The impact of biofuels on the world fertilizer market

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Presentation overview

- Definitions and scope
- Factors which translate biofuel market developments into fertilizer demand
- Recent global biofuel developments and forecast
- The impact on fertilizer demand

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Some definitions

- Biofuel – renewable crops used for transportation
- Technology
  - 1G – Bioethanol (sugar and starch-based) and Biodiesel (vegetable oils)
  - 2G (cellulosic, etc) - 5-10 years away

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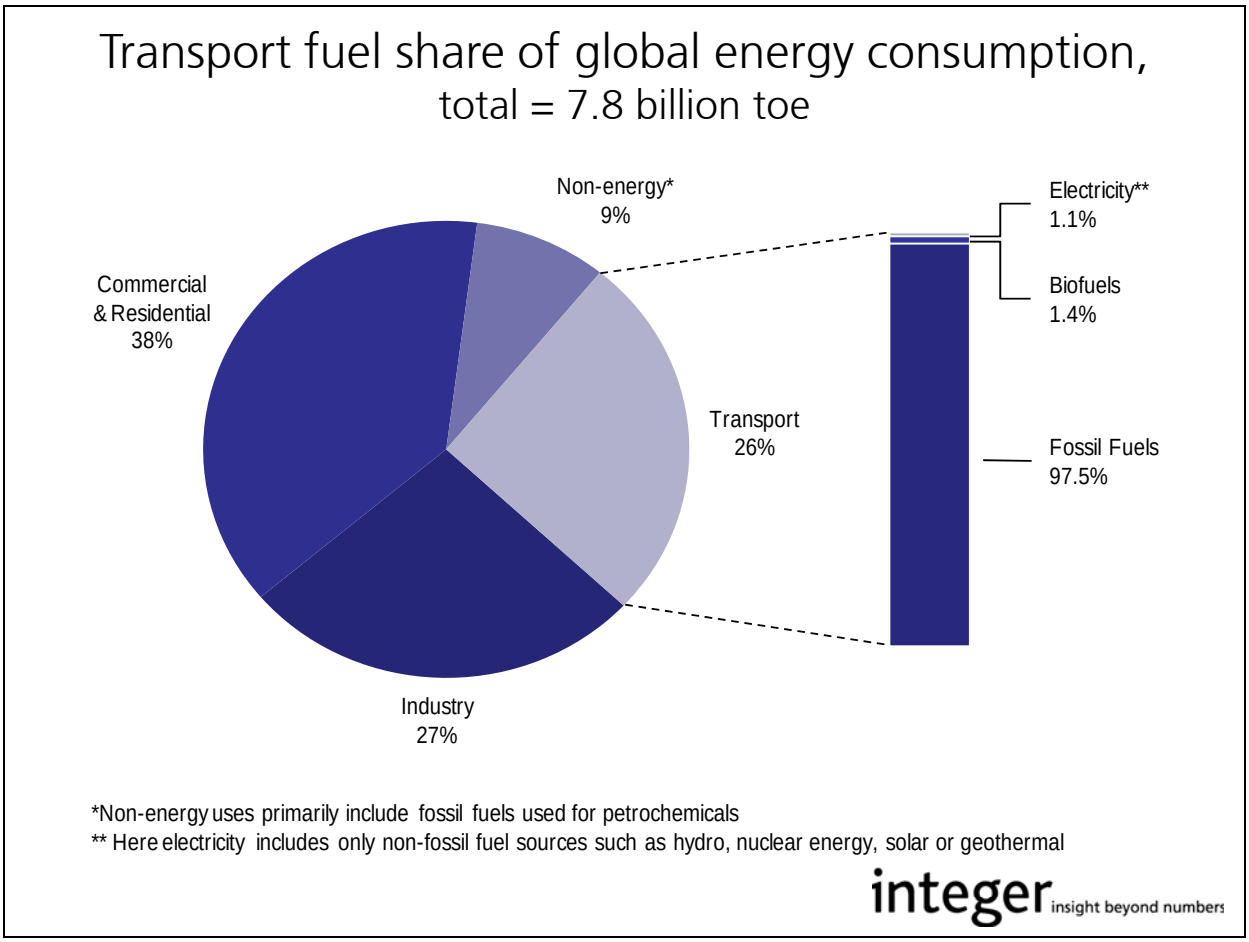
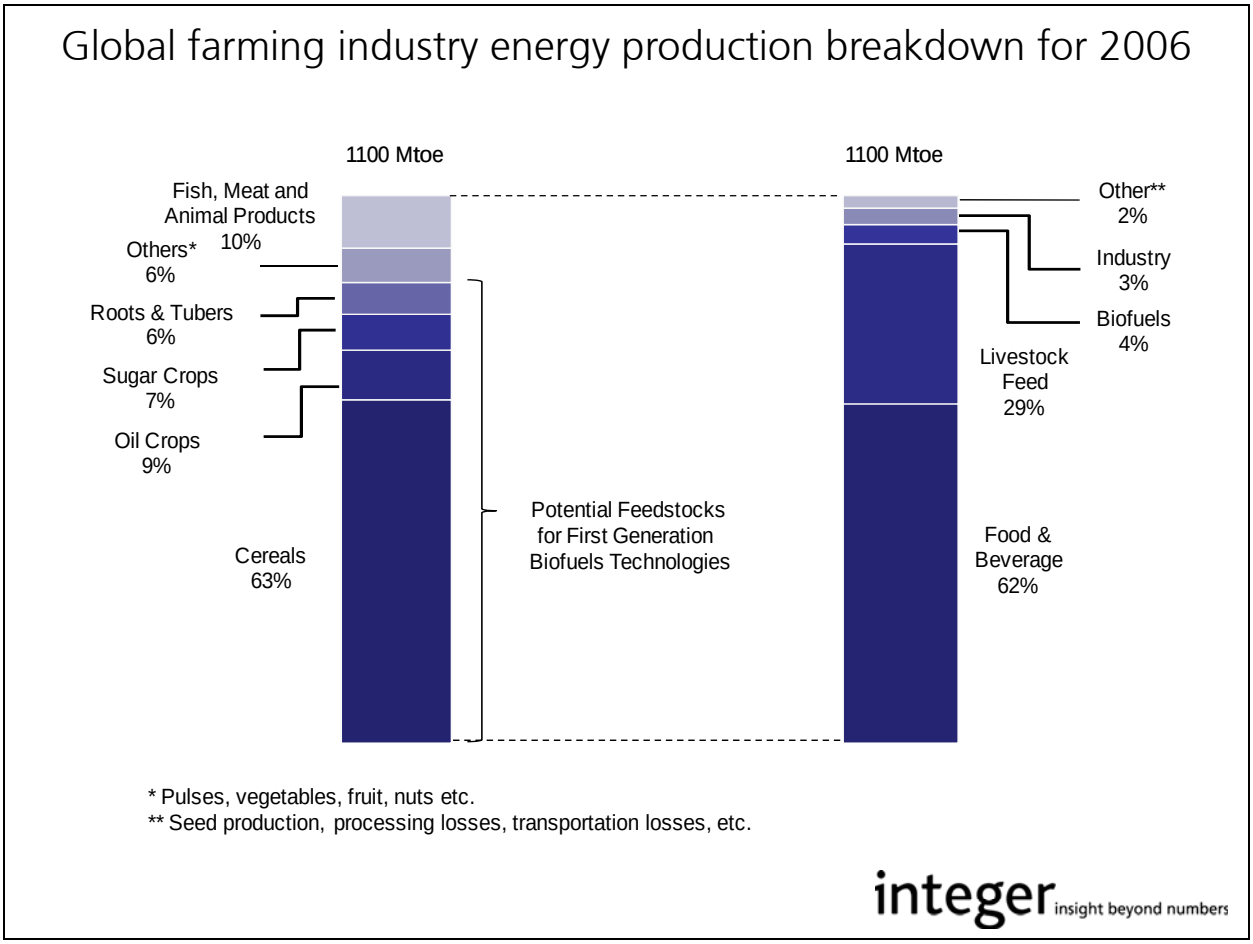
- The scope of the paper covers biofuels using the following definition 'Transport fuel produced from renewable crops'. This is a segment of a much larger definition of biomass.
- This paper deals only with biofuels produced using so called 'first generation' technology. That is the production of bioethanol and biodiesel from crops to be used or blended with existing fossil fuel diesel and gasoline. These crops are sugar cane or beet; maize (corn), wheat and other cereals to produce bioethanol; and vegetable oil crops like soyabean, rapeseed and oil palm to produce biodiesel.
- Second generation biofuels technology, for example, which can convert cellulose to biofuel, is not expected to be commercially viable for at least 5 years and is not discussed in this paper.



