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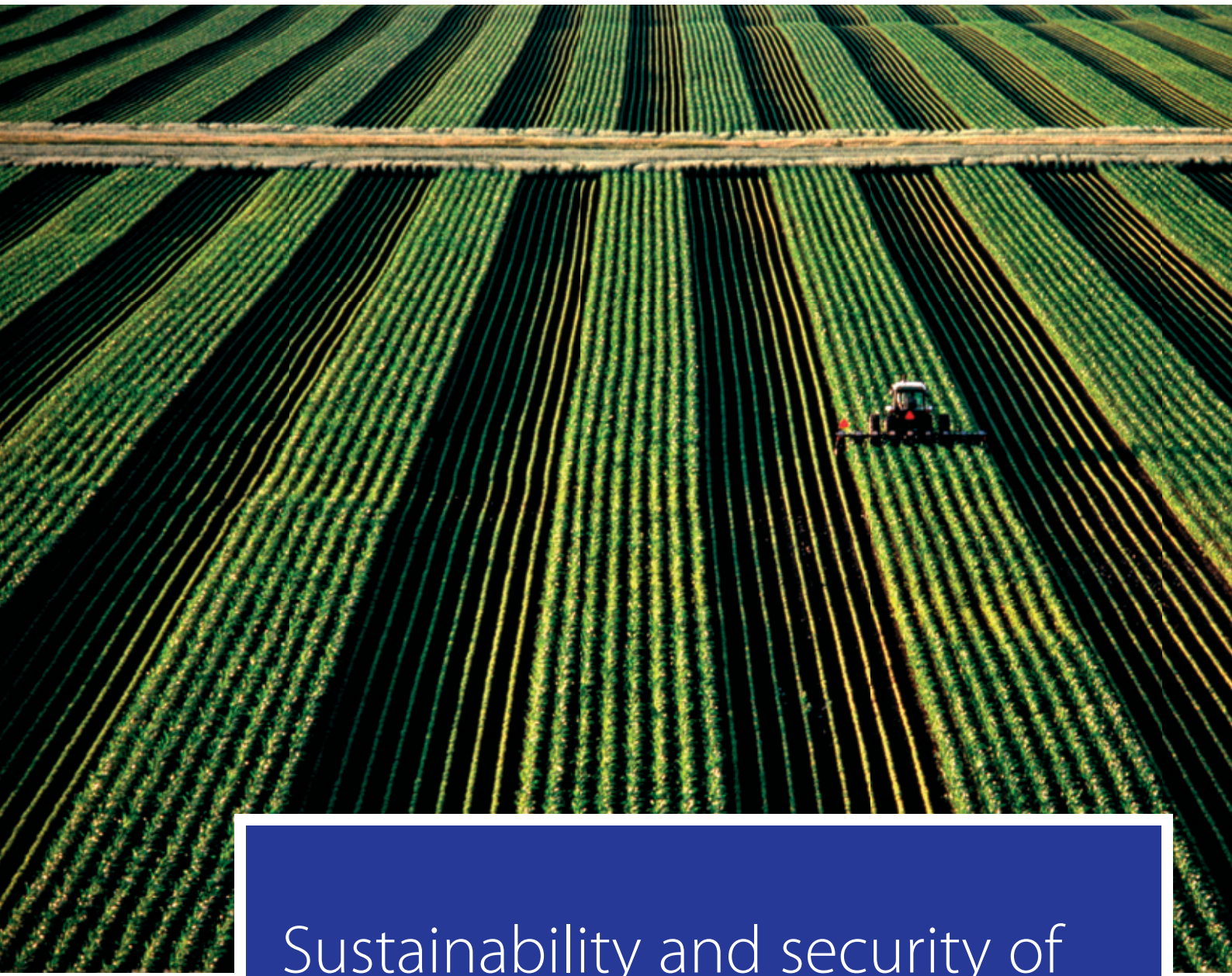

