Chapter 2
Developments in International Liquid Biofuel Trade

Patrick Lamers, Frank Rosillo-Calle, Luc Pelkmans, and Carlo Hamelinck

Abstract This chapter describes the past developments, current status, and trends in global liquid biofuel production and trade. Apart from providing quantitative overviews, it also elaborates why markets developed as they did. By 2011, close to 2,500 PJ of liquid biofuels were produced globally; over two-third of which were fuel ethanol and the remaining biodiesel. The feedstock base is exclusively regionally specific oil, sugar, or starch crops. Global trade in biodiesel has been and will in the foreseeable future be primarily driven towards the European Union, where renewable energy policies stimulate the consumption of sustainable transport fuels – although the EU biofuels market growth is slowing down. Fuel ethanol is largely produced and consumed in the Americas, with the USA and Brazil dominating global production, trade and deployment. International trade is both supply and demand driven. National support policies increased the domestic market value of biofuels and shaped demand side developments. Trade flows emerged where such policies were not aligned with respective trade measures. Import duties had the strongest effect on trade volumes while trade routes were influenced by tariff preferences. Most trade regimes appear to have been designed and adapted unilaterally along national interests causing market disruptions, trade inefficiencies and disputes.

P. Lamers (✉)
Copernicus Institute, Utrecht University, Utrecht, The Netherlands
e-mail: p.lamers@uu.nl; pa.lamers@gmail.com

F. Rosillo-Calle
Imperial College, London, UK
e-mail: f.rosillo-calle@imperial.ac.uk

L. Pelkmans
VITO, Mol, Belgium
e-mail: luc.pelkmans@vito.be

C. Hamelinck
ECOFYS, Utrecht, The Netherlands
e-mail: c.hamelinck@ecofys.com

M. Junginger et al. (eds.), *International Bioenergy Trade: History, status & outlook on securing sustainable bioenergy supply, demand and markets*, Lecture Notes in Energy 17,
DOI 10.1007/978-94-007-6982-3_2,

2.1 Introduction, Objective, and Methodology

Few markets have seen a similar internationalization trend and turbulences due to policy regulations and changes over the past decade in the bioenergy field as liquid biofuels.[1] We have seen an exponential growth in global production and trade; with volumes being strongly linked to national policies (Lamers et al. 2011). Changes in these policy frameworks though have also shown how vulnerable markets and trade patterns still are. Biofuel markets are inherently linked to other sectors, agriculture in particular, and face significant market disturbances some of which have led to various inefficiencies in the past.

The main objective of this chapter is to describe the past developments and the current status of global biofuel production and trade. Apart from providing quantitative overviews, it also elaborates why markets developed as they did and provide a methodological assessment and understanding of the numerous influencing factors. The chapter closes with possible scenarios for the near future based on past experience.

The basis of the production data is derived from industry sources (e.g. ePURE, UNICA) and double-checked with government statistics (e.g. USDA, Eurostat) and other literature (e.g. REN21). Trade data was collected via international statistics (e.g. USDA GAIN, UN COMTRADE) but contains uncertainties linked to trade codes as no harmonized system (HS) classifications beyond digit-6-level apply to biofuels. Countries can define their own codes and definitions, e.g. minimum blend volumes. Specific trade data quantifications therefore depended on previous IEA T40 work (Walter et al. 2007; Rosillo-Calle et al. 2009) and scientific literature (Walter et al. 2008; Lamers et al. 2011), which provided anecdotal data and methodologies to account for energy related trade only.

Trade flows of fuel ethanol are hard to statistically distinguish from trade in denatured, non-denatured, and mixed ethanol blends as no HS classification by end-use exists. We follow the methodology by Lamers et al. 2011, after which the fuel ethanol imports of country A (e.g. Nigeria) from B (e.g. Brazil) in any given year are derived by: (1) taking the total ethanol imports by Nigeria (e.g. 10 PJ), (2) defining the relative share per import country (e.g. 5 PJ from Brazil i.e. 50 %), (3) subtracting the local Nigerian fuel ethanol production (2 PJ) from the local fuel ethanol consumption (8 PJ) and thus defining the net import demand for fuel ethanol (6 PJ). Hence, of all imported ethanol, 6 PJ will be for fuel. Assuming that ethanol is imported and stored independent of end-use, we can say that 50 % of the imported fuel ethanol stems from Brazil, i.e. 3 PJ.

2.2 Developments in Liquid Biofuel Production

While global liquid production has been relatively constant across the 1990s, it has seen an exponential growth over the past decade (Fig. 2.1). 50 % of all biofuels were produced in North America (largely the USA) by 2011. Fuel ethanol is the leading

[1] In the context of this chapter, we refer to liquid biofuels merely as biofuels.

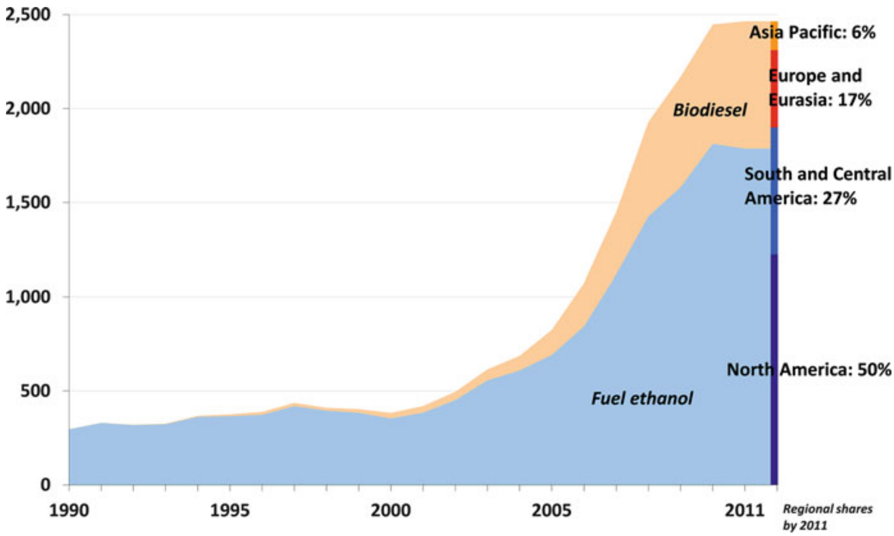

Fig. 2.1 Global liquid biofuel production [in PJ] (Data: Lamers et al. 2011; BP 2012)

biofuel at about 72.5 % of world production by 2011. It is almost exclusively produced across the Americas, with little production in Europe and Asia. World biodiesel production has been centred within the European Union (EU) and Asia, whereas recent production increases predominated in South America.

2.2.1 Biodiesel Related Vegetable Oil Production

The top vegetable oil markets are food (>80 %) and industrial applications (including biodiesel). Since biodiesel production did not really pick up significantly prior to 2008, the main driver for the vast expansion of vegetable oil production since the late 1990s (Fig. 2.2), palm and soya oil in particular, can be attributed exclusively to the growing demand for oils and high value protein in the food sector; particularly in emerging countries such as China and India caused by, among other things, population growth, improved standards of living and changing diets (Rosillo-Calle et al. 2009).

