5D: FOOD PRODUCTION AND FOSSIL FUELS

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Oil in a nutshell

The world reduced dependence on cheap Persian Gulf oil after the 1970's oil crises by developing supplies elsewhere, substituting coal and natural gas for oil and by pursuing energy efficiency. Persian Gulf oil was used as a last resort. This strategy has run its course.

Discovery of oil peaked in the early 1960s and production has exceeded discovery since 1980 and is now four times as much as discovery. Non-Persian Gulf oil is expected to peak through 2001 and the supply focus is shifting to the Persian Gulf where 60 per cent of the world's remaining oil is located. These countries are not investing on the scale needed and an oil shortage is expected in the near future. This will usher in a complex period expected to end with the global decline of oil extraction around the end of the decade, when the Persian Gulf could be supplying half the world's oil, and world production commences its decline.

Australia's oil self-sufficiency is likely to decline rapidly during the coming decade with imports having a major impact on the balance of payments. Natural gas is an alternative fuel for land transport and agriculture in the medium term.

The area of agricultural land per capita in the world has declined from 0.25 Ha in 1950 to 0.14 Ha in 1998, while grain production per person has increased by over 20 per cent, a doubling of crop yields per hectare. These increased yields have been made possible by an increased direct and indirect fossil fuel input to agriculture, principally by petroleum fuels. The dependence of the Persian Gulf countries on food imports to feed 75 per cent of their rapidly growing population and paid for with the income from oil exports is a major international issue for the next 40 years. A large proportion of their population will have to migrate elsewhere to survive over this period.

Australia's agricultural production is particularly dependent on fertilisers because of its nutrient deficient soils, all of which involve a significant petroleum input. Industrial agriculture has been described as a way of converting petroleum into food.

A world-wide strategy is needed first to halt population growth then reduce it while giving priority to agriculture in the use of the remaining economic petroleum supplies. Natural gas is critical in the manufacture of nitrogen fertilisers, both as an energy source and as a source of hydrogen for the synthesis of ammonia. Nitrogen fertilisers made the Asian Green Revolution possible.

Changing fuel supplies

This conference on *Food – Healthy People and a Healthy Planet* was held just after oil prices went on a roller coaster ride (August 2001). There is a growing acceptance in the petroleum industry that cheap-to-produce oil from fields outside the Persian Gulf is reaching its peak and is about to decline, that the focus of supply is shifting to the Gulf producers.

After the 1970’s oil crises, consuming countries minimised their use of cheap Persian Gulf oil, substituted gas and coal for oil, companies developed oil elsewhere and energy efficiency was pursued. Consumption declined after 1979 and a supply excess developed. Consumption increased from 1986 when prices fell and now the supply excess has disappeared.

The Persian Gulf has 60 per cent of the world's remaining oil, supplies 30 per cent and can expand production for another 10-15 per cent. However, more important are the petroleum investment strategies of Persian Gulf countries, the political, economic and production consequences of these and the huge problem they have feeding a rapidly increasing population dependent on food imports funded from oil export revenue. Furthermore, industrial agriculture has been described as a way of converting petroleum into food. Essential freight traffic and agriculture must get priority for the remaining oil supply.

World discovery and production

Free-flowing oil comprises 90 per cent of production at low cost and is known as *conventional oil.* The world has been sufficiently explored for confident estimates of ultimate recovery of *conventional* oil to be made. By contrast, *non-conventional oil* from tars, bitumens and heavy oils is very expensive to produce, arising from the massive scale of operations, the high energy consumption and environmental problems. Most will be produced well after world oil peaks and in limited quantities. About 60 per cent of the world’s oil powers its transport systems.