Sustainability and security of the global food supply chain

Rabobank Group

Content

Preface

The years 2007-2008 were a remarkable period in recent history. The world witnessed a severe global financial crisis followed by the deepest economic recession of the last seventy years and a global food crisis which posed major threats to global food security. One of the universal impacts of the crises was that many more people were pushed into hunger and undernourishment, while the food world focused its attention on the sustainability of long-term global food security.
As with the financial crisis, many studies have been conducted to determine how the global food crisis could happen and how we can prevent it from being repeated. After all, food is one of the basic human needs and vital for a stable development of the global economy. Conclusions of these surveys include that agricultural production must expand substantially in order to provide food for a growing world population that will be wealthier and will live largely in urban areas. Furthermore, the imbalance between the demand for and supply of food is expected to grow, and in order to bridge the food gap local and global food supply chains must be integrated and operate more efficiently. One of the major challenges of the global food supply system is to align international trade rules and conditions and food standards, as well as reduce differences in environmental and social issues between countries and regions in order to achieve sustainability of the global food supply system and safeguard food security.
The good news of the long-term global food supply studies for the businesses is that there will be billions of new consumers and customers and that new market opportunities will emerge. These, in turn, will create new business opportunities for companies. The bad news is that agricultural production systems are not resource-efficient nor productive or responsive to the consumptive lifestyle that is commensurate with wealth in today's affluent food market. The main reason is that the stock of natural resources such as land, water, nutrients, energy and genes is shrinking and the use must be limited substantially in order to reduce environmental impact and preserve the Earth's productive capacity. Moreover, as of one of the major contributors to climate change, the agricultural sector must reduce greenhouse gas emissions substantially.

The overall conclusion is that the current global food system is on an unsustainable track, which poses a threat to long-term global food security. The global food system needs to be transformed in order to secure the long-term food supply. The pathway is variable, might be radical and coordinated action at many levels by multiple partners is needed in order to establish the conditions required to move global growth of food supply towards a more sustainable track. This will require major changes in terms of regulations, markets, consumer preferences, pricing and measurement of profit and loss. Large investments are also needed to improve current agriculture, including down- and upstream activities, and secure the sustainability of the global food supply.
Driven by these fundamental changes, new markets and business opportunities will emerge.

All these trends will impact prevailing business growth strategies and models. To survive in tomorrow's world, companies are forced to develop a long-term vision and an action plan. Businesses will continue to play a leading role in linking food demand and supply while at the same time tackling sustainability issues throughout the global food supply chain.

A growing number of companies are already taking first steps. Rabobank is eager to play its role and is committed to these types of developments in the global food supply chain. After all, we are the world's leading specialised food & agribusiness bank and the largest Allfinanz bank in the Netherlands rooted in Dutch agriculture. We therefore feel comfortable participating in discussions and finding integrated supply chain solutions for companies with a view to achieving global food security in a sustainable way. This Rabobank study highlights the key challenges involved in striving for food security and sustainability of the global food supply system and encourages the business world to become involved in the discussion.

I hope this report will assist stakeholders of the global food supply chains in finding solutions to contribute to a more sustainable global food supply system. I am convinced that by working together we add value to the business of our customers throughout the global food chain, which goes far beyond traditional banking services. We have developed Food & Agribusiness Principles that serve as the guidelines for our business operations and our dealings with customers and other stakeholders. Our aim in growing our business and profitability is to ensure the sustainable development of wealth for all. After all, the nature of a co-operative bank such as Rabobank is focused on people, while planet and profit are essential to a sustainable future.

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Chairman of the Executive Board of Rabobank Nederland

Abstract

There is sufficient global potential to produce the food required to feed the world population that will total more than nine billion in 2050. Global food shortages do not consequently constitute the foremost challenge for future food security. The main challenge instead involves working incrementally towards enhancing sustainability of the global food system. Achieving sustainability within the long global supply chain that encompasses different countries and numerous participants and stakeholders is, however, not an easy task. Moreover, there are numerous uncertainties and constraints and a number of sustainability drivers that must be tackled on time in order to produce the 70 percent more food that will be needed to feed the world in 2050. The local food supply chains of individual countries should be integrated into a smoothly operating global food supply system. The global food trade needs price signals and rules in order to maintain stable global agricultural markets based on the future trends and outlook. Huge investments in current agriculture, especially in developing countries, are needed in order to meet the future needs for food.

It is furthermore crucial to promote more sustainable consumer behaviour. All these developments will affect the current economic and business models and even the long-term strategies and market/competitive positions of companies in the global food supply chain. The valuation of scarce natural resources will, sooner or later, be factored gradually into costing and companies' balance sheets. The key message of this view is that new business opportunities will arise as part of the build-up to the internalisation of the new costs of resources. Private sector companies in the global food supply chain should take the lead in exploring new opportunities and implementing them into their business models as a means of transforming supply chains into value chains. They should furthermore be at the vanguard of anticipating tomorrow's global food & agribusinesses in order to meet the long-term food security challenge. Governments in turn have a role to play in creating and facilitating the conditions for sustainable food systems and supervising the results. They are, after all, ultimately responsible for the food security of their countries.