Biodiesel feedstock depends on the geographic region. Biodiesel in the US, Argentina, and Brazil, is almost exclusively soya oil methyl-ester (SME), whereas Indonesian and Malaysian biodiesel is palm oil methyl-ester (PME). In the EU it is traditionally rapeseed oil methyl-ester (RME) although shares of PME and SME have increased since 2005. Until a few years ago, the use of palm and soya oil in EU biodiesel was limited by technical requirements to the final product. Now, less strict technical requirements as well as the production of drop-in biodiesel (by hydrotreating vegetable oil) allow for even larger fractions of non-rapeseed oil. Expansion trends

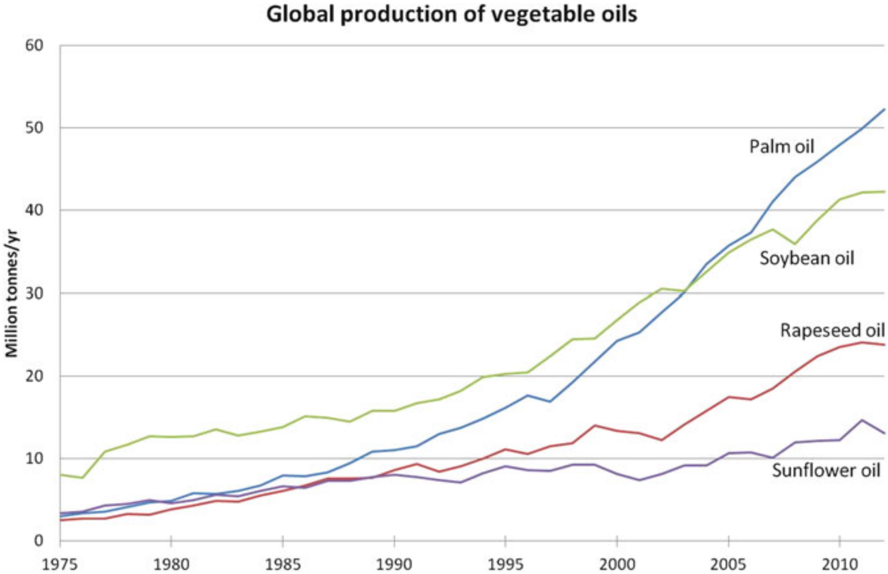

Fig. 2.2 World vegetable oil production (all end-use) [in Mtonnes] (Data: USDA 2012b)

of rapeseed oil production post 2003 show a strong link to the introduction of support policies for biodiesel in Europe. Biodiesel production increases in other world regions were much more recent and also linked to aforementioned feedstock, i.e. palm oil in Asia and soya oil in South America.

In recent years, we have observed important new actors and trends on the supply and demand side. China is rapidly emerging as the world leading importer of vegetable oils. Indonesia, Malaysia and Argentina dominate the export market of vegetable oil, representing approximately 75 %. Brazil has become one of the world's largest exporters of soybeans,[2] next to the USA. Also Argentina, whose share in this market has been continuously growing, is rapidly becoming one of the world's top exporters of soya oil.

The vegetable oil market is bound for major changes, and will face substantial challenges and opportunities. Improving living standards in emerging economies, population growth together with changing diets and the expansion of biodiesel, are new trends that will have a major impact in the future development of this sector.

2.2.2 *Biodiesel Production*

Biodiesel has been utilized as a substitute for mineral diesel since the early twentieth century, though in small quantities. Significant production increases only came after the European introduction of indicative biofuel targets in 2003 via the

[2] Soybeans are traded for animal feed (soybean meal) and soybean oil.

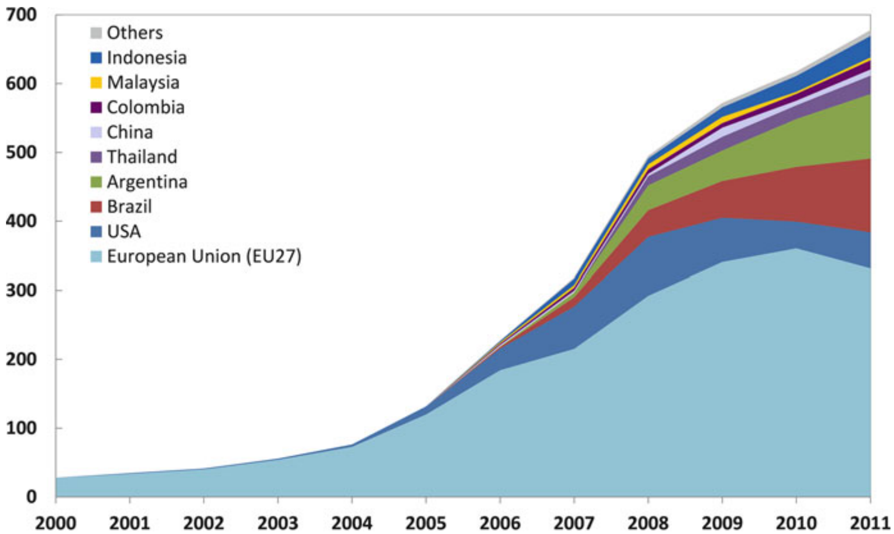

Fig. 2.3 World biodiesel production by country [in PJ] (Data: Lamers et al. 2011; BP 2012; Eurobserver 2012; Licht 2012; Lamers 2012)

EU-directive on the promotion of the use of biofuels or other renewable fuels for transport (2003/30/EC); triggering initiatives on EU Member State level to promote biofuels via tax exemptions or as a blend component in fossil fuels (more information in the Policy Sect. 2.5 of this chapter).

The EU, with its core production centres in Germany and France (followed by Spain, Italy, and Poland), has dominated biodiesel production globally over the past decade (Fig. 2.3). In recent years, this dominance has been challenged by increased generation in other world regions; though much of it can be linked to exports to the EU (more information in the Trade Sect. 2.3 of this chapter). An exception to this is Brazil whose production is merely consumed nationally. European biodiesel production is assumed to stabilize or even decline in the coming years, whereas further growth is expected in South America (Brazil, Argentina and Colombia) and Asia.

2.2.3 Fuel Ethanol Production

Close to 90 % of world fuel ethanol is produced in the US and Brazil which cover around two-thirds and one-third of this share respectively (Fig. 2.4). Overall volumes have increased over the past decade, but varied significantly with harvest qualities: the 2009 floods in the mid-west USA have reduced corn harvests and slowed ethanol production growth, the low sugarcane harvest around the world (and resulting high world sugar prices) dropped Brazilian fuel ethanol output in 2011. The export of Brazilian surplus ethanol was almost zero in the past 3 years.

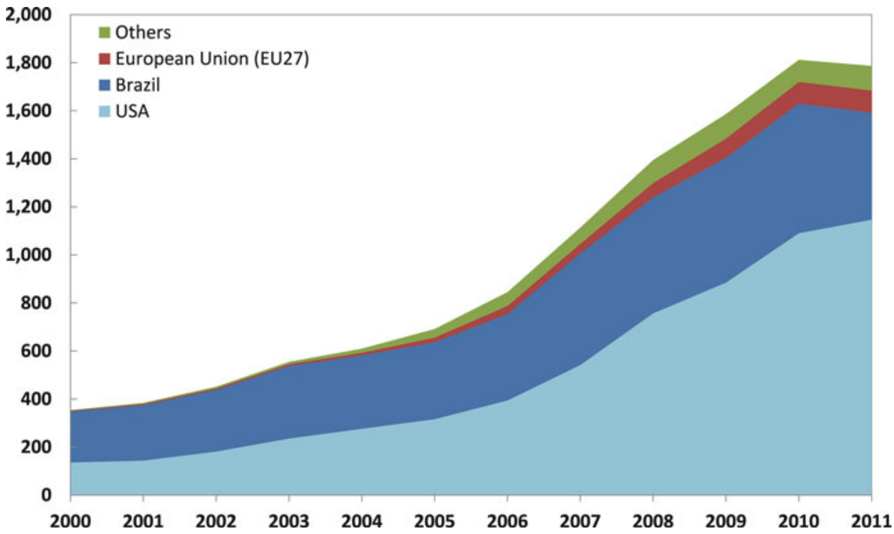

Fig. 2.4 Global fuel ethanol production [in PJ] (Data: Lamers et al. 2011; BP 2012; Eurobserver 2012; Licht 2012)

Significant production in other world regions is mostly concentrated in the EU where production has risen to 4.4 Billion Litres (93 PJ) in 2011 (Eurobserver 2012); representing 5 % of global production. China currently produces around 2 Billion Litres (Licht 2012).

2.2.3.1 Emerging Markets in Africa

Africa, with vast areas of idle land, an underdeveloped agricultural sector, cheap labour and favourable import conditions to the EU has an enormous potential in bioenergy feedstock production. Especially in sub-Saharan Africa, there have been many biofuel initiatives in the past 5 years. In reality, most of these initiatives failed or remained small-scale. Today the African biofuel production is still practically non-existent, let alone biofuel export to the rest of the world. Table 2.1 below shows the total production of biodiesel and ethanol in Africa in 2010. In Malawi, biofuels have been promoted since the 1980s, in Zimbabwe the production of biofuels is promoted since 2004. The large ethanol production in Sudan results from one existing 100,000 ha sugar cane plantation in Kenana which aims to export fuel ethanol to the EU market. Total African biofuel production combined is so far smaller than the average output of one European facility. There are only a handful of serious large-scale new projects that focus on producing for the EU market (e.g. in Sierra Leone and Tanzania).