Two retired petroleum geologists, Colin Campbell and Jean Laherrere, lead the debate on depletion in oil industry circles. They pay rigorous attention to definitions, the correct use of statistics and of the failings of others in this regard. A consensus is converging on the 1800 to 2100 billion barrels range for ultimate *conventional* oil production. These issues are discussed in Campbell (1997), Campbell and Laherrere (1998) and Fleay (1999).
Figure 1 shows *conventional* oil discovery and production from 1950. Discovery is now one quarter of annual production and only a limited amount is left to find. Sixty per cent of *conventional* oil has been found in 360 giant oil fields (> 500 million barrels), less than one per cent of all fields. The discovery of giant oil fields has slumped since 1980. Eighty per cent comes from fields over 25 years old, most are ageing and many are in decline (Campbell and Laherrere 1995).

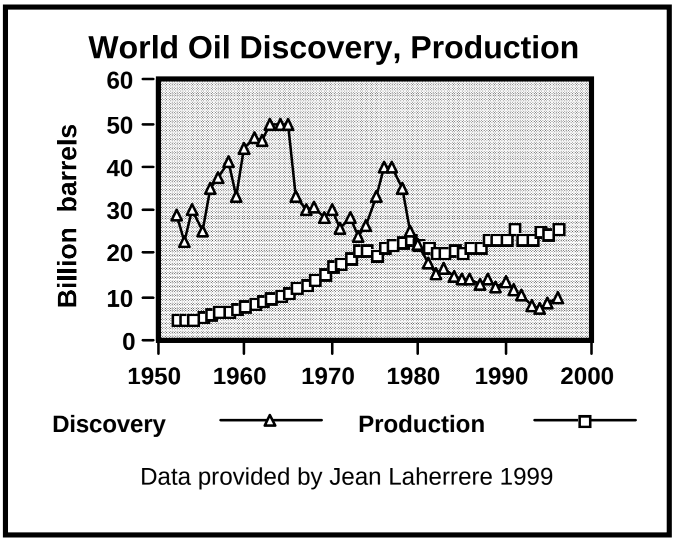

Figure 1

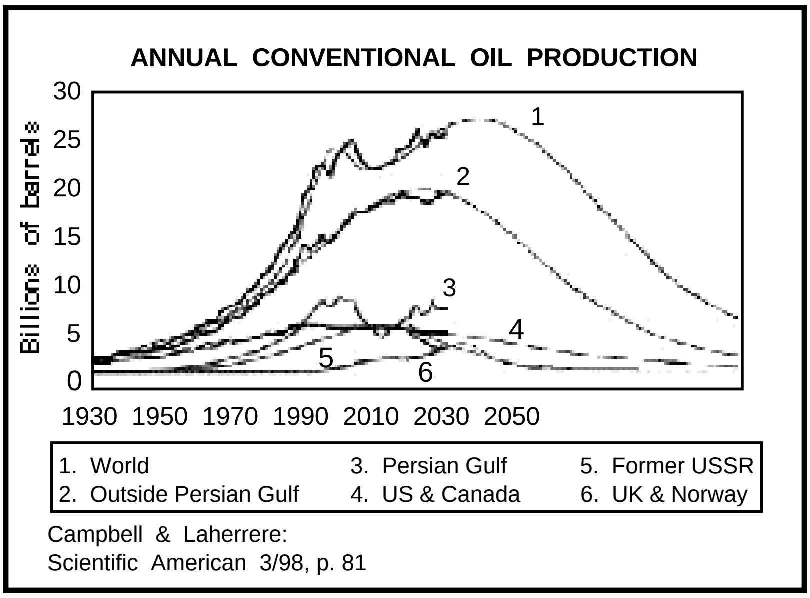

Figure 2

MK Hubbert pioneered the use of the logistic equation to describe oil discovery and production profiles. In 1956 he successfully predicted the time and magnitude of the 1970 peak of US oil production. Figure 2 shows actual production and future estimates for the world and some major regions (Campbell and Laherrere 1998).

Australian oil and gas

The Australian Geological Survey Organisation (AGSO) has made estimates of crude oil and condensate production compared to forecast consumption to 2010. Condensate is liquid stripped from natural gas. AGSO says about half of Australia's ultimate oil production has been produced.