1 Introduction

The food crisis of 2007-2008 has placed long-term food security[1] back on the global political agenda. Many interesting surveys have been published about the key question of 'How to feed the world in 2050?' (FAO expert meetings). Most studies conclude that it is possible to feed the world in 2050, but can this be done in a sustainable[2] way and what are the conditions? This Rabobank study highlights the key challenges involved in striving for food security and sustainability of the global food supply system[3] (chapters 2, 3 and 4). Chapter 5 outlines the conclusions of the analysis, and puts up for discussion key questions regarding the role and position of the business world.

The study will provide a succinct overview of a complex topic that affects all of us either directly or indirectly and has the clear objective of making the topic more accessible and comprehensible for a broader business public that has a professional interest in the global food supply chain.

A wide range of external reference studies and articles were consulted in order to compile this study on the global food supply chain. Internal existing sources[4] of the international food & agribusiness and knowledge on good social and environmental practices at Rabobank were also utilised extensively for this study. These are valuable resources considering that Rabobank's roots as a co-operative bank have been firmly grounded in the Dutch agricultural sector for well over a century. Today, Rabobank is a leading international Food & Agribusinessbank with operations in more than 46 countries. It specialises in providing wholesale banking services to food and agribusiness industries worldwide and retail banking services in selected countries.[5] Based on this position in the food and agribusiness world this Rabobank study can be seen as a wake-up call to all stakeholders of the global food supply chain for achieving a sustainable food supply system in order to meet the global food security challenge now and in future.

1 Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO).

2 According to the Brundtland definition, sustainable development represents a pattern of resource use that aims to meet human needs while preserving the environment so that these needs can be met not only in the present, but also for future generations.

3 The global food system is defined as a system that links national and local food systems from around the world in a clearly defined manner, for example through trade, information sharing, technology or some other observable way.

4 Partly published on www.rabobank.com.

5 Box 3 at page 42 provides more information about Rabobank.

Background of the theme

Food commodity crisis

Following a prolonged period of growing and 'silent' global food markets, the food crisis of 2007-2008 shook up the sector and forced policymakers to review the drivers of agricultural commodity prices and the long-term demand and supply potentials of food worldwide. The major food crises in the post-World War II era, namely the crisis relating to:

1. The Korean War in the 1950s that affected only agriculture, and
2. the energy crisis of the 1970s that impacted inflation, energy and agriculture.

The food crisis of 2007-2008 involved, however, the full spectrum of commodities including energy, metals and food as well as all countries. The recent food security alert was strengthened by the outbreak of the global financial crisis after the bursting of the house price bubble in the U.S.A. This was followed by a deep economic downturn from the second half of 2008 and a slow recovery of the global economy.

Basic food commodity prices show a decline in the period from the early 1950s till about early 1990s. The trend lines since then have been steady, although there continue to be fluctuating patterns (Saris, A., 2009). Not only internationally traded food commodity prices for particularly oilseeds, cereals and dairy were spiky, the prices of crude oil, metals and fertiliser also increased manifold from 2003 to 2008.

Several drivers that affected the food crisis of 2007-2008 have been discussed and analysed by many authors and think tanks around the world.

They include:

1. Growing worldwide demand for basic food commodities due to fast and sustained economic and population growth in emerging economies, especially China and India.
2. Rising demand for cereals (maize in the U.S.A.), sugar cane (Brazil) and edible oil (in Europe) for biofuel production.
3. Rising energy prices and strategic geopolitical concerns about the strong dependence of the economy on the oligopolistic fossil energy market.
4. Adverse weather conditions and rising temperatures attributed to global warming/climate change.
5. A sharp decline in global food commodity stocks, exacerbated by bad harvests in many regions around the globe.
6. Slowing rates of increases in farm productivity and under-investments in agricultural production and infrastructure over the past decade.
7. Negative effects of the financial crisis and economic downturn on the macroeconomy and stability of commodity markets and prices.
8. Lack of investment in agriculture to improve productivity, especially in developing countries.