Nevertheless, there are sincere concerns about socio-economic impacts of large-scale biofuel feedstock production in Africa, most importantly land-use rights and the loss of access to land and water resources. As impacts are partially related to the

Table 2.1 Biofuel production in Africa in 2010 [in ktonnes] (EIA 2012)

	Biodiesel	Ethanol
Sudan		22.8
Malawi		9.1
Zimbabwe	5.2	0.9
Ethiopia		4.6
South Africa	1.6	
Mozambique	1.0	
Tanzania	0.5	
Rwanda	0.5	
Total	**8.8**	**37.4**

establishment of plantations, the currently still small production is a poor indicator. Several biofuel projects developed over the past 5 years indeed include aspects of land grabbing; though as analysis shows (e.g. Ecofys 2012), not at the scale that has often been suggested.

Governments of several African countries, such as Tanzania and Mozambique have noted the importance of guiding the biofuels development towards benefits for their countries. Mozambique adopted a biofuels strategy in 2009, to reduce the country's dependence on oil imports and to strengthen agricultural development and food security. In Tanzania, a holistic biofuels policy framework is under development, covering not just the production and deployment of biofuels, but also requesting that the domestic market will be fulfilled before biofuels are exported, and putting much focus on socio-economic aspects.

2.2.3.2 Emerging Markets in Asia

India is currently the world's second largest producer of sugarcane (after Brazil), mainly used for sugar production to satisfy its huge domestic market. The Government's National Policy on Biofuels, adopted in 2009, proposes a target of 20 % blending of biodiesel and bioethanol by 2017. India's biofuel strategy continues to focus on the use of non-food resources; namely sugar molasses for production of ethanol and non-edible oils for the production of biodiesel. The target is to blend 5 % ethanol to petrol. It has however not been achieved due to the short supply of sugar molasses in 2008–2010 harvest seasons and the overall low sugarcane crop production. Ethanol is a major feedstock in the chemical industry in India. Unlike China, India does not seem to have any clear policy on import/exports. Currently, India has 330 distilleries producing around 4 billion litres of rectified spirit (alcohol) annually. About half of those distilleries have the capacity to produce 1.8 billion litres of conventional ethanol per year, sufficient to meet the 5 % blending mandate (USDA 2010b).

China is the world's third largest producer of sugarcane ethanol, although cassava, wheat and maize are also used. Ethanol production almost tripled in the last 10 years, reaching over 2 billion liters by 2010 (Licht 2012). The current use of biofuels in China is part of a strategy to decrease oil imports, foster agricultural and social development, and promote environmental sustainability. Currently the situation is delicate due to a combination of poor harvests and food price hikes causing concern regarding potential ethanol production expansion in the country. China is currently a net-importer of ethanol; a situation which would be fostered should the government decide to expand the use of ethanol fuel.

2.3 Developments in International Trade 2005–2011

2.3.1 Biodiesel

Global net biodiesel trade has grown from practically zero in 2005 to almost 2,500 ktonnes by 2011. Trade almost exclusively targets blending and consumption within the EU; only a marginal fraction is traded elsewhere, e.g. EU exports to Norway. Today's key export nations include Argentina, Indonesia, and the US; although the past years have shown dramatic changes in trade routes and volumes due to support policy changes in the US and the introduction of EU trade measures. Malaysian exports and trade volumes have come to a halt by 2010; apparently linked to the absence of local policy support and strong competition from (supported) Indonesian biodiesel. Brazil, despite its large production, has so far remained a closed market; primarily due to remote plant locations and relatively high production prices in comparison to other exporters.

Figure 2.5 shows a timeline of biodiesel trade flows between 2008 and 2009, the key phase of the splash-and-dash era; and the current situation as by 2011. It highlights that early trade to the EU came primarily from and via the US. This was largely driven by the US volumetric excise tax credit (VETC) given to biodiesel blended with fossil fuel; established in 2004. As the VETC was not linked to domestic production or consumption, it could also be collected for imports/exports. This allowed and ultimately established a practice called 'splash-and-dash', under which biodiesel was shipped to the US from a third country (e.g. from Argentina) solely to claim the tax credit before it was re-exported[3] again. These re-exports exclusively went to the EU where the biodiesel would receive a second financial incentive through many Member State's support schemes (Lamers et al. 2011). Another term, 'B99 effect', was linked to the same phenomenon as the VETC definition of blending made it possible to receive the credit by adding <1 % of mineral oil resulting in trade of B99 biodiesel. By March 2009, the EU put anti-dumping and countervailing duties on US biodiesel imports in place. This dramatically reduced US trade volume, and clearly revealed their original origins, as biodiesel was again traded directly towards the EU, e.g. from Argentina, Malaysia, Indonesia (Fig. 2.5). The

[3] Re-exports are defined as exports of previously imported commodities.

introduction of trade measures quickly lead to increasing triangular trade, i.e. US produced biodiesel was shipped to the EU via Canada (in 2009) and more recently also India. Canada was ultimately included in the anti-dumping and countervailing duty regulation, whereas EU-investigations to include, e.g. Singapore, the prime hub for palm oil derived biodiesel, could not verify similar practices.

Obviously, import volumes differ between EU Member States in terms of EU-internal and international trade (see Lamers et al. 2011; Eurostat 2012, 2013 for details). Biodiesel supply in the Netherlands, the UK, Spain, Portugal, and Italy is covered to a large extent by EU-external imports whereas those are

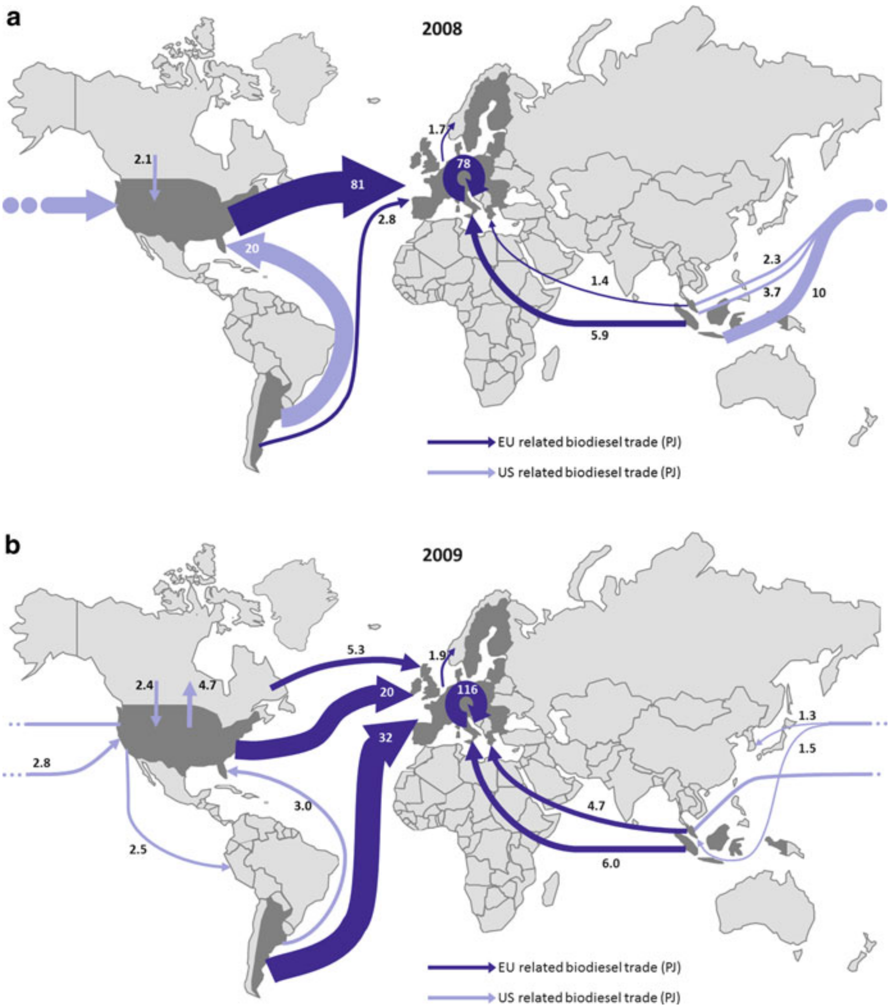

Fig. 2.5 Global biodiesel trade streams in (**a**) 2008, (**b**) 2009, (**c**) 2011 (min. 1 PJ)