- This chart illustrates the size of the market biofuels is seeking supply. It shows total world energy consumption by end-use.
- Biofuels is supplying the transport segment, which makes up about a quarter of total world energy consumption. There is a breakdown of transport fuel by source, and in 2006, biofuels accounted for about 1.4% of transport energy consumption.



- This chart shows resources currently available to produce biofuels. It shows world food production in terms of its energy value, broken down by product group in the left hand bar, and then by end-use market in the right hand bar.
- The crops available to biofuels are highlighted in the left hand bar, namely cereals, oil crops, sugar crops, and roots and tubers.
- Note that there is a significant difference between the value of energy currently available from food, and global energy consumption shown in the previous slide. Food production is around 1.1 billion tonnes of oil equivalent, whereas current world energy consumption is around 8 times bigger. The multiple is greater if we compare food production with energy production as there are significant losses between energy production and final consumption.
- So even if we diverted all food resources to make energy (and stopped eating!) we still would only be able to replace a relatively small part of total energy consumption using current technology.

Factors which translate biofuel in to fertilizer demand

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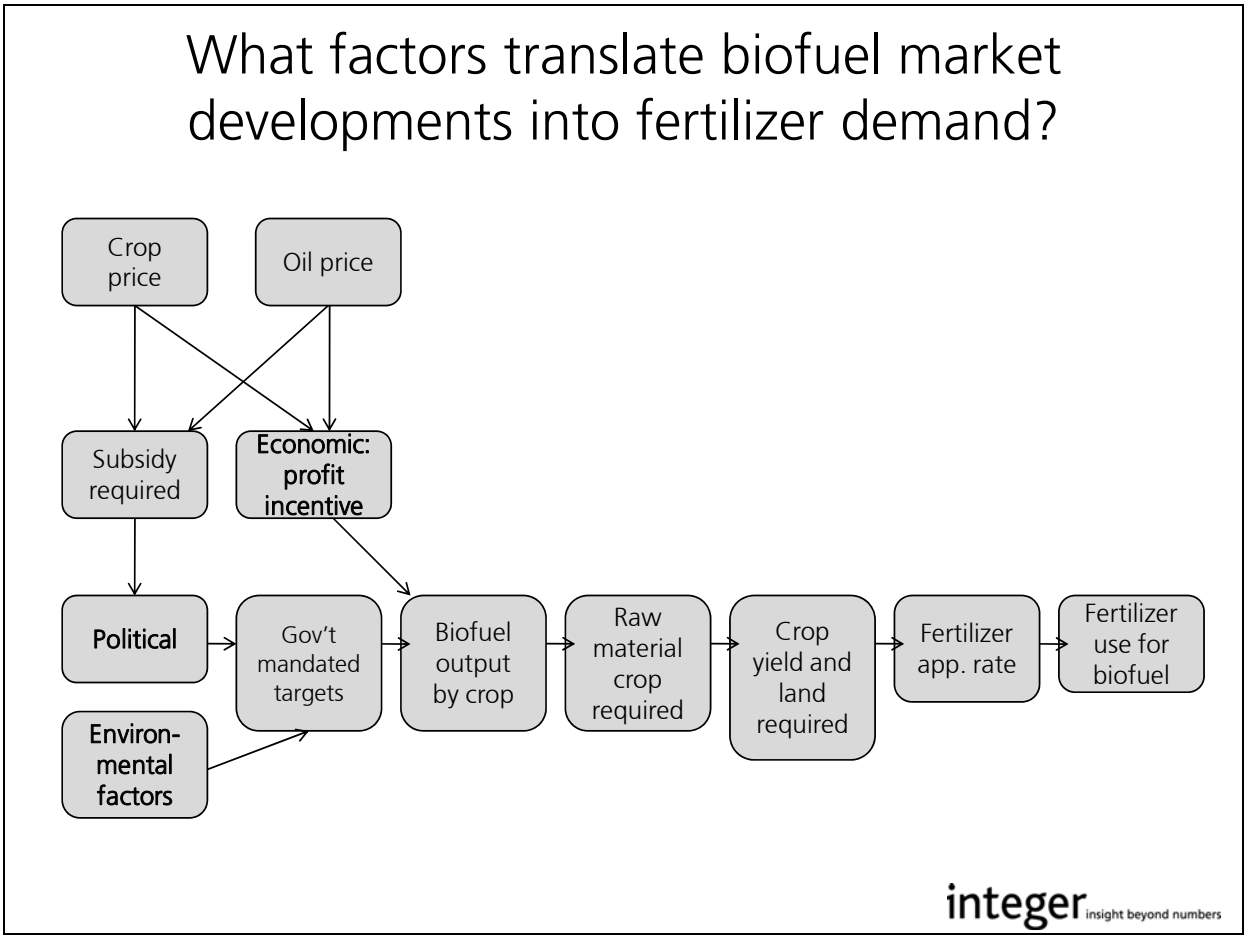
- So now we have an idea of the scope and scale of the issue, we can now consider the mechanism through which biofuels production translates in to fertilizer demand, and explain the variables involved.



- This slide shows the main variables we need to understand in order to be able to quantify the future impact of biofuels on fertilizers, and how they interact. The central point is biofuel output by crop. In order to understand and predict this value in future, we need to have an idea of the key drivers of biofuel production.
    - Firstly, there is an economic or profit motive. If transport fuel can be made profitably from crops, then production is likely. The key drivers of profitability are prevailing crop and energy prices.
    - However, there are other motives which drive biofuels production even if it is not profitable. In some countries, producing biofuels is politically desirable, and subsidies are available if production is not profitable.
    - Similarly, there might be environmental goals which provide an incentive to produce biofuels.
- Once we understand the main drivers and have a prediction of biofuel production, we can begin to translate this in to biofuel production by crop, the quantity of crop required to produce biofuel, the land required, then finally how much fertilizer is likely to be used.

- The variables with the greatest degree of uncertainty are the drivers of biofules, from which we derive a biofuel production forecast. The other variables are much more predictable.

Political drivers

- Energy security, diversity of sources, reduced dependence
- Employment and industrial development
- Agricultural support
  - Higher crop prices = happy farmers

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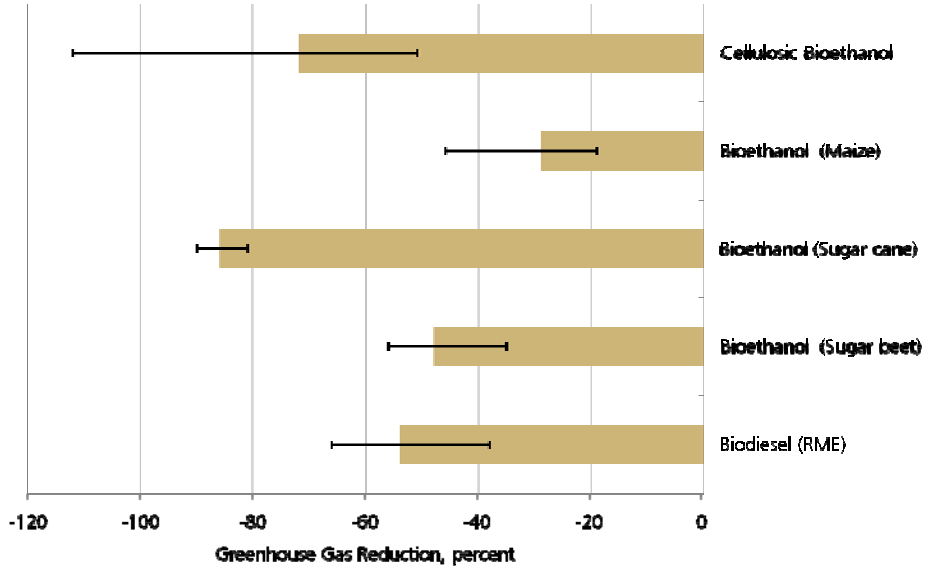
- Many different political reasons are commonly offered for producing biofuels.
  - Hydrocarbons are frequently imported in significant quantities and often from countries with political regimes considered to be unstable. Biofuels offers greater energy dependency by displacing imports, and reduces support to undesirable governments.
  - The biofuels industry can be a significant source of employment, generating jobs and promoting industrial development.
  - A key factor is agricultural support. Biofuels drives up demand and prices for crops, raising farmer incomes. Agriculture is a key political constituency.

