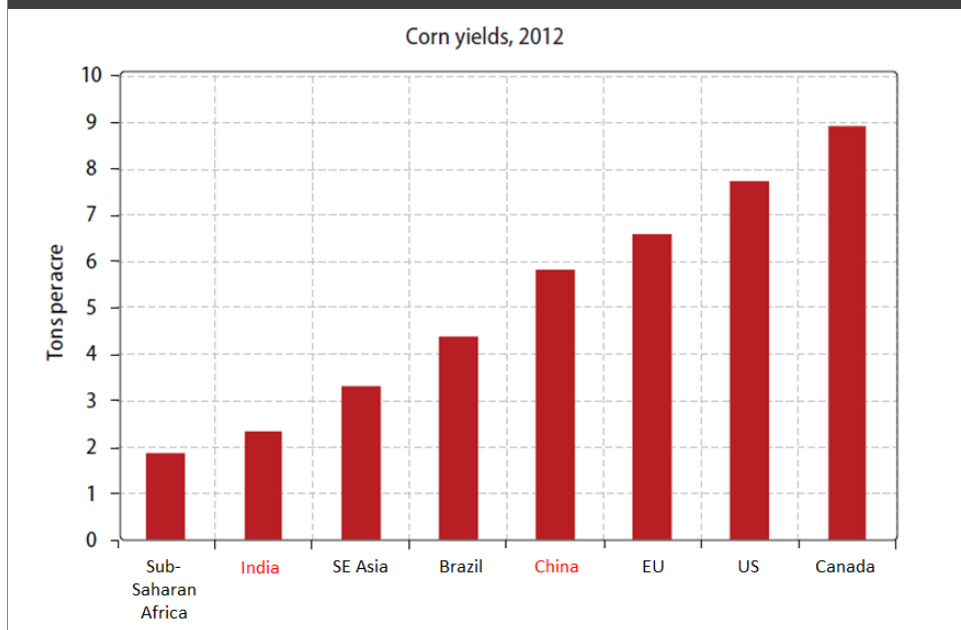
Source: OECD-FAO Agricultural Outlook 2010-2019

- **Crop Yields.** Developing nations are still a long way behind in crop productivity, providing substantial opportunities for yield improvement through technology and infrastructure investment (Figure 10)

To meet demand, a 15% increase in cropland is required by 2030

There is dramatic growth of demand for protein in developing countries

Figure 10 China and India will need to do more to raise agricultural productivity



Source: Dragonomics: "How to Feed a Dragon", February 2013

More recently, under-investment in food production since 2000 (driven by low prices, distorted trade barriers and the collapse of the Soviet Union), led to a decline in world food stocks. A food price bubble in 2008, driven by commodity speculation, followed by a collapse, generated further issues from price volatility.

On the expectation of rising demand and changing appetites, major opportunities are emerging for additional investment and efficient management of global food and agriculture resources, for example:

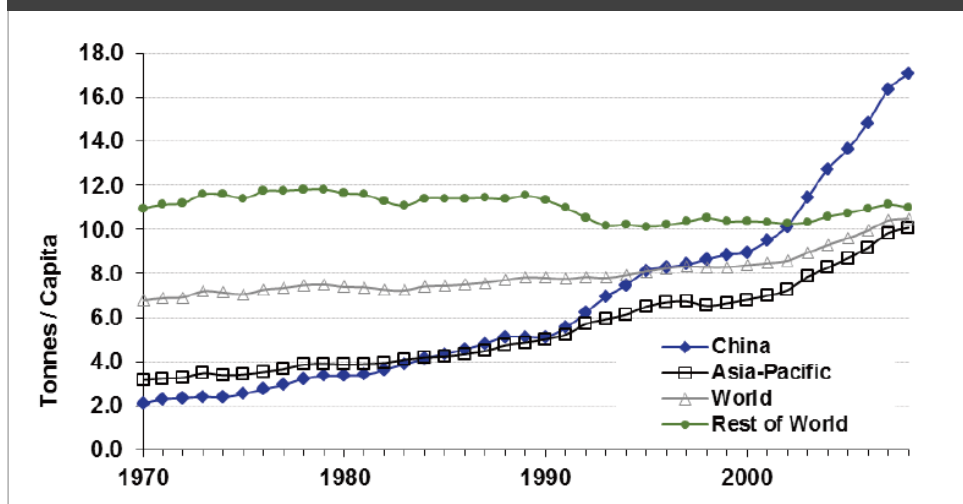
- **Improving productivity:** Rising crop yields, in addition to more acreage, is vital to increasing food production. Investment in seeds, crop protection and irrigation are all expected to expand in the search for higher crop yields.
- **Improving storage, transport and distribution:** Areas of food production are not always near areas of food demand and there is considerable wastage during transport, storage, preservation and processing of food. Investment opportunities exist both in the expansions of these supply chains as well as driving greater efficiencies, for example in the use of enzymes in food production. In addition, as supply chains get longer, more complex testing and traceability of food inputs for quality control is becoming a significant market opportunity.
- **Changing appetites:** Changing appetites, both from more affluent consumers in developing countries and more health conscious consumers in developed countries, provides opportunities for companies with applicable products, dominant market positions and brands.