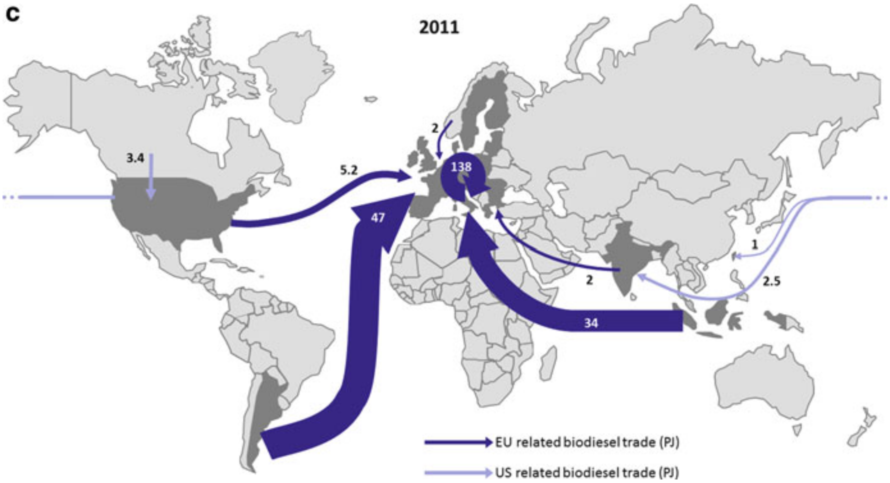

Fig. 2.5 (continued)

marginal, e.g. in the German biodiesel trade balance (Eurostat 2012, 2013; Lamers 2012). Existing oilseed crushing capacity and production cost reductions via feedstock imports (e.g. rapeseed from Poland) are assumed to have safeguarded German biodiesel production against competition from imports so far. The Netherlands, due to its large fossil fuel refining capacities in Rotterdam and Amsterdam, is the largest biofuel distribution place in Europe. In recent years, imports from Argentina at prices below production costs in Spain and Portugal have troubled the biodiesel industry in these markets. By summer 2012, the Spanish government issued a new biofuel policy aiming to ban imports of Argentinean and Indonesian biodiesel. Argentina has filed an official complaint at the WTO on this aspect.

In addition, the introduction of minimum sustainability criteria for liquid biofuels under the EU Renewable Energy Directive (RED) 2009/28/EC has led to complaints by key exporting nations, primarily Indonesia and Argentina; although so far without WTO sanctions or other trade implications. It is also reported that since mid-2011, certificates awarded to RED compliant rapeseed-methyl-ester (RME) were transferred to biodiesel volumes made from other, non-RED feedstock to enter the German market (AM 2012). While the practice has eventually been officially acknowledged by Germany’s finance ministry, the German industry association is currently trying to reverse this decision, claiming it undermines demand for European RME while artificially swelling consumption of RED-compliant biodiesel for summer grades made from imported palm and soya oil methyl-ester.

2.3.2 Fuel Ethanol

Fuel ethanol is traded together with ethanol for other end-uses. A differentiation is inherently difficult to make, especially since trade codes do not specify end-use (see Methodology Section for details). Limiting trade streams to markets where respective policies have stimulated fuel ethanol consumption in transport, the main routes are between the EU, US, and Brazil (Fig. 2.6).

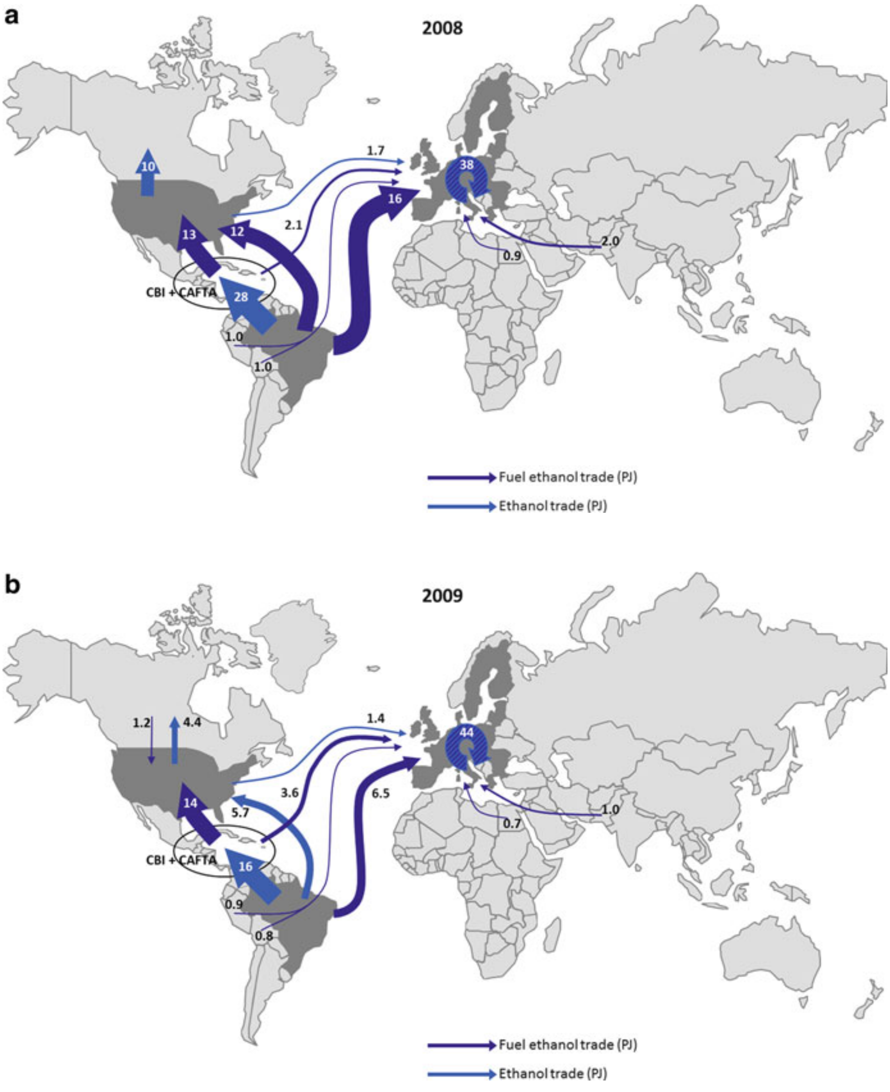

Fig. 2.6 Global (fuel) ethanol trade in (**a**) 2008, (**b**) 2009, (**c**) 2011 (minimum 0.5 PJ)

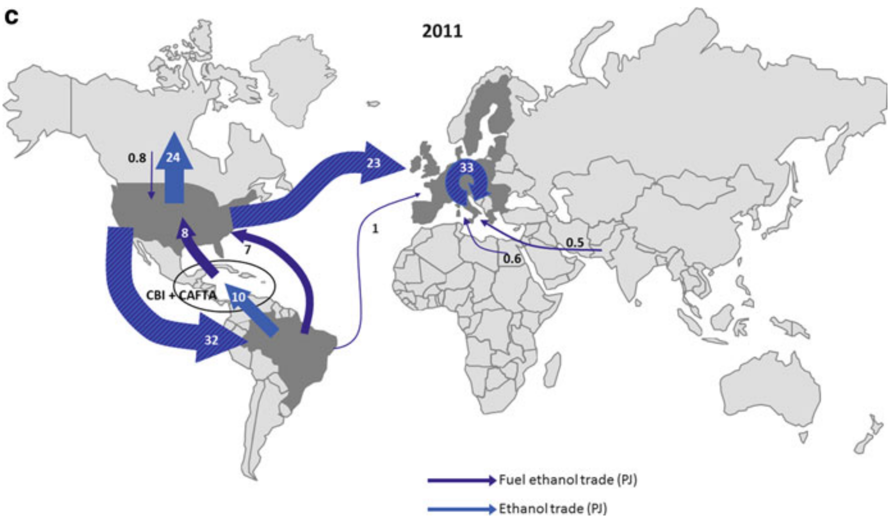

Fig. 2.6 (continued)

For most of the past decade, Brazil has been the leading export nation of (fuel) ethanol. Its highly efficient sugarcane production and conversion made it highly price competitive in many markets, including the US and the EU; where local markets were protected via respective tariff lines. In terms of export volume, Brazil was surpassed in 2011 by the US, whose strong production increase, high corn harvests, and a limited national market (E10) boosted export volumes; in particular to the EU. The US even exported ethanol to Brazil, whose low sugarcane harvest in 2011 made it a net importer.