Environmental drivers

- In general, CO2 saving with intensification
- Expansion of land = ?



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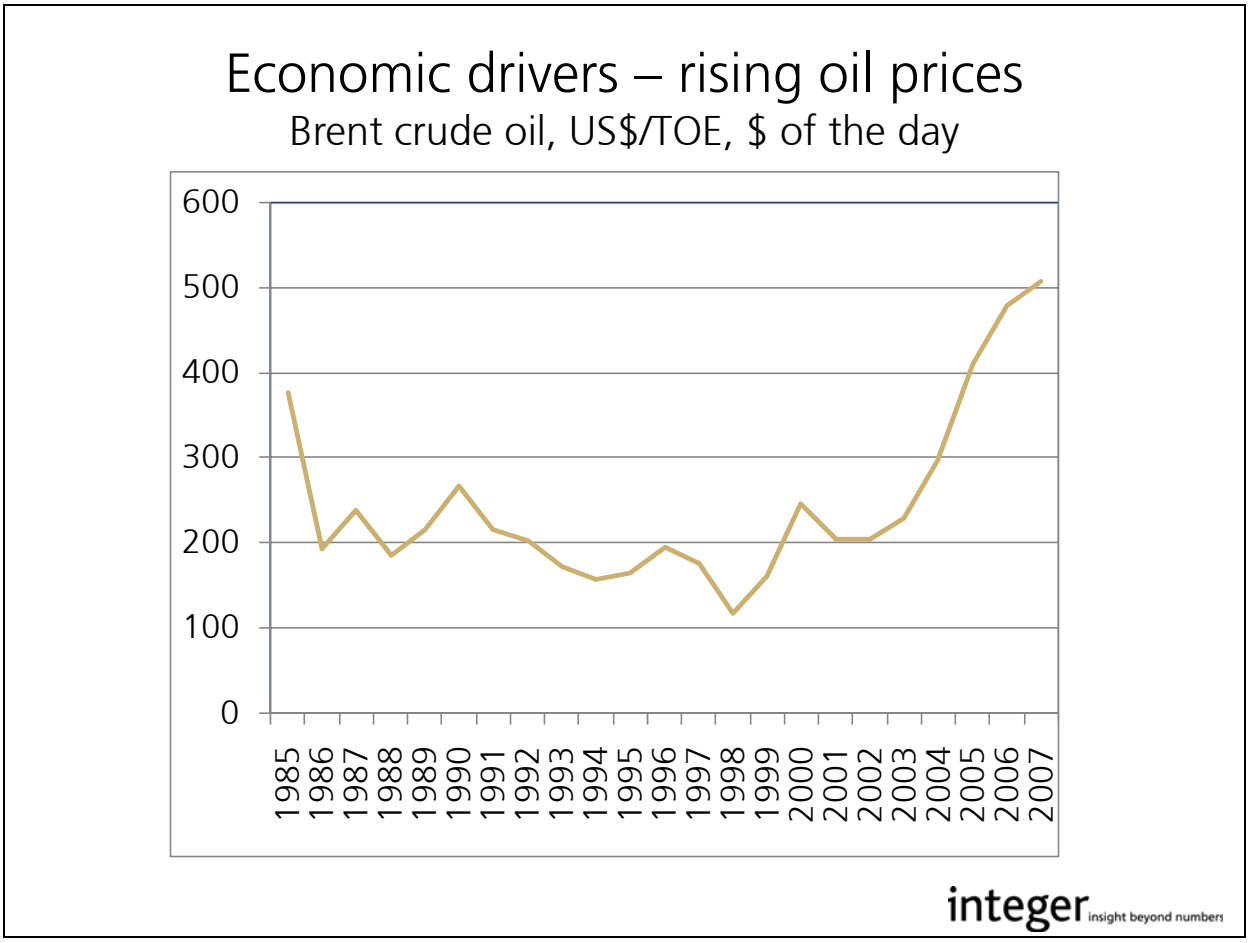
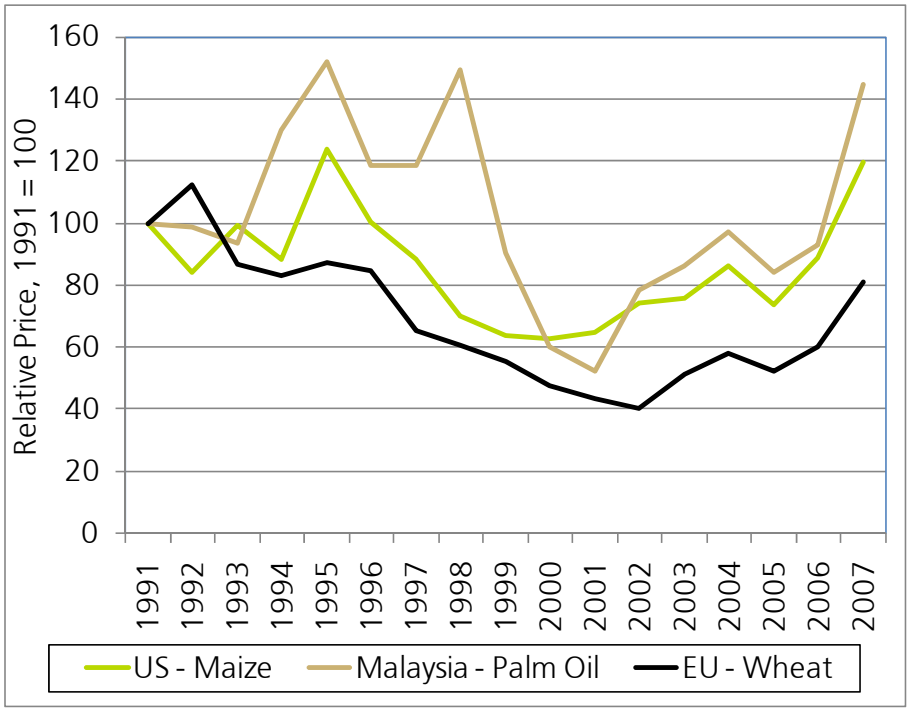
- It is argued that biofuels offers environmental benefits, but the extent is disputed.
- Studies indicate that producing fuel from renewable crop sources offers a greenhouse gas saving compared to producing the same unit of fuel from hydrocarbon, but measuring the extent of this is difficult.
- This chart shows the outcome of various studies and surveys attempting to identify the greenhouse gas saving of using biofuels compared to hydrocarbon. The bar is the average greenhouse gas saving identified by different studies, and the line shows the high and low range.
- The chart shows that in general, biofuels offers significant savings compared to using hydrocarbon fuel. However, we must also consider two other issues:
    - The secondary effects. If biofuels requires an expansion of land, then the positive effect on greenhouse gases may be lost, since converting forest and scrub to arable land can release significant quantities of carbon.
    - Secondly, biofuels production in many locations requires subsidy. That subsidy might be spent more cost effectively on alternative methods of reducing greenhouse gases.



- The economics of producing biofuels are clearly important. In simple terms, biofuels production can compete without subsidy with hydrocarbons in some locations when energy prices are high and/or when crop prices are depressed.
- This chart shows the energy side of the equation. The spike in oil prices in the last five years has provided a major incentive to alternative fuels. The price of oil measured in US dollars has more than doubled during this time.