4) Materials

Materials use in the global economy has risen almost ten-fold over 20th century^{xx}, with consumption of industrial materials and ores rising 27 fold^{xxi}. A key driver for this has been the growth in consumption in developed, industrialised economies after the end of the World War II. Since 2000, this has accelerated further as measured by the increase in direct materials usage per capita from as expanded consumption in emerging market economies, with China in particular becoming the largest global end user of many raw materials^{xxii}. (See Figure 11)

The challenges presented by competition for finite resources, coupled with the increasing cost and complexity of extraction, has driven users of materials to seek more efficient ways to use raw materials. For instance, during the last century direct materials inputs per unit of GDP more than halved^{xxiii}, assisted by the adoption of newer, smarter materials replacing older or scarcer alternatives. Furthermore, over the past ten years the increase in price volatility of materials has focused companies on more efficient use due to the effect on margins. A typical OEM has approximately 15-20% of its total costs directly derived from raw materials, while in process industries, raw materials make up 50-60% of costs. It is estimated that companies can improve margins by 2-5% through effective resource management. As such, the efficient use of materials is being recognised as becoming as important as extracting the primary materials themselves.

Figure 11 Rising domestic material consumption in developing economies (in tons per capita)



Source: West J, Schandl H, Heyenga S and Chen s (2013). Resource Efficiency: Economics and Outlook for China, UNEP, p6

Investment opportunities in optimising the efficient use of materials are likely to arise in four areas:

- **Improving primary materials extraction and processing yields:** Rising costs and complexity in the primary materials sector has created a large end market for products and services to improve efficiency. In the steel and chemical sectors, industrial gases are being used to improve yields: for instance, adding oxygen raises the furnace operating temperature thereby increasing output and reducing emissions. The market for industrial gases is estimated to grow to US\$81B by 2015^{xxiv}, driven by the steel and chemicals sector. As another example, the use of scientific testing services in commodity sectors to improve efficiency now represents 20-40% of the US\$10B+ sales generated by leading testing companies^{xxv}.

Smart materials may dramatically accelerate the improvements in efficiency of materials use

- **Efficient industrial manufacturing processes:** There are significant cost savings to be realised by optimising the use of materials during manufacturing. In the UK alone, it is estimated that the potential savings from resource efficiency initiatives with a less than one year payback is US\$8.4B a year^{xxvi}. Technologies for generating these savings include factory automation equipment, sensors and controls to optimise operating conditions in industrial processing plants. The market for industrial automation is estimated to be US\$68B annually^{xxvii}.
- **Recycling and reuse:** Recycling has been one of the key measures for dealing with scarce resources and an important source for numerous raw materials. Recycling is now estimated to supply 40% of global raw material needs with an annual turnover of US\$200B^{xxviii}.
- **Smart materials:** Advanced materials are replacing incumbents due to better features, lower cost and reduced environmental impact. The market for smart electric materials used in motors, transducers and sensors is estimated to grow at 13% per annum to US\$40B by 2016^{xxix}. Lighter-weight materials are also being used in many end markets: for example, 50% of the new Boeing 787 Dreamliner's frame is comprised of a lightweight carbon fibre composite resulting in lower expected fuel costs for airlines^{xxx}. The market for these composites is estimated at US\$10.8B annually^{xxxi}.

Conclusion - An emerging growth opportunity

Macro economically, there are few fundamental drivers of long term, global growth as important as rising populations, rising living standards and increasing urbanisation. The resultant demand growth in resources, particularly in energy, water, materials and food are unprecedented. In our view, investors who assume that incremental production improvements will continue to meet resource demand without dislocation, could miss out on an enormous opportunity for value creation in resource optimisation and resource efficiency. In other research papers, we explore this opportunity in further detail.

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