Historically, with the introduction of the US Volumetric-Excise-Tax-Credit (VETC) in 2004, synthetic ethanol imports from Saudi Arabia were replaced by Brazilian imports as the previous were not eligible. The introduction of the VETC also increased the US market value for imported ethanol and it became economically viable to import Brazilian ethanol despite US import tariffs. In recent years, Brazilian ethanol has been increasingly transferred to the US via the Caribbean Basin (which enjoys tariff preferences). A marginal share has also originated in Canada (Fig. 2.6). US ethanol exports (all purposes) have mainly been destined for Canada and the EU (USDA 2012a). Previous exports to Mexico were diverted towards the EU after the introduction of the EU biofuels quota.

Most of the EU's ethanol imports originated in Brazil, while shares from nations subject to tariff preferences in particular Central and South America, increased until 2009. As of 2010, imports of US corn based ethanol increased sharply. In many EU Member States only undenatured, i.e. drinkable, ethanol is eligible to fulfill the respective nation's biofuel quotas (USDA 2009, 2010a). This effectively works as a trade protection against lower priced imports (mainly from the US and Brazil), as EU tariffs for undenatured ethanol (0.192 €/l) are almost twice as high as those of denatured ethanol (0.102 €/l).

It is not surprising that many efforts have been made to circumvent EU ethanol tariffs. Most have aimed at importing under alternative tariff lines (with lower duties); an effect triggered by the absence of specific fuel ethanol custom codifications. A relatively prominent example was the so-called ‘Swedish loophole’ under which, by mixing ethanol with 12.5–20 % gasoline just prior to customs declaration, ethanol for fuel blending was imported into Sweden as a chemical compound under the ‘other chemicals’ tariff line (CN 3824); eventually reducing the tariff to 6.5 % rather than 0.192 €/l (equaling about 63 %) for undenatured or 0.102 €/l (equaling roughly 39 %) for denatured ethanol (Kutas et al. 2007; Lamers et al. 2011). Eventually legislative changes were made in 2007 to close the loophole.

In 2010, concerns were again raised that a similar practice was applied by US ethanol exports to the EU (REA 2010). The EU ethanol industry became aware of it as US imports rose to over 1.1 billion liters (23 PJ) by the end of 2011 (Fig. 2.6); the majority of which entered the UK, Netherlands, and Finland classified as a chemical compound (CN 3824.90.97) in the form of E90 (ePURE 2012; Eurobserver 2012). A new EU customs regulation was eventually put in place in spring 2012 which forces imports of fuel blends containing at least 70 % ethanol to be classified as denatured ethanol.

2.4 Links Between Agricultural and Liquid Biofuel Markets

Current (“1st generation”) liquid biofuels almost totally rely on agricultural crops, with sugarcane, corn, wheat and sugar beet for bioethanol, and rapeseed oil, soybean oil and palm oil for biodiesel. This creates a strong link between the agricultural and liquid biofuel markets.

2.4.1 Evolution of Commodity Prices

Agricultural commodity prices have varied tremendously in the past years. The following Fig. 2.7 shows the price indices for cereals, oils and sugar between 2002 and 2012, on a monthly basis (source: FAO 2012).

For comparison, Fig. 2.8 below shows the evolution of crude oil prices, also on a monthly basis (source: EIA 2012).

It is quite remarkable that the indices of grains and vegetable oil have similar tendencies as crude oil prices, with a spike in 2008, a fall-back late 2008, early 2009, and a steady recovery by 2011. The sugar prices seem to have their own mechanisms, with high fluctuations over the past 6 years.

The spike of commodity prices in 2007–2008 has triggered several studies to investigate the reasons behind the increase in commodity prices. Biofuels were often blamed – particularly by NGOs and the media – to be the main reason for these increases, but looking back it is clear that several causes have played a role at the same time (Pelkmans et al. 2009):

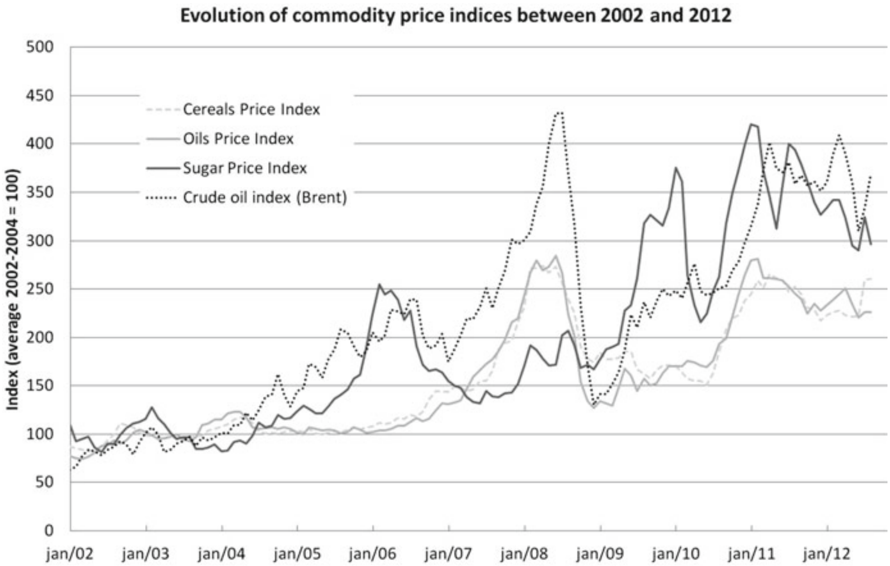

Fig. 2.7 Evolution of commodity price indices between 2002 and 2012 (Data: FAO 2012)

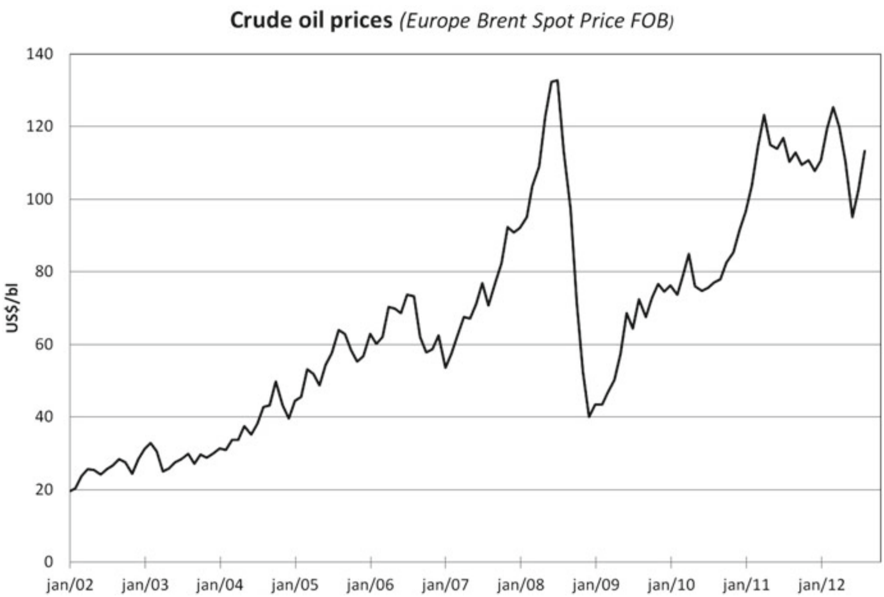

Fig. 2.8 Crude oil prices (Data: EIA 2012)

- increase of crude oil prices from 50 to over 140 $US per barrel,
- decrease of the value of the US dollar, as most markets are traded in this currency,
- speculation by the financial sector in agricultural commodities ("self-fulfilling prophecy" of increasing prices). This also seems to be linked to the low value of the US dollar,
- export restrictions in certain countries (e.g. Russia) as a response to expected global shortages,
- growing economies in Asia, with increasing demand for energy and food, and changing diets (e.g. increased consumption to meat),
- low crop yields in certain regions due to bad weather circumstances (e.g. Australia in 2006–2007 whose grain harvest fell by more than 50 %),
- decrease of stocks in the past years (not controlled by governments anymore, but by commercial parties who have interest in increasing prices),
- growing demand for biofuels.

In fact feedstock prices have increased much more than biofuel prices – for which the biofuel sector's financial margins were dropping – so the biofuel sector was apparently not the price-setter.