The Bureau of Resource Sciences (1996) estimated that Australia's ultimate endowment of *conventional gas* was four times greater than for oil. Nine per cent has been produced and about 80 per cent is off the north west coast of WA. We do not have as much cheap gas as many people think and it is the only local fuel we can rely on to operate our present land transport and agricultural systems after 2010. It must not be squandered unwisely.

Food, population and petroleum

The world's 20 year strategy to minimise use of Persian Gulf oil has run its course. This time the world must face the consequences of oil depletion; there are no North Seas waiting on the sidelines. By the end of 2000 only Saudi Arabia had some spare production capacity, and elsewhere wells were producing to the limit (IEA 2000). Production is declining in the USA, North Sea, China, Argentina, Egypt, Syria, India and Colombia, while Venezuela and Mexico are only holding their present level by heroic efforts (IEA 2000). The Persian Gulf producers need to massively expand their investment in oil to meet world consumption.

However, rapidly growing populations plus 14 years of low oil prices since 1985 has substantially reduced these countries' per capita export income needed to pay for food imports. The population of the region has quadrupled since 1950, is now about 100 million and could double again by 2025. About 75 million people now depend on food imports paid for from oil export income (Youngquist 1999). After food, welfare for the elite and the masses, plus high military outlays, little was left for oil investment after 1985. The scale of investment now required makes some external investment inevitable, but it is an extremely sensitive internal political issue and US inspired sanctions effectively prohibit such investment in Iraq and Iran. These countries are fearful of creating excess production capacity and inducing a price fall. Consequently there is under-investment that could lead to a supply shortfall in 2-3 years as decline gathers pace elsewhere. It is in these countries' interests to ration oil at high prices, but not at levels that damage the world economy.

It is becoming increasingly difficult for these countries to juggle production, oil prices and investment in oil and have sufficient revenue left over for food imports, which increment must increase at 2.5 per cent per annum just to keep such per capita income constant. As these countries approach their oil peaks between 2008 and 2020 they will start to lose this revenue battle.

Perhaps some 100 million people will have to migrate somewhere else by 2040. Managing this migration is one of the major issues of economic globalisation, a vastly different agenda from the one at the forefront of the business world today. We have a scenario where oil supply can be subject to unexpected interruptions. There is no certainty that the timely high investments required in the Persian Gulf petroleum industry will always take place, nor that infrastructure will be maintained in good working order. These countries also have over 25 per cent of the world's natural gas.

A similar but lesser problem also exists for the oil producing countries of Libya, Algeria and Venezuela.

The food exporters

The area of land suitable for grain production in the world has declined from 0.25 Ha per person in 1950 to 0.14 Ha per person in 1998. Over the same period, annual grain production per person has increased from 250 Kg to over 300 Kg, by more than doubling grain yield per Ha (WWI 1999). How was this increased grain production achieved? Georgescu-Roegen (1975) observed that a growth in economic productivity always implies a growth in energy consumption. The principal grain exporting countries are Argentina, Australia, Canada, the European Union and the United States.

Conforti and Giampietro (1997) have made a 75 -country comparison of fossil energy use in agriculture related to the use of chemical and mechanical inputs, using aggregated data. Technical developments in agriculture follow different paths according to relative factor scarcity: thus land abundant regions produce and adopt mainly labour-saving techniques – mechanisation - to increase the area of land cultivated by each farmer, while land scarce countries adopt techniques to increase outputs/hectare, identifiable with fertilisers, pesticides and crop rotations. Their study included cereals, starchy roots, pulses, oil crops, sugar crops, stimulants, fruit and vegetables. Animal products were excluded. Energy outputs of food were compared with fossil fuel inputs. They found this ratio varied from less than one to over 20. The poorer countries of Africa dominated the latter category while all OECD countries have ratios below three. Southern and Central America, some European and southern Asian countries were irregularly distributed.