Relatively stable crop prices, until 2006



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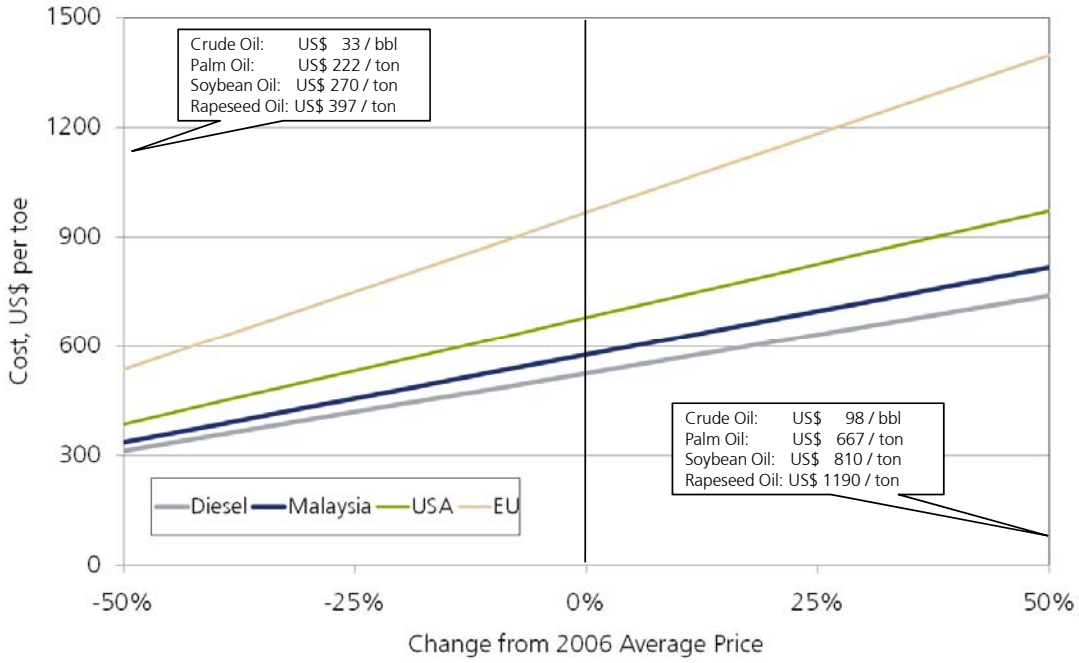
- On the other side of the equation, the cost of the main biofuels raw materials was flat until the last year or two. After spiking in the mid-1990s, the price of cereals and oilseeds declined significantly in real terms.
- Although crop prices have increased significantly in recent years, they are still at or around the same real level as the mid-1990s.
- We discuss rising crop prices in a later slide.

Feedstock sensitivity analysis for biodiesel cost of production vs. fossil diesel



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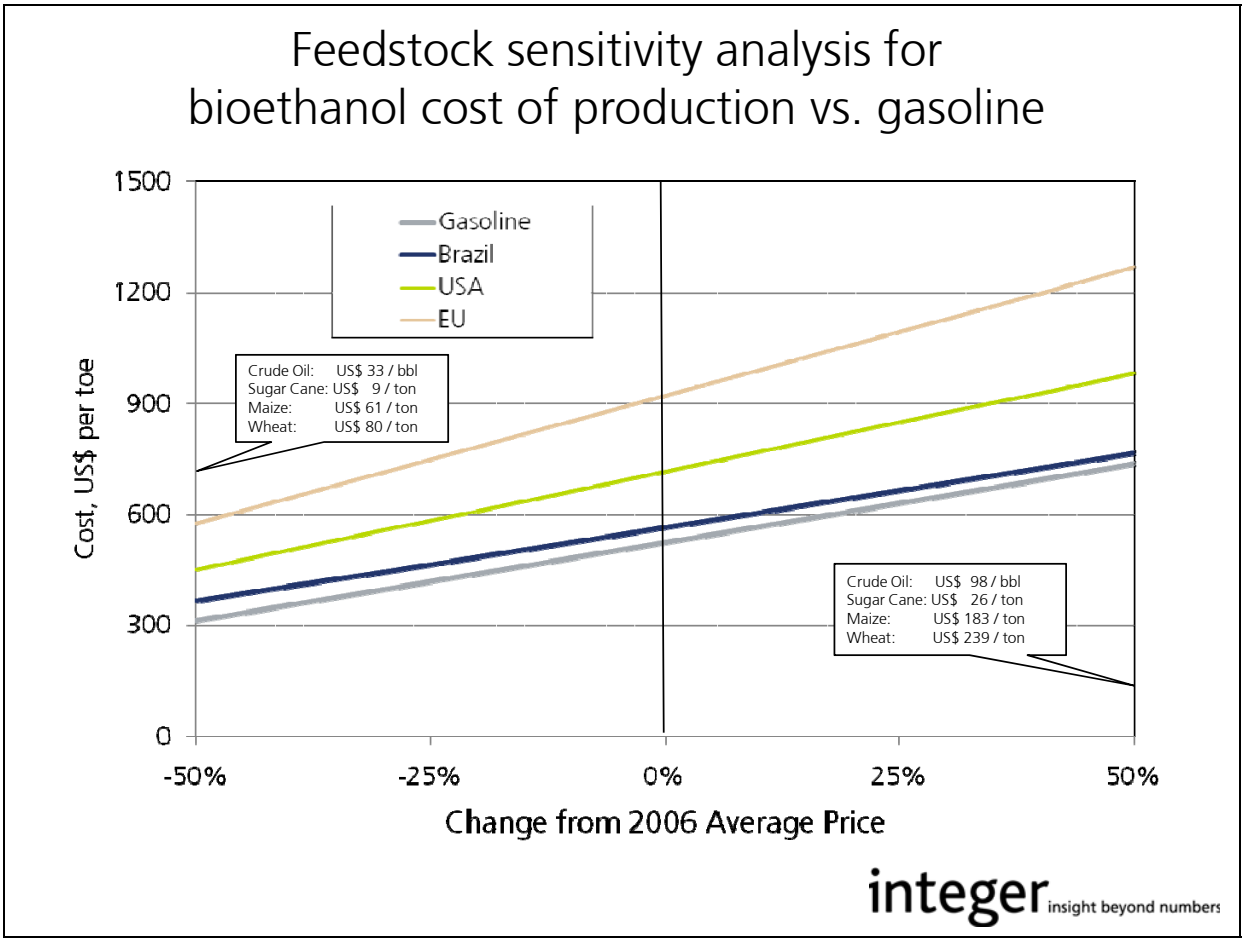
- This chart considers the sensitivity of producing biodiesel to the two main economic drivers – oil prices and crop prices.
- The central vertical line shows the 2006 average cost of producing hydrocarbon diesel and biodiesel from alternative crop feeds at prevailing prices in different locations, measured in tonnes of oil equivalent to allow comparison.
- Moving away from the vertical line, illustrates what happens to production costs if the main raw material price changes. For example,
    - If the price of oil goes up by 50% compared to the 2006 average, the cost of producing diesel rises from around US$500 per TOE, to around US$750 per TOE.
    - If the palm oil price increases by 50% compared to the 2006 average, the cost of producing palm oil-based biodiesel rises from US$500 per TOE to US$850 per TOE.
- The chart shows that in 2006, biodiesel production required a subsidy, particularly using rapeseed.
- It is interesting to note that the economics of biodiesel have worsened for each of the main oilseeds. Based on 2007 year to date numbers, the price of oil has increased by around 8%, while the price of palm oil has increased by 55%.



- This slide shows the economics of producing bioethanol. In 2006, bioethanol produced from sugar cane in Brazil was more or less competitive with hydrocarbon gasoline. Production from cereals in other locations generally required a subsidy.
- The economics of producing bioethanol from cereals have also worsened in 2007. Whereas the oil price has increased by 8% year to date compared to the 2006 average, the price of corn has increased by 32%, and the price of wheat by 31%.

Projection of biofuel production

- Forecast fuel consumption
- National/regional targets: are these targets achievable given economics, politics etc?
- % share of biofuel of total transport fuel consumption
- Biofuel production forecast:
  - By region, by fuel

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- So once we have interpreted the impact of these political, economic and environmental drivers, we can feed them in to our biofuels forecast.
- This requires analysis of current and future transport fuel consumption patterns, together with government biofuels consumption targets as a percentage of transport fuel consumption.
- Crucially, we must factor in whether or not governments are likely to meet their stated objectives, taking account forecasts of future crop and fuel prices.
- We can then make a biofuel production forecast, by region and by fuel.