Since summer 2008, commodity prices have dropped again. Again different causes have played a role, but now in the other direction: the worldwide financial crisis has lowered energy demand and economic growth rates, reducing prices of crude oil and other commodities; crop production was again at normal level (while 2006 and 2007 were exceptionally bad, especially in Australia), so stocks could be filled again; speculative markets have reduced with the financial crisis. Meanwhile prices have recovered again, and are again in the same range as during the 2007–2008 period.

2.4.2 Biofuel Feedstocks in Relation to Production and Trade Volumes of Agricultural Commodities

We looked at typical cases where biofuel markets had possible interference with food and feed markets. Cases considered are corn, wheat and sugarcane for ethanol; rapeseed, palm oil and soybean oil for biodiesel.

2.4.2.1 Corn for Ethanol in the United States

The US accounts for roughly 30–40 % of global corn production, and is traditionally the world's dominant corn exporter (over 50 % of global corn trade), followed by Argentina and Brazil. While the US dominates world corn trade,

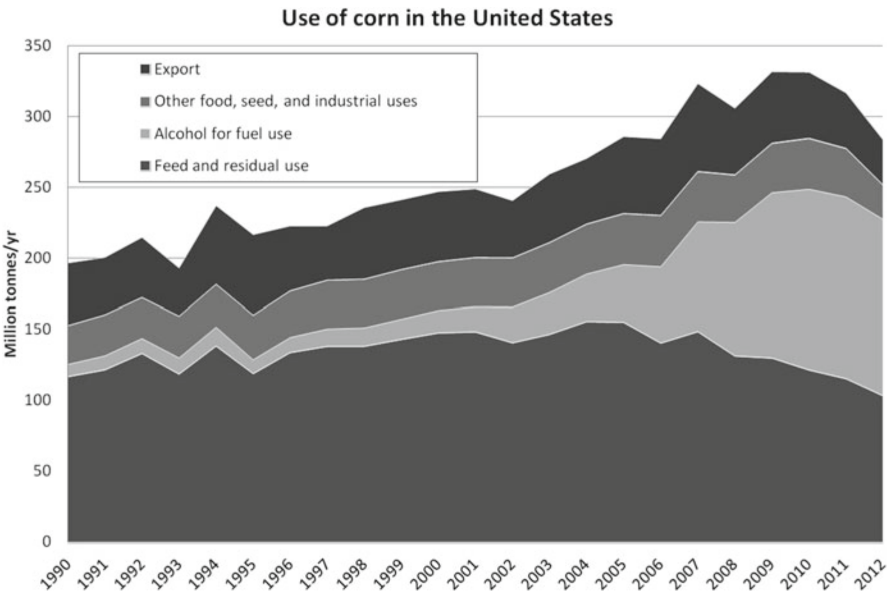

Fig. 2.9 Use of corn in the USA (Data: USDA 2012b)

exports only account for a relatively small portion of US corn use (about 15 %). This means that corn prices are largely determined by supply and demand relationships in the US market, and the rest of the world must adjust to prevailing US prices. As a result, the amount of corn grown in the US and the share of corn used for domestic consumption versus exports, has significant impact on international corn prices.

Corn use for ethanol represented 40 % of US corn production in 2011. The availability of US corn for feed, food and export markets has diminished since 2007 (Fig. 2.9). Mind that DDGS, the by-product of ethanol production, is now also available for the feed market.

2.4.2.2 Corn and Wheat for Ethanol in China and the EU

In the rest of the world (outside the US), the use of grains for ethanol is limited. EU ethanol is mostly based on wheat, but only few percent of European wheat production (2.6 % in 2008) is used for ethanol production. This has an insignificant effect on the availability of EU wheat for food, feed or export markets as most of the increase is covered by yield increases and extra land availability in East Europe.

In China 1.5 % of the local grain production (mainly corn) was used for ethanol in 2007–2008. While this number is also marginal, in response to high food prices, the government in 2007 suspended new ethanol projects based on edible grains, including any plans to expand existing plants.

2.4.2.3 Sugarcane for Ethanol in Brazil

The Brazilian sugarcane harvest is used almost evenly as feedstock for two major commodities: sugar and ethanol. Sugar and sugarcane prices have seen a high increase in 2010–2011, mostly due to reduced sugarcane harvests in Brazil related to bad weather conditions. As a consequence, more sugarcane was being refined into sugar and less into ethanol. This has led to a serious reduction of ethanol exports from Brazil. While Brazil has been exporting 15–20 %[4] of its ethanol production between 2005 and 2009, in 2010–2011 Brazil even became a net importer of ethanol from the US. Currently 8 million hectares of land is used to produce sugarcane. Brazil has no fundamental feedstock problems as it has ample space to extend its sugarcane production (outside rainforest regions). Nevertheless there are some concerns for this expansion. The expansion could happen on degraded grass planes, but there is a risk that fields in the natural Cerrado area or surroundings could be claimed for sugarcane expansion. Furthermore there could be indirect effect that extensive livestock breeding would shift to the north.

In the past, there seemed to be a price link between sugar, ethanol and petrol. However since 2006, sugar prices have behaved differently from the crude oil prices and the link is less pronounced. On the contrary, the price of sugar determines the price of ethanol on world markets.

2.4.2.4 Vegetable Oil for Biodiesel

In the past decades there has been a steady growth in the use of vegetable oils, with a prominent role for palm oil, soybean oil and rapeseed oil. While there is a growing role for biofuel use, consumption of vegetable oil for food keeps growing at a rate of 3–4 % per year. When comparing the growth of vegetable oil consumption from 2005 to 2011, vegetable oils for food have increased with more than 18 million tonnes, vegetable oils for biodiesel with around 13 million tonnes, while other industrial use is rather stable. Worldwide about 12 % of worldwide vegetable oil production is used to produce biodiesel (Fig. 2.10).

When looking at the division between palm oil, soybean oil and rapeseed oil, and its use in industrial vs. food use, the period around 2005 created a shift to more industrial applications, in all three cases. For soybean and rapeseed oil this can be directly linked to biodiesel production as their industrial application was rather modest before (Fig. 2.11).

2.4.2.5 Biodiesel in Europe

Europe has been the main player in biodiesel for a long time. Biodiesel was promoted in the 1990s, mostly to offer alternative outlets for agriculture, which was facing overproduction at that time. Traditionally, biodiesel in Europe is

---

[4] http://ageconsearch.umn.edu/bitstream/60895/2/Crago_CostofCornandSugarcaneEthanol_AAEA.pdf [January 2013].

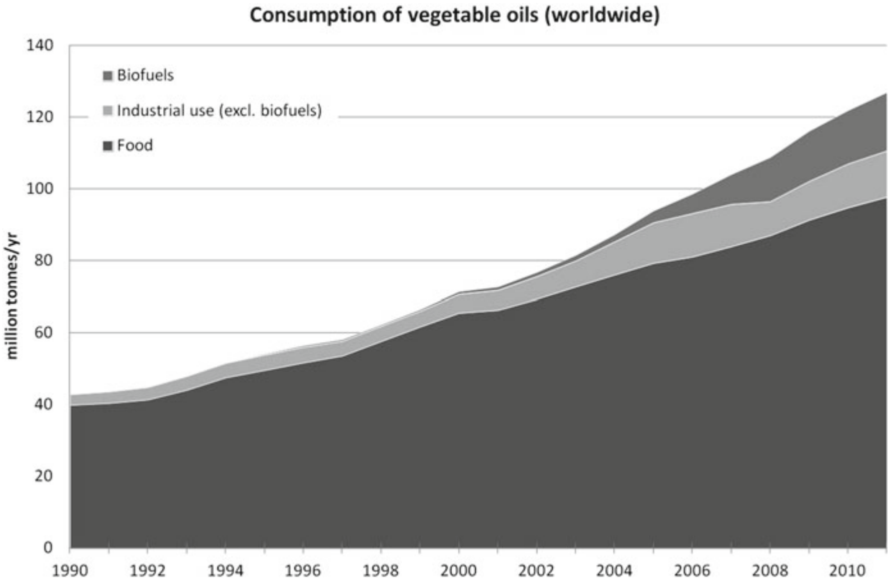

Fig. 2.10 Worldwide consumption of vegetable oils (Data: USDA 2012a, b, Licht 2012)

predominantly produced from domestically grown rapeseed. According to the Biofuels Baseline 2008 Study (Hamelinck et al. 2011), 66 % of biodiesel produced in the EU came from rapeseed, 13 % from soybean oil and 12 % from palm oil in 2008; the latter two are mainly imported. The reason for the dominant role of rapeseed oil is to be found in the tradition of producing rapeseed, its technical properties, and the high level of public support provided in EU countries. The increasing demand from the biodiesel sector has tightened the EU's vegetable oil balance, making feedstock imports for biodiesel production necessary. With the discussion on sustainability of biofuels, and increasing prices of biodiesel feedstocks, the biodiesel market in Europe has stagnated in the past years.