The food security challenge

Although most commodity prices have declined since the mid-2008 peak, they are still much higher than their 2000 levels and have become more volatile, and Rabobank expects that this will continue to be the case. The world population will grow by some 40 percent to more than 9 billion people in 2050 and they will also be far wealthier than today. Approximately 70 percent more food will have to be produced in order to feed the world in 2050 (FAO/OECD, 2010). Key questions are if this volume can be produced and how this must be produced in a sustainable way to ensure food security.

This is of particular concern, since the world is on an unsustainable track:

- World population growth will occur mainly in developing countries, especially in the less wealthy regions (chiefly in Africa).
- 70 percent of the world population will live in urban areas in 2050 (2010: some 50 percent).
- The world is running out of vital natural resources such as fertile land, clean water, nutrients and a number of non-replaceable raw materials/metals. The existing natural resources are also not equally distributed among countries.
- Environmental degradation (water and soil pollution, desertification and soil erosion) and decline of vital ecosystems (rainforest and marine life) are taking place.
- Rising greenhouse gas emissions, to which agriculture is one of the largest contributors, contribute to global warming[6] and extreme weather conditions, which have a huge impact on agricultural production.
- There are significant inefficiencies (yield gap and losses) in current agricultural production and transport and storage, particularly in developing countries.

- In today's world, some 15 percent (one billion people, FAO) of the world population still suffers from hunger and malnutrition[7] (apart from the pressing problem of overweight and obesity).

Requirements for increasing the production and distribution of food

It is important to note that the additional food required to feed the world in 2050 will not be produced and distributed automatically, due to the unequal distribution of natural resources and wealth between countries and regions. In addition, sustainable national agriculture policies and adequate local infrastructure, knowledge base and entrepreneurship are indispensable, while measures to reduce the huge post-harvest, transport and storage losses could contribute to higher availability of produced food.

Additional food production to meet the growing and changing food demand also does not mean that everyone on the planet will have access to food. Hunger and malnutrition will not be eradicated automatically. What's more, increasing production will be able to provide sufficient availability of basic food in the world, but it will not be able to ensure sufficient availability of all the foods needed to satisfy consumer demand owing to the different functions of food. Calculations (FAO) on food security are based on the basic function of food, namely to provide enough energy and nutrition for basic human bodily functions and physical activity: intake of energy per person or conversion in grain equivalent.

However, increasingly higher incomes will favour the consumption of more meat (animal protein) instead of the consumption of rice, grains and roots/tubers (carbohydrates). Dietary shifts instead of increasing physical food consumption will consequently be responsible not only for changing but also for higher claims on available natural resources. The very reason is that to produce animal protein a multiple quantity of plant material is needed. The ecological and water footprint of animal products is also much larger than that of plant materials.

Further growth of the international agricultural commodity trade

A continually growing international agricultural commodity trade will be a consequence of the increasing imbalance between food demand and supply among countries. Approximately one third of the world population lives in China and India; these countries have very scarce suitable land and clean water for growing additional food commodities. China, in particular, is expected to play a driving role on the demand side in the global food market, while on the supply side the importance of Brazil, in particular, will grow. The prospering economic growth and dynamism of emerging economies, particularly in China and India in the coming decades, will lead to new balances in the global economic and political landscape.

Securing a sustainable global food supply will require more than increased commodity trade although this certainly helps to mitigate demand-supply imbalance. In addition, huge investments are needed to improve productivity on current farm level and in new technologies/ system innovation in the supply chain.

To resume

A huge number of unsustainable conditions will, however, have to be overcome in order to boost food production worldwide to meet the challenge of future food security. While these issues are actually not very new for the food world, we can now all see the next roadblocks that lie ahead and which we are approaching.

6 Global warming is the increase in the average temperature of the Earth's near-surface air and oceans caused by increasing concentrations of greenhouse gasses in the atmosphere. Human activity such as the use of fossil energy and deforestation contribute to the rise of the concentration of greenhouse gasses in the atmosphere. Reports of the Intergovernmental Panel on Climate Change indicate that the global surface temperature is likely to rise by 1.1 to 6.4 Celsius during the 21st century.

7 The failure to of the economy to grow as rapidly as the rest of the developing world has left a terrible legacy of poverty and hunger. As a consequence, Sub-Saharan Africa is the only region in which poverty has increased in absolute and relative terms (AIDS prevalence rates are also high). It has made Africa more dependent on food imports and much more vulnerable than other regions to food price shocks.