Biofuel raw material crop requirements

- Biofuel capacity/production by crop
  - US – ethanol from corn, diesel from soybeans
  - Brazil – ethanol from sugar, diesel from soybeans
  - Europe – ethanol from cereals, diesel from rapeseed

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- In order to establish the raw material crop requirements, a key factor is the raw material available. This slide shows the main biofuels and their feedstocks.
- By observing capacity and project activity, we can see how much crop feedstock is required. The most complex market is Europe, where biofuel is being produced from many different cereals, sugar beet, and rapeseed and other oilseeds.

Land requirements and fertilizer consumption

- Crop production/yield = land use by crop
- Fertilizer application rate x land use by crop = biofuel related fertilizer consumption

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- Having established which crops are required, and how much, we can use typical crop yield values to work out how much land will be required to produce biofuels.
- Then finally, we can use fertilizer application rates to work out total biofuels-related fertilizer consumption.

Recent global biofuel developments and forecast

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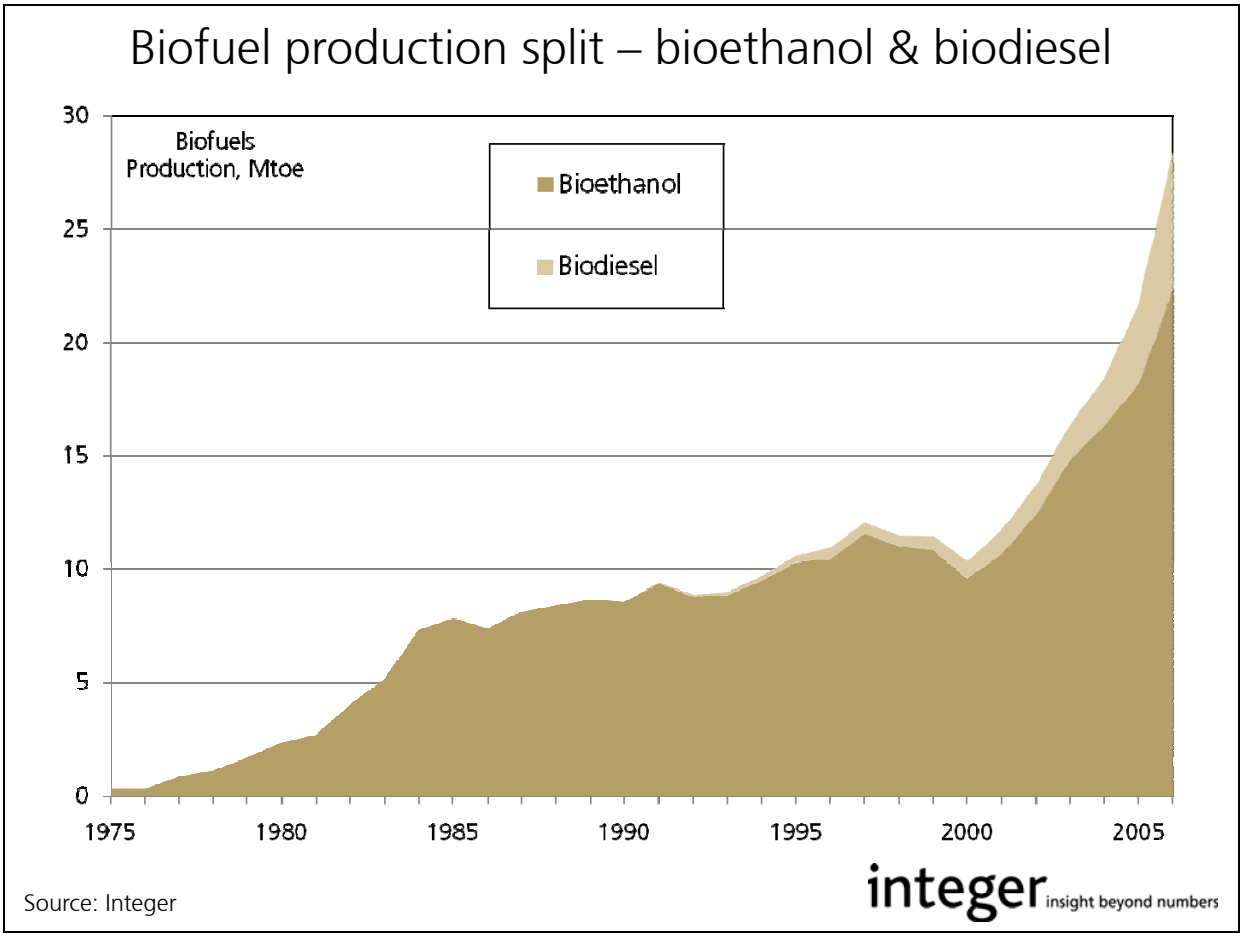
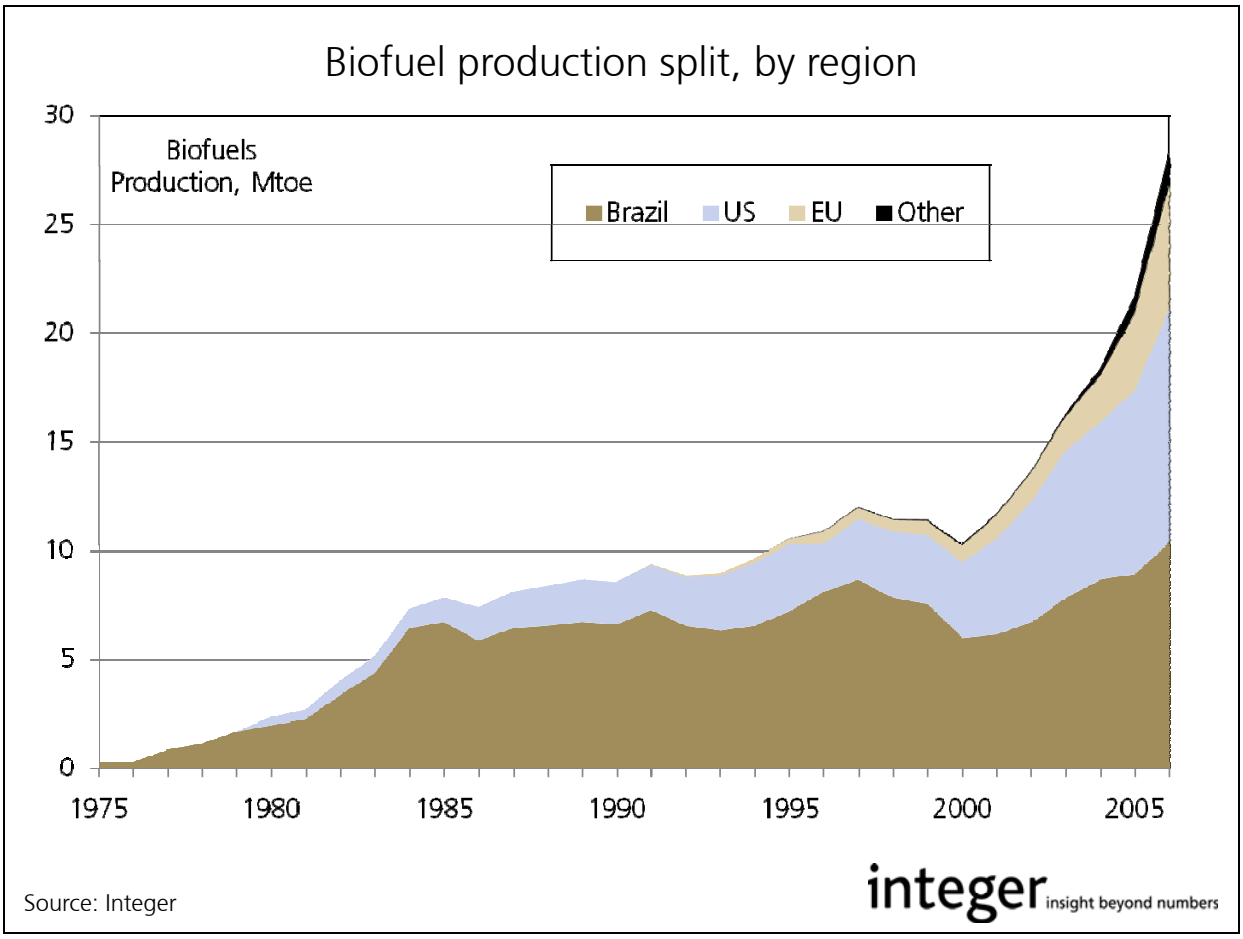
- Now we have explored the variables which translate biofuels in to fertilizer consumption, we can review recent developments and outline our forecast.