2.4.2.6 Biodiesel in North and South America

Only after 2005 other world regions started to introduce biodiesel in their diesel markets. Until 2005 industrial use of soybean oil was marginal, but from 2005 its use for biodiesel is growing, mainly in the USA and South America. Soybean oil use for food still grows at the same time. Biodiesel producers in South America benefit from a large exportable soya oil surplus (connected to soymeal production), part of it is also targeting export to the European market.

While soybeans are not the most efficient crop solely for the production of biodiesel, their common production and use for food products has led to soybean biodiesel becoming the primary source for biodiesel in the US.

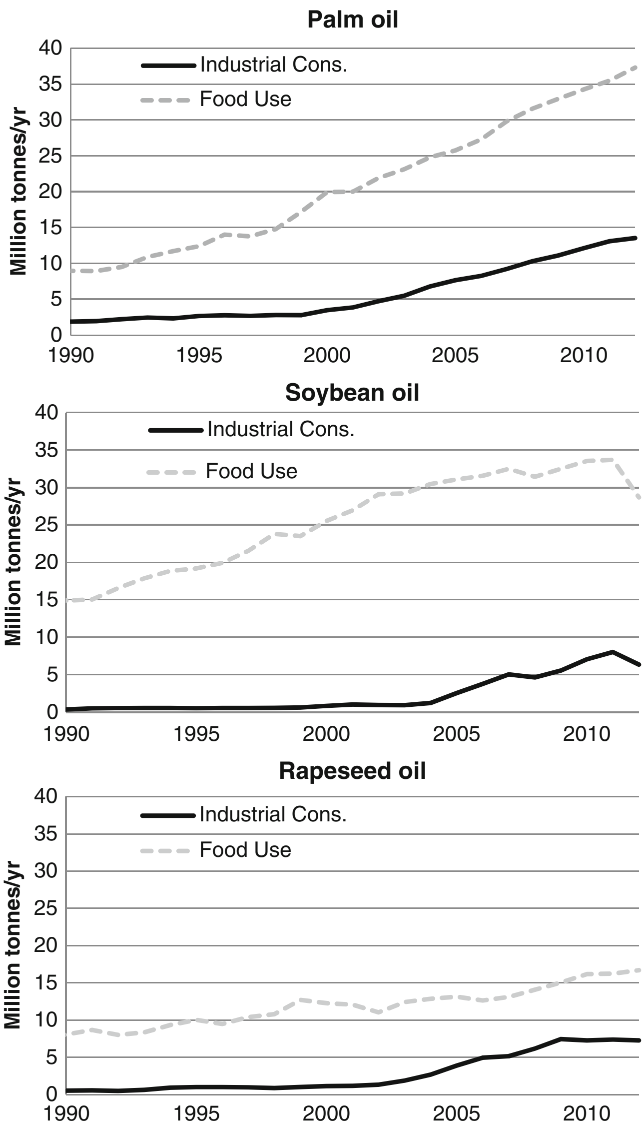

Fig. 2.11 Global consumption of palm, soybean, and rapeseed oil (Data: USDA 2012a, b)

2.4.2.7 Biodiesel in South-East Asia

Around 80–85 % of worldwide palm oil is produced in Indonesia and Malaysia, and most of it is exported to the rest of the world for food purposes. The global use of palm oil for food has actually doubled in the past 8 years. Since 2003 industrial applications are also growing; this may be partly related to biodiesel production, partly to other oleochemical applications (possibly replacing other vegetable oils for these applications). While the role of palm oil for biodiesel production has been limited so far, also from a quality point of view (low temperature behaviour), the instalment of HVO technology (hydrotreated vegetable oil), as e.g. the NExBTL facilities in Finland, Rotterdam and Singapore creates possibilities to enlarge the share of palm oil for biodiesel. On the other hand sustainability requirements for the European market might restrict the application of palm oil for biodiesel in the future.

The previous discussion shows that biofuels are indeed taking a substantial share of some agricultural commodities on global level, in particular for vegetable oils, corn and sugar. While there is already a link between commodity prices and energy prices, this may be reinforced through the applications of (1st generation) biofuels. Thus, if crude oil prices remain high, in the long run, biofuel feedstock prices will experience an upward pressure as well. If we continue to rely on biofuel feedstocks that are used directly to produce food or that are produced on land that would be producing food, then we will strengthen the direct link between crude oil prices and food prices. There may be some disagreement about the magnitude of the impact on food prices from biofuels, but there is no disagreement that there is an impact.

2.5 Policies and Other Influencing Factors

Biofuels were promoted by governments worldwide for a number of reasons, e.g. reducing greenhouse gas (GHG) emissions, enhancing the security of energy supply, but also revenue generation for local industry and job creation (the US VETC e.g. was part of the US Job Creation Act; USCH 2004).

Moreover, as past analysis shows, EU and US biofuel policies, originally strictly aimed at promoting domestic industry, had significant impacts on world biofuel production and trade patterns (Lamers et al. 2011). The main reasons for unintended impacts on international trade seem to be the mere focus on steering domestic production and consumption while neglecting international trade aspects (market factors) in policy making. A clear example on this is the design of the US VETC. The US fossil fuel consumption in passenger transport is mainly petrol, i.e. fuel ethanol is the key biofuel. To prevent ethanol imports from being blended under the VETC, i.e. to favour local production, the US levied an import tax on fuel ethanol. Such a tax though was not put on biodiesel imports allowing for trade effects as observed under the 'splash-and-dash practice'. Similar examples exist also for the European context, where the phase-out of tax exemptions and the introduction of blending mandates across several EU Member States led to import increases as blenders preferred cheaper imports (PME and SME) over domestically produced RME. The second EU example was the introduction of anti-dumping and countervailing measures against US produced biodiesel that neglected the option of triangular trade or the general possibility for traders to down-blend and import biodiesel below the EU customs mark of B20 concentrations (under CN 3824.90.91).

While biofuel support policies in the EU and the US have prompted an increased international production and trade in liquid biofuels, it is important to stress that actual trade flows evolved due to interconnected and additional market/economic factors. It was these market factors, i.e. price differences connected to support policies which directed international biofuel trade flows towards one region or the other. Generally, support policies (artificially) increased the domestic market value for biofuels. Wherever such policies/prices were not accompanied by trade measures restricting trade volumes or imposing import duties, international trade developed (Lamers et al. 2011). However, even under the presence of trade measures, trade was economically viable for export regions with large resource potential and relatively low production costs compared to the destination markets (i.e. Argentinean, Indonesia, or US exports to the EU).

International trade in liquid biofuels is both demand and supply driven. Production costs and trading options are also influenced by additional short- and long-term market factors such as varying international feedstock and crude oil prices. A complete overview of influencing factors is given in Table 2.2. To steer international biofuel trade, policy makers would need to influence the economics of trade (see Kaditi 2009 for a broader discussion).

2.6 Outlook and Conclusions

International biofuel markets have grown exponentially over the past decade. Today's markets, although still volatile and policy dependent, have become much more transparent. The biodiesel industry has become interwoven with the already existing global vegetable oil and oilseed market (players). Trade volumes have increased from practically zero 10 years ago, to 2.5 Mtonnes (94 PJ) of biodiesel by 2011. The EU has been and will most likely remain the key production and consumption region for biodiesel until 2020. Many countries have followed suit and implemented national blending targets for biodiesel, thus stimulating domestic production and consumption. Partly, their production has been targeted for export to the EU. Such trade is expected to grow in the future. Economic margins under existing EU policy schemes (predominantly blending mandates) will remain low and comparative cost advantages will have to be used; causing a growth in production capacity in strategic locations offering diverse and cheap(er) feedstock and other input factors (e.g. labour) (Lamers 2012).