2 The challenge of sustainable food security en route to 2050

The long-term increase in food demand is largely driven by an increasing population and economic growth. Based on UN projections, the world population is expected to grow by approximately 40 percent from the 2005/07 level to more than nine billion in 2050. While this represents a considerable slowdown in population growth compared to the last forty years – in which the world population has doubled – it nonetheless marks an increase of some 2.4 billion people on top of this already high number.

The majority of this growth will moreover take place in developing countries, while the populations of high-income countries will decrease. The world will also undergo rapid urbanisation in the decades ahead. Approximately 70 percent of the world population will live in urban areas by 2050, compared to the current level of roughly 50 percent. Average income is expected to grow in the coming decades. Income growth rates[8] are also forecast to be much higher in developing countries[9] than in developed countries, while emerging economies have the highest economic growth worldwide. As incomes rise, people will move from a grain-based to an animal protein diet and will become more concerned about the origin and quality of the products.

One of the key consequences of this differential in population and income growth rates in the world is that we could witness a substantial shift in the share of global food demand among countries and regions. This is one of the driving forces for a further increase in the imbalance of global food demand and supply.

One consequence of these developments in food demand and on the supply side is that sustainability of food production will increasingly become the focus of attention in terms of food security.

This chapter will discuss the projected long-term food demand and supply in greater detail.

Long-term projections for food production and demand presented in FAO studies[10] have been used as the primary source in order to gain a more general sense of the magnitude of the global food security challenge.

8 The global economy is expected to grow at an average rate of around 2.9 percent per annum between 2005 and 2050. This breaks down into 1.6 percent per annum for high-income countries and 5.2 percent per annum for developing countries (Mensbrugghe et al., 2009).

9 Populations in low and middle-income countries earning USD 4,000 to USD 17,000 per capita (purchasing power parity) are expected to rise from 400 million to 1.2 billion in the period 2005-2030 (World Bank, Global Economic Prospects, 2007).

10 Many studies have been conducted in light of 'How to Feed the World' (refer to references).

2.1 How much food will the world need in 2050?

This paragraph includes FAO projections of food consumption in 2050. However, there are a number of uncertainties which threaten these projections, such as dietary shift, biofuels and other non-food use of biomass, global warming, water scarcity and soil productive quality. These will be explained in more detail in this paragraph.

Food consumption levels in 2050

According to the long-term FAO projection (FAO, 2006), the global average daily caloric intake could rise by approximately 10 percent in comparison to 2003/2005 levels to 3,050 kcal per person per day in 2050. It was calculated that food consumption will increase on average by 1.9 percent per annum in the period (2005-2050).[11] Taking into account the expected population growth and changes in diet, world agricultural production would need to increase by some 70 percent (nearly doubling in developing countries). This would entail producing 110 percent more cereals, 135 percent more meat and 140 percent more soybeans in comparison to current production. Future growth in agricultural production is expected not to follow the path of the projected growth in the world population and dietary changes. Annual crop production growth will slow down from 2.2 percent per annum (1997-2007) to 1.3 percent per annum during the period (2005/07)-2030 and 0.8 percent per annum during the period 2030-2050. In developing countries, this figure will decrease from 2.9 to 1.5 and 0.9 percent per annum during these respective periods (Bruinsma, J., 2009).

It is also important to note that this long-term food projection overlooks both the additional demand for agricultural products to be used as feedstock in biofuel production and the possible impact of global warming on agriculture in the different regions of the world.

Higher income will impact agricultural production due to factors including dietary shift

Rising incomes, urbanisation and lifestyle changes are causing a shift in diet and eating habits. A growing number of consumers with middle and higher incomes in developing countries will increase both their consumption of meat and dairy products and of fruits, vegetables and processed and fast foods. As a result, rice consumption is expected to decline in favour of wheat, both directly in wheat-based bakery products and indirectly via meat consumption.

From a sustainability perspective, the greatest challenge will be the expected steep rise in the demand for animal proteins, including dairy, eggs and fish. A multiple[12] quantity of plant products is required to produce one quantity of animal product. This means that a substantial amount of scarce land, water[13] and fertiliser will be used to produce the animal products required to meet the forecast future animal protein demand.

Another effect of rising incomes involves increasing consumer concerns regarding food safety, the environment, health, animal welfare and fair trade. There will also be mounting concerns regarding the negative impact of a growing concentration of greenhouse gases in the atmosphere.