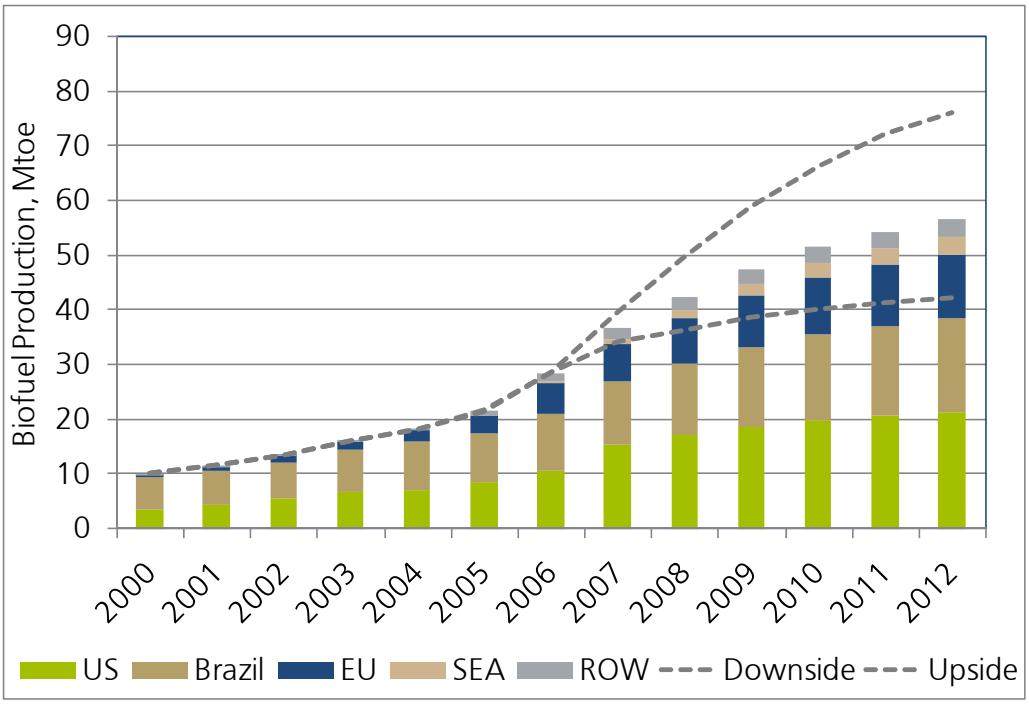


- This chart shows global biofuel production since the mid-1990's. The main growth spurts coincide with rises in oil prices, starting at the end of the 1990s, and then the most recent acceleration since 2000.
- Global biofuels production has nearly tripled in the last five years or so.
- Production was largely concentrated to ethanol in Brazil until the 1990s, underpinned by Brazilian government support in infrastructure, cooperation with the auto industry and so on. Interestingly, Brazilian biofuels production actually declined at the end of the 1990s as the price of sugar soared, which shows the sensitivity to raw materials costs and energy .



- This slide shows the same data broken down by region. Again, Brazil was the largest producer until 2006, when it was overtaken by the US.
- EU production is also growing quickly, albeit from a small base. The EU is focusing on biodiesel rather than bioethanol.
- The chart clearly shows the decline in production in Brazil in the second half of the 1990s.
- Consumption in the rest of the world is relatively small by comparison. Although there are some ambitious programmes, biofuels production remains comparatively small.

Biofuel production forecast – total by region



Source: Integer

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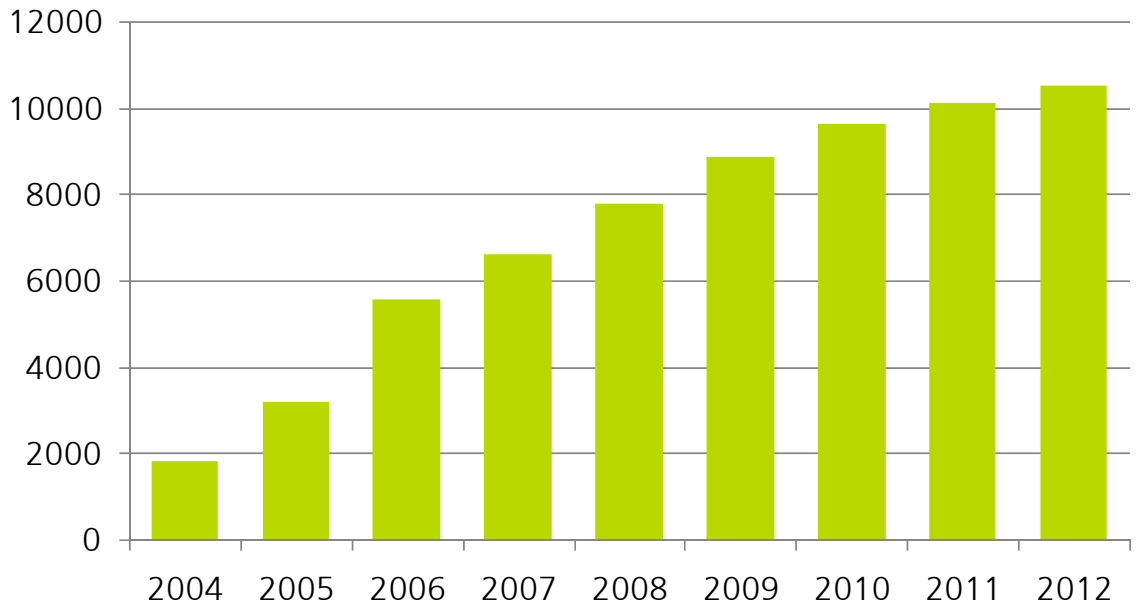
- This chart outlines Integer's forecast of biofuels production by region.
- As we described earlier, there are many variables driving this forecast, and in order to account for the range of possible outcomes, we have outlined 3 alternative scenarios – base case, upside and downside.
- The main assumptions in the base case are that the growth in the US will continue although the growth rate will moderate. US production will double in the next five years, compared to 2006.
- We can predict future Brazilian production growth with the greatest certainty as it is the most mature market, and the least dependent on political support. Brazilian biofuels production will grow broadly in line with fuel consumption growth.
- EU production will expand significantly, but we predict the region will miss its 5.75% fuel consumption target for 2010.
- In the rest of the world, consumption will grow, but will represent a relatively small market compared to the 'big 3' countries and regions.