Fuel ethanol dominates global biofuel markets in terms of volumes. The primary policy schemes responsible for its growth over the past decade were tax incentives and blending mandates. Given the latter, consumption has been highest in markets with a petrol focused transport fuel matrix. The global industry has grown beyond its role model, sugarcane based Brazilian ethanol, to become dominated by US corn based ethanol production.

Table 2.2 Policy and market factors (Lamers et al. 2011)

	Stimulating domestic biofuel market	Increasing international biofuel trade
Policy		
Production related measures/policies	Investment support for local production facilities, RD&D, infrastructure projects, etc. Agricultural subsidies (e.g. EU CAP, US corn) Tax incentives in combination with import duties (e.g. VETC for fuel ethanol in US) Production mandates	Tax incentives without import duties (e.g. VETC for biodiesel in US) Differentiated export taxes (e.g. Argentina: reduced taxes for non-food products)
Consumption related measures/policies	Consumption mandates or incentives targeting domestically produced biofuels in combination with trade measures limiting biofuel imports (e.g. eligibility criteria under mandates such as undenatured ethanol in some EU MS)	Consumption mandates or incentives that do not discriminate the type or origin of the biofuel (e.g. blending mandates in the EU leading to a diversification of biodiesel feedstock)
Trade related measures/policies	Import duties/taxes Technical standards Sustainability criteria (if fulfilled by domestic production and sufficient, cost and GHG efficient biomass available; or criteria hard to fulfill by international imports)	Tariff preferences Varying tariff/duty levels stimulating alternative or triangular trade Sustainability criteria (if not sufficient, cost or GHG efficient biomass available in export destination and criteria fulfillment in exporting country is possible)
Market		
(Long-term) Market factors	Strong agricultural sector: existing infrastructure for feedstock production and processing including (strong) market players with respective know-how, networks, and associations (driving political support) Availability of cost efficient domestic feedstock Imbalanced transport fuel matrix guarantees a long-term market for investors and traders of respective biofuel substitute(s)	Agricultural export orientation Preferential climatic conditions (i.e. biomass potential) General lack of feedstock production potential in export destination (long-term) or adverse climatic conditions affecting volumes and/or prices of domestic feedstock (short-term)

(continued)

Table 2.2 (continued)

	Stimulating domestic biofuel market	Increasing international biofuel trade
Short-term market factors in regards to the EU and US	Decrease in crude oil prices significantly reduces production costs of grain and oilseed derived biofuels	Increase in crude oil price enhances the cost competitiveness of efficiently produced biofuels (esp. sugarcane derived fuel ethanol from Brazil)

CAP Common agricultural policy (EU), *MS* Member State (EU), *RD&D* Research, development and demonstration, *VETC* Volumetric excise tax credit (US)

The future of the biofuel sector will be strongly influenced by sustainability standards/requirements, focusing on land-use (conversion), conservation of highly biodiverse areas and areas with high natural carbon stock, and minimum greenhouse gas (GHG) emission reductions (see Chap. 10 of this book for more details).

References

AM. (2012). *Producers seek mass balance clampdown*. London: Argus Media.

BP. (2012). *Statistical review of world energy*. Available at: http://www.bp.com/sectionbodycopy.do?categoryId=7500&contentId=7068481

Ecofys. (2012). *Progress in renewable energy and biofuels sustainability*. Utrecht: Ecofys. Available at: http://www.ecofys.com/en/publication/progress-in-renewable-energy-and-biofuels-sustainability/

EIA. (2012). *Monthly energy review*. Washington, DC: US Energy Information Administration (EIA).

ePURE. (2012). *Rob Vierhout: Secretary-general of ePURE*. Brussels: European Renewable Ethanol.

Eurobserver. (2012). *Biofuels barometer – Various issues*. Observ'er, IJS, ECN, Eclarean, EC BREC. Available at: http://www.eurobserv-er.org

EUROSTAT. (2012). *Data explorer – nrg_1073a*. Available at: http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home

EUROSTAT. (2013). *Data explorer – EU27 trade since 1995 by CN8*. Available at: http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home

FAO. (2012). *FAO trade and markets*. Rome: Food and Agriculture Organization (FAO) of the United Nations. Available at: http://www.fao.org/economic/est/en/. Accessed Sept 2012.

Hamelinck, C., Koper, M., Berndes, G., Englund, O., Diaz-Chavez, R., Kunen, E., & Walden, D. (2011). *Biofuels baseline 2008*. Available at: http://ec.europa.eu/energy/renewables/studies/doc/biofuels/2011_biofuels_baseline_2008.pdf. Accessed 5 Feb 2012.

Kaditi, E. (2009). Bio-energy policies in a global context. *Journal of Cleaner Production, 17*, S4–S8.

Kutas, G., Lindberg, C., & Steenblik, R. (2007). *Government support for ethanol and biodiesel in the European Union*. Geneva: Global Subsidies Initiative of the International Institute for Sustainable Development. Available at: http://www.iisd.org/gsi/sites/default/files/subsidies_to_biofuels_in_the_eu_final.pdf

Lamers, P. (2012). *International biodiesel markets – development in production and trade*. Berlin: Union zur Förderung von Oel- und Proteinpflanzen (UFOP)/Ecofys. Available at: http://www.ufop.de/downloads/EV_Ecofys-UFOP_en_2012.pdf. Accessed Feb 2012.

Lamers, P., Hamelinck, C., Junginger, M., & Faaij, A. (2011). International bioenergy trade – A review of past developments in the liquid biofuels market. *Renewable and Sustainable Energy Reviews, 15*, 2655–2676.

Licht FO. (2012). Various issues. In *World ethanol & biofuels report*. Kent/Ratzeburg: Informa UK Ltd. Available at: http://www.agra-net.com/portal2/showservice.jsp?servicename=as072

Pelkmans, L., Kessels, K., & Bole, T. (2009). *Induced market disturbances related to biofuels*. Available at: http://www.elobio.eu/fileadmin/elobio/user/docs/Report_ELOBIO_subtask_2_3v6.pdf. Accessed Sept 2012.

REA. (2010). *Renewable transport fuels group meeting*. UK Renewable Energy Association. Available at: http://www.r-e-a.net/member/renewable-transport-fuels

Rosillo-Calle, F., Walter, A., & Pelkmans, L. (2009). *A global review of vegetable oils, with respect to biodiesel* (IEA bioenergy task 40). Available at: http://www.bioenergytrade.org/downloads/vegeTable 2.oilstudyfinaljune18.pdf

USCH. (2004). American jobs creation act. In *PL 108–357 (H.R. 4520)*. Washington, DC: US Congress House.

USDA. (2009). *EU27 – Biofuels annual*. The Hague: US Department of Agriculture, Foreign Agricultural Service. Available at: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/General%20Report_The%20Hague_Netherlands-Germany%20EU-27_6-15-2009.pdf

USDA. (2010a). *EU27 – Biofuels annual*. The Hague: US Department of Agriculture, Foreign Agricultural Service. Available at: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_The%20Hague_EU-27_6-11-2010.pdf

USDA. (2010b). *India – Biofuels annual*. Delhi: US Department of Agriculture, Foreign Agricultural Service. Available at: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_New%20Delhi_India_6-20-2012.pdf. Accessed July 2012.

USDA. (2012a). *Global Agricultural Trade System (GATS)*. Washington, DC: US Department of Agriculture, Foreign Agricultural Service.

USDA. (2012b). *Production, Supply, and Distribution (PSD) online*. Washington, DC: US Department of Agriculture, Foreign Agricultural Service.

Walter, A., Rosillo-Calle, F., Dolzan, P., Piacente, E., & da Cunha, K. (2007). *Market evaluation: Fuel ethanol* (IEA bioenergy task 40). Available at: http://www.bioenergytrade.org/downloads/finalreportethanolmarkets.pdf

Walter, A., Rosillo-Calle, F., Dolzan, P., Piacente, E., & da Cunha, K. (2008). Perspectives on fuel ethanol consumption and trade. *Biomass and Bioenergy, 32*, 730–748.

Springer

http://www.springer.com/978-94-007-6982-3

International Bioenergy Trade
History, status & outlook on securing sustainable bioenergy supply, demand and markets
Junginger, M.; Goh, C.S.; Faaij, A. (Eds.)
2014, VI, 233 p. 56 illus., 36 illus. in color.,
ISBN: 978-94-007-6982-3