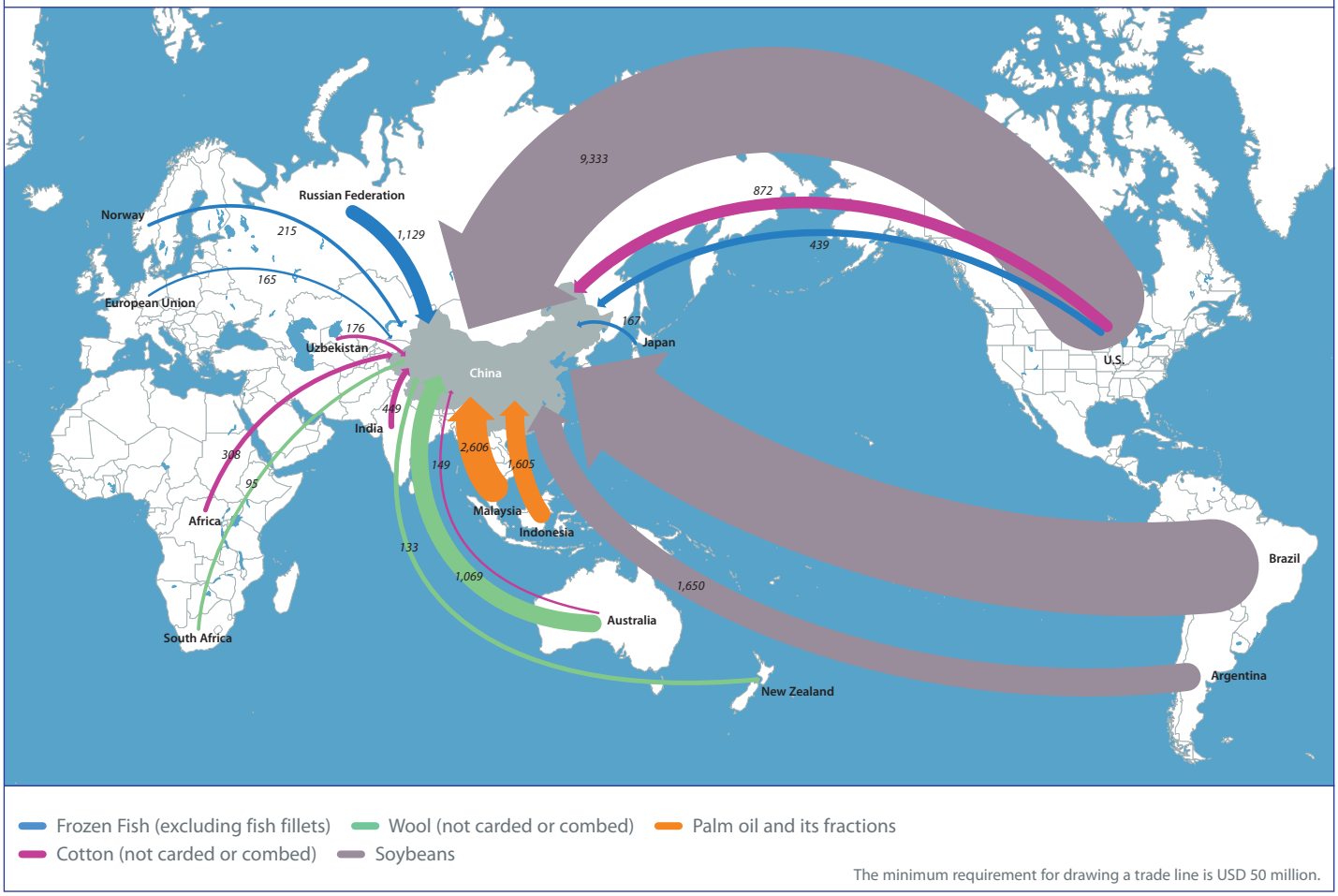
Finally, changing incomes and diets coupled with an unequal distribution of available arable land and water around the world will result in greater agricultural exports from regions that have abundant resources to those that have scarce supplies of these resources. Finally, an expansion of animal production and international trade will call for effective

11 With average per capita incomes rising by 2.2 percent between 2005 and 2050, an income elasticity of 0.5 would yield an increase in food demand of 1.1 percent and this amount added to the 0.8 percent increase in population equals a total increase of food demand of 1.9 percent per annum during this period (Mensbrugghe, D. van der, et al., 2009).