EU –targets elusive, but still major impact on land use

Biofuel planted area (thousand hectares)



Source: Eurostat, Integer forecast

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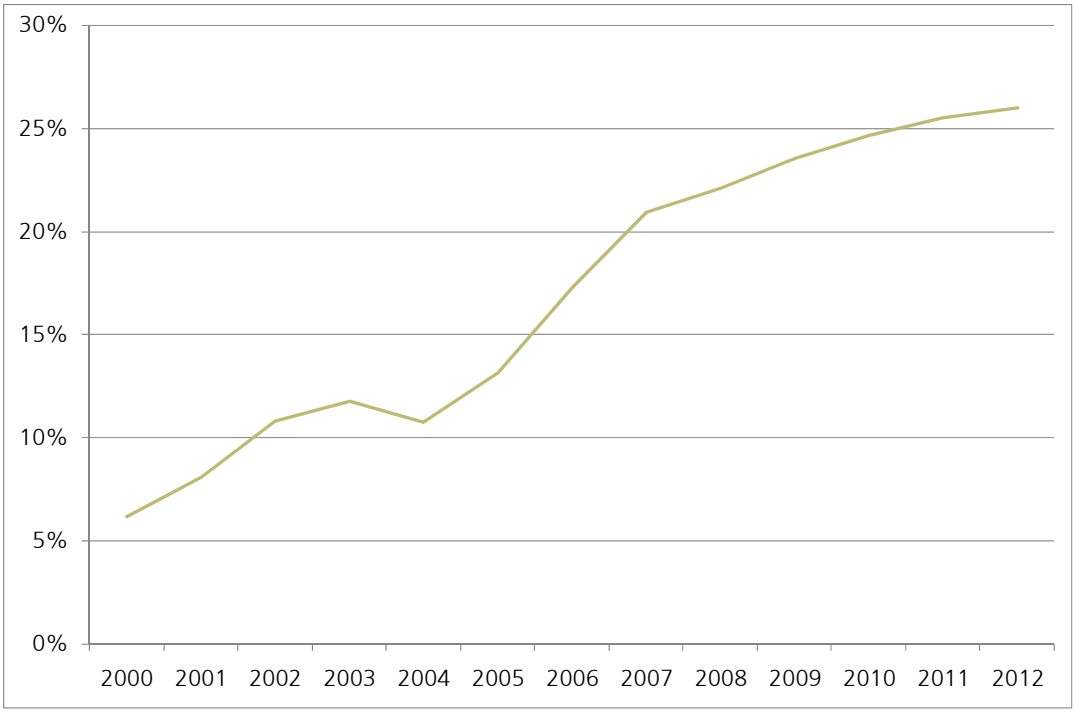
- The chart gives some indication of the impact of EU biofuels production.
- Although we expect the region will miss its 5.75% biofuel fuel target, there is still likely to be a major impact on land use. By 2012, we predict land used to grow biofuels will account for around 10 million hectares, compared to current total arable land of 110 million hectares.
- The EU is already loosening up supply constraints with a zero rate of set-aside recently agreed.

USA – biofuel demand taking over corn

Corn use for ethanol as % of total corn production



Source: USDA, Integer forecast

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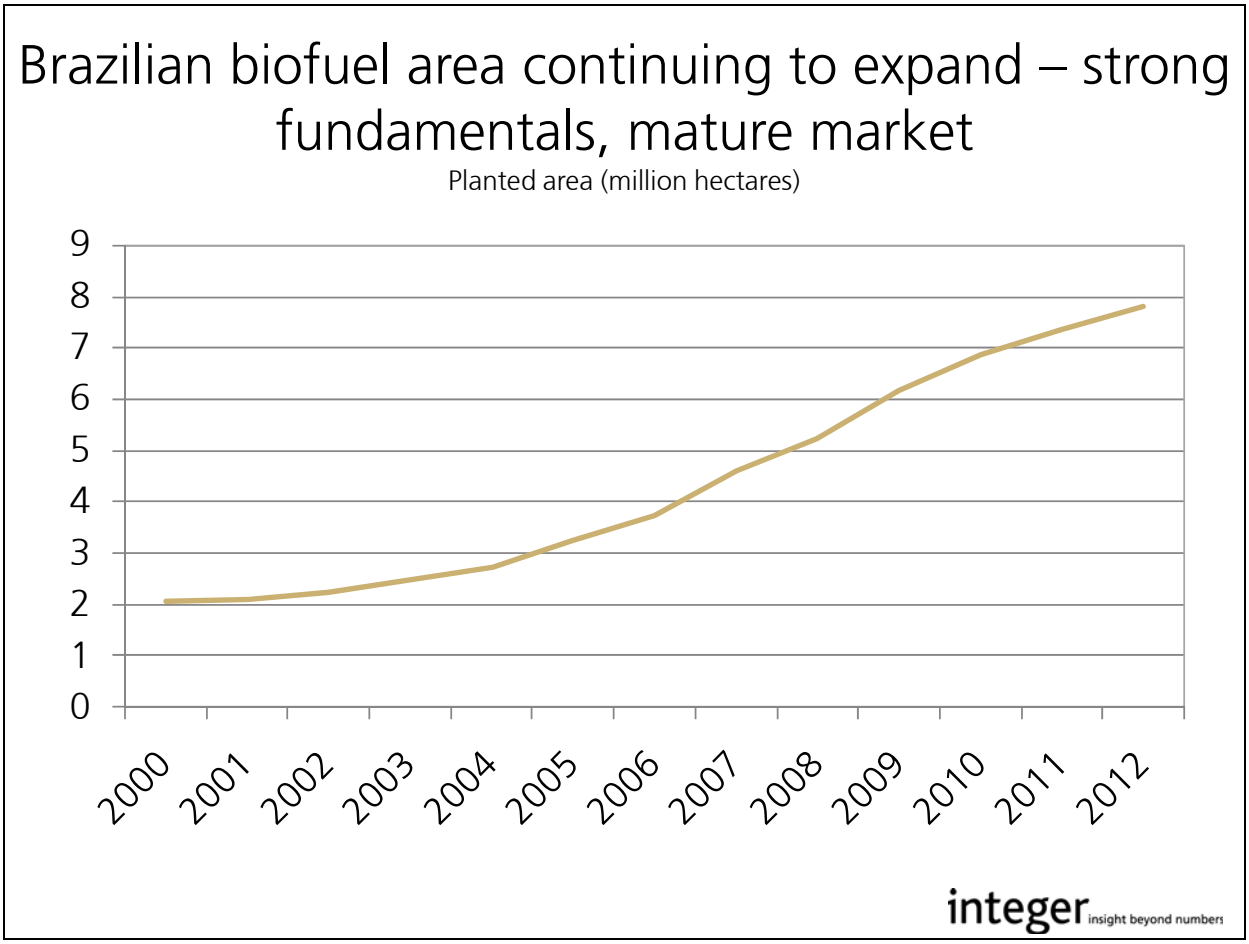
- The US is already seeing a major impact on agriculture. This chart shows the percentage of corn being used to produce ethanol, as a percentage of total corn production.
- Although corn area is expanding, and yields are improving, corn use for ethanol will rise in importance to more than a quarter of the total by 2012.
- As new biofuels capacity is added, profitability on new investment will decline and new projects will be more difficult to justify. Nevertheless, there is a significant amount of political momentum behind the US biofuels industry and it will expand.
- Some of the growth in corn use in biofuels will be met from improving corn yields, but there will need to be some expansion in corn area, most likely at the expense of soyabeans and wheat.



- The Brazilian biofuel market is the most mature as we have already explored.
- Around half of Brazilian sugar area is devoted to producing bioethanol.
- In our forecast, we are assuming that bioethanol production will grow in line with rising transport fuel consumption.
- As a result, sugar area will grow from around 3.5 million hectares in 2006 to nearly 8 million hectares in 2012.

Rest of the World

- Indonesia and Malaysia – oil palm growth and strong potential
  - But doubts over exports, recent economics unfavourable, no subsidies
- Rest of the world
  - Developing - lower on political agenda than food security
  - Developed- many schemes and targets, but compared to 'big 3', biofuels potential is much smaller

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- In SE Asia, there is significant potential to produce fuel from crops, as palm oil has until recently offered the best economics for producing biodiesel of conventional crops using first generation technology.
- However, there is comparatively little government economic support available, and a significant rise in the price of palm oil in recent months is likely to constrain growth until the economics become more favourable. A further source of uncertainty, is how much biodiesel the EU will decide to import in order to meet its biofuel consumption targets.
- In the rest of the world, for populous countries like China and India, food security is higher on the agenda than producing fuel from food. For other countries, like Argentina and Canada, biofuels is significant, but the size of the potential biofuel market is much smaller.

- Finally, we can measure the impact of biofuels on fertilizers.