Australia, Canada and the USA had ratios of 1.7 to 2.5 and were the principle countries where mechanisation dominated, with extremely high labour productivity. The EU and Argentina had ratios of 1.5 and 2.4 respectively, partly due to mechanisation, partly to chemical inputs. Their observations support the hypothesis that a land constraint, with respect to the population, implies a higher cost of agricultural production in terms of fossil energy use than does a labour constraint. Emancipation of agricultural production from land shortage is paid for in terms of an increased fossil fuel input.

Australia is perhaps a special case. There is a high level of mechanisation and consequent high labour productivity. But our nutrient deficient soils require a high fertiliser input. In Western Australia there would be no cereal crops at all without using superphosphate, farmers are now turning to urea to maintain yields and protein content which in turn is leading to soil acidification that will soon need the application of one million tonnes of lime per year. There is extensive use of herbicides for weed control. At every turn a substantial petroleum input is required, including for the supporting transport systems.

Petroleum products are the major fossil fuel input to agriculture world-wide and their significant direct and indirect use began in the 1930s, but principally since 1950.

The subsequent adoption of monocultures can lead to soil erosion, depletion of water tables and land degradation, loss of biodiversity and genetic diversity at the ecosystem level. The chronic problems with dryland salinity, land and water degradation in Australia are examples.

The major food exporting nations therefore are only able to produce a surplus for export by a substantial petroleum input to agriculture. An input where oil is concerned that must increasingly come from the Persian Gulf countries, who in turn depend on these five exporting nations for their growing food imports!

Discussion notes

- The suggestion that 100 million people from the Persian Gulf oil producing states will have to move somewhere else by 2040 is disturbing. The rationale for their going is that there will not be enough income left over to pay for food imports, but that assumes these countries will not be exporting sufficient oil to maintain agriculture as we know it in the food producing countries. Australia may have to become a food importer rather than exporter under this scenario. So where do the 100 million people go? It is time the world began thinking and planning what to do and how – a major issue for the globalisation agenda
- It seems the world is in for a hot (in some places a cold) time, with declining oil supplies/discoveries, a rapidly expanding population in the Middle East and the “war on terrorism”. We need to reduce our profligate consumption of fossil fuels and realise that they are a non-renewable resource. Some (theoretical) adaptive steps might include:

  1) Reserve remaining fossil fuels for agriculture, essential services and public transport, with limited (and expensive) rations for private cars
  2) Encouragement of local agricultural/horticultural production to reduce transport costs
  3) Heavy investment in renewable energy technologies, such as wind, solar, biomass, hydrogen/fuel cell (using solar, wind or hydroelectric power to manufacture hydrogen by electrolysis of water)
  4) Do everything possible to reduce food and resource inequalities, thereby diminishing the likelihood of social and political unrest

  - Clearly there is a great need for homework on all these issues, both at the political and technical levels. There is a limit to the rate at which renewable sources of energy can be harnessed, because significant quantities of existing fossil fuels have to be diverted to this task. For most renewables this initial input of energy is high, being incorporated in the hardware and construction costs. After commissioning, the energy input for maintenance, etc. is relatively small

- The biggest obstacles to providing a sustainable energy future are entrenched economic policies which take a short term outlook, lack of a bipartisan approach to political vision and commitment, and a general community reluctance to accept a slowing of unsustainable growth rates to provide for future energy security
- There is no universal answer to the question of what form agriculture will take when oil supplies dry up. Food production methods will be shaped by local environmental configuration. It is possible that the human population will peak at 7 billion by 2020 and then decline, under the restraints of diminishing fuel supplies and decreasing agricultural land
- One of the good things which may eventually emerge from the disasters of 11/9/01 in New York and Washington is a break in past patterns of thinking into a new paradigm which is more attuned to addressing these problems on a global scale

Further reading

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