12 Based on a certain conversion factor, the production of 1 kg poultry meat requires 2-4 kg grain (1 kg pork requires 3.4-6 kg grain and 1 kg beef requires 7-10 kg grain), depending on the production system and country.

13 The water required to produce 1 kg of meat and other products, referred to as the 'water footprint', has been calculated by Hoekstra, A., (2010). A total of 3,900 litres of clean water are needed to produce 1 kg of poultry meat, 15,000 litres of water are required for 1 kg of beef and 3,400 litres for 1 kg of rice.

Chart 1 China's agricultural imports in 2008
in USD million



Source: Rabobank

veterinary measures to avoid the possible spread of diseases. China, for example, holds a dominant position among the developing countries and emerging economies on the food demand side due to its high economic growth and because it has the world's largest population. Per capita demand for meat in China[14] has been projected to increase by 60 percent (or 29 kg per capita) during the period 2000-2050, while demand for meat in developing countries as a whole is expected to grow by 20 percent (or 6 kg per capita) in the period 2000-2050 (IFPRI, 2009). The consumption of dairy (excluding butter) in the form of fresh milk, etc. in developing countries will also rise substantially by more than 70 percent (or 33 kg per capita) in the period 2000-2050 (FAO, 2006). Charts 1 and 2 illustrate the growing importance of China in the international food commodity trade.

Impact of biofuels and non-food use on food production

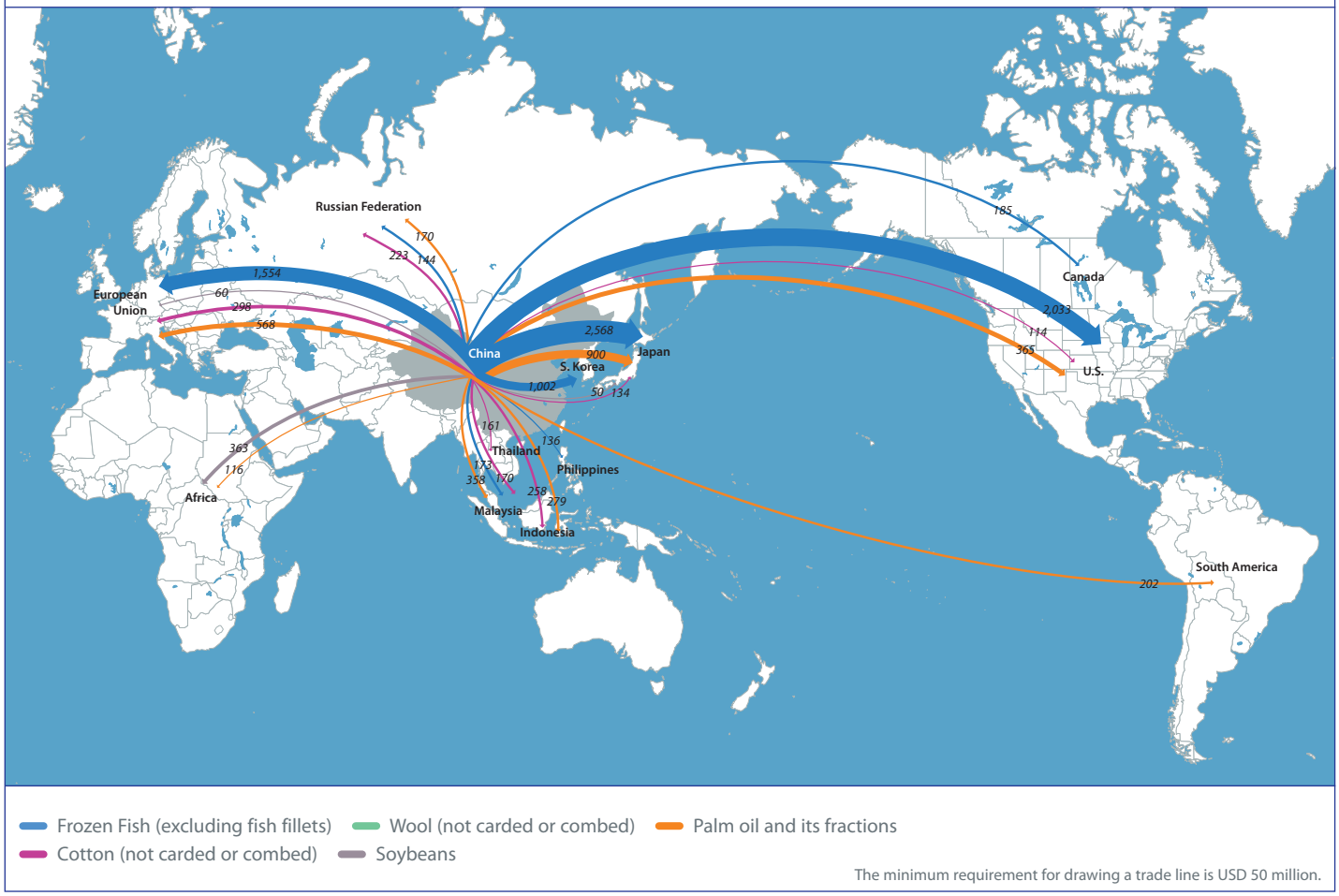
Biofuels[15] are a wide range of fuels which are in some way derived from biomass. The term covers solid biomass, liquid fuels and various biogases. Biomass (primarily soft commodities and sugar) is turned into biofuels, driven by factors such as oil price spikes, the need for increased energy security and concern over greenhouse gas emissions from fossil fuels. Biofuels are gaining increased public and scientific attention and offer opportunities for many parties, e.g. the smallholders. However, the main concern of stakeholders is the overall sustainability of the supply chain. This ranges from the production part (deforestation, land degradation, social issues, etc.) to the consumption part (biofuels should emit less greenhouse gases along the value chain than their fossil counterparts). Another possible impact is the effect of rising food prices on poor urban consumers in developing countries (access to food),