Measuring the biofuels effect on fertilizers

• Factors to consider:

- Impact overall: change in world fertilizer consumption as a result of crop production related to biofuel

- Change in fertilizer consumption at country/region level in biofuel producing/consuming countries

- Changes in other countries/regions affected indirectly – increased fertilizer use as a result of shifting crop patterns, supply gaps, higher crop prices

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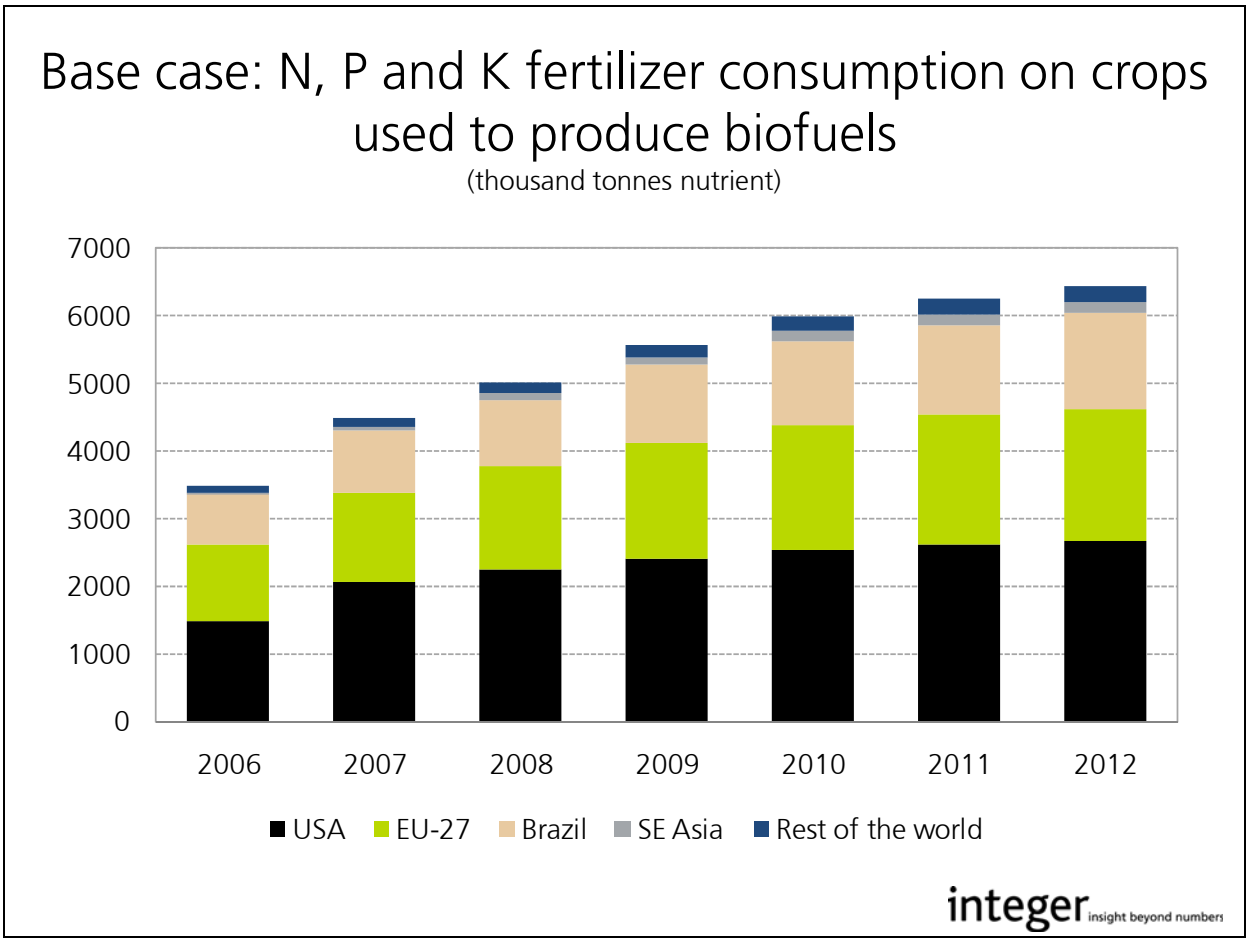
- There are several methods of measuring the impact of biofuels.
- Firstly at a global level
- Secondly, what is the impact on fertilizer demand of changing crop patterns, increased intensification, or expansion of land on country or region fertilizer consumption
- Finally, is there any indirect or knock on impact on fertilizer consumption in other countries which are not producing biofuels.



- This chart summarizes our base case forecast of fertilizer consumption related to biofuels, in total for all nutrients.
- We can see that biofuels already accounts for around 3.5 million tonnes of fertilizers in nutrient terms, and considerably more in product tonnes.
- By 2012, the total rises to 6.2 million tonnes.
    - The US accounts for around 42% of the total in 2012, and the EU a further 31%.
    - In percentage terms the NPK ratio in 2012 is around 50/20/30 where nitrogen is 50%, phosphate 20% and potash 30%.

The relative impact of biofuels growth

- Assuming non-biofuel fertilizer demand increases by a straight line 2.5% per year to 2012:
  - Increase in nitrogen demand for biofuels 7% of total increase (biofuels + non-biofuels)
  - Increase in phosphate demand for biofuels 8% of total increase
  - Increase in potash demand for biofuels 15% of total increase

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- In order to equate this growth in biofuel related fertilizer consumption to the whole market, we run a crude analysis.
- We assume that fertilizer demand for N, P and K each grow from their current level by 2.5% p.a. compound each year and compare this growth with the biofuel related growth. On this basis:
  - Nitrogen would make up 7% of the overall increase in demand – fertilizer growth, plus the biofuel demand growth.
    - In 2012 biofuels would account for 3% of total nitrogen fertilizer consumption.
  - Biofuel related phosphates demand would make up 8% of the increase, and 3% of total demand
  - Potash would account for 6% of the total and 15% of the growth.

What is happening at a country/region level

- Growth in nitrogen in US for corn, at the expense of soybeans (low N)
- In the EU:
  - Switch to rapeseed in Europe, biggest increase in nitrogen
  - Expansion of area – reduction of set aside
- Growth in sugar cane in Brazil, some expansion of soyabeans for diesel, more so to compensate for lower US production

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- We can also consider what is happening at a country/region level.
  - In the US there is a significant increase in N, P and K demand, because corn acreage is expected to replace less fertilizer intensive soyabean acreage.
  - In the EU, the main impact is an increase in land use due to reduced set-aside. But also, rapeseed is likely to replace some crops like sugar beet, which increases nitrogen intensity, but reduces P and K intensity.
  - In Brazil, the main direct impact is an increase in sugar production, which uses significant quantities of N and K. Brazil is also likely to expand soyabeans area, albeit as an indirect consequence of biofuels (reduced soyabean area in the US), which is P and K intensive.

Knock-on effect on other countries/regions

- EU/US area is constrained such that productivity increases are insufficient to supply new biofuels market demand
- Impact of biofuels on crop markets:
  - Lower US corn availability for export
  - Lower US soyabeans availability
  - Lower EU cereals crop availability
- Reflected in higher cereal/oilseed prices
- Positive impact on countries with potential for intensification (dormant crop yields, immature fertilizer use)
- And potential for land expansion – Brazil!

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- We note the following likely knock on effects:
  - The US and EU will be unable to meet the new demand for biofuels by yield alone.
  - As a result, other countries will be indirectly affected.
  - The main impacts will be higher prices for cereals and soyabeans as cereal availability from the US and EU declines and soyabeans availability declines.
  - Other countries with either land expansion or yield improvement potential stand to benefit, such as Brazil. This will result in higher fertilizer consumption in these countries, not directly related to biofuels.
  - Other countries like Russia, Ukraine and Central European countries have obvious potential to improve crop yield as their current yields are lower than neighbouring or comparable countries.
    - Increasing fertilizer applications will play an important part in improving yields.

Summary and conclusions

Summary and conclusions

- The relationship between land and energy is now strongly established
    - Technological lock in, sunk investments, political commitments
    - Winners – land owners, farmers, input suppliers
    - Losers – crop consumers, tax payers?
- Biofuels and renewable energy are high on the political agenda, even though 1G economics are questionable

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Summary and conclusions

- Biofuels will continue to exert significant positive influence on the fertilizer industry:
  - Across all nutrients,
  - In biofuel producing/consuming countries
  - In countries with intensification/expansion potential for filling crop supply gaps
- But, key point to watch
  - Longer term growth rate subject to swings in energy and crop prices

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