14 The projection of China's meat consumption presented in the FAO report entitled 'World agriculture: towards 2030/2050' was rejected due to uncertainties surrounding China's meat statistics. Meat consumption in developing countries excluding China and Brazil was projected to grow from 16 kg to 32 kg per capita per annum during the period.

15 There are different types of biofuels: Bioethanol is an alcohol produced by the fermentation of the sugar components of plant materials and is made mostly from sugar and starch crops. Ethanol in its pure form can be used as a fuel for vehicles, but it is usually used as a gasoline additive to increase octane and reduce harmful vehicle exhaust gas emissions. Bioethanol is widely used in the U.S.A. (maize) and in Brazil (sugar cane). Biodiesel is made from vegetable oils, animal fats or recycled greases. Biodiesel in its pure form is used as a fuel for vehicles, but it is mostly used as a diesel additive to reduce levels of particulates, carbon monoxide and hydrocarbons from diesel-powered vehicles. It is used mainly in Europe.

Chart 2 China's agricultural exports in 2008

in USD million



Source: Rabobank

because of the use of food for fuel on a large scale. Biofuels are mainly used due to political incentives to reduce the consumption of fossil fuels and the emission of greenhouse gases and other pollutants. For this purpose, the use of biofuels in the transport sector is favoured.

Brazil, the U.S.A., the EU, China, India, Indonesia and Malaysia have adopted policy measures and targets for large-scale biofuel use including ones for exports in the decades ahead. The annual growth rate of biofuel in the medium term has been forecast at between 10 and 14 percent (IAE), mainly depending on the political will; economics play a minor role. Other drivers are the price of crude oil, prices of agricultural commodities, etc. Long-term projections assume that biofuels use will grow in the coming decades, although its total share in global consumption of all transport fuels will amount to less than five percent.[16]

Notwithstanding this overall positive outlook for bioenergy, the question remains how much biofuel can be produced in a sustainable way. Although various studies have demonstrated that, in the short run, food security is not likely to be threatened as a result of growing energy crops, it should be noted that there are huge differences in environmental impacts and greenhouse gas (GHG) emissions between the various bioenergy supply chains. Some crops (e.g. maize in the U.S.A.) require far more acreage and inputs per litre of biofuel than others (e.g. sugar cane in Brazil).

Overseeing the food-for-fuel debate, some reticence is justified in the case of traditional food crops such as cereals. In addition, there are indirect impacts leading to land use change which may have adverse local (food, biodiversity) and even global (climate) effects. On the other hand the rural poor might benefit from growing biofuel production,

16 The share of biofuels in the global consumption of all transport fuels has been projected to be 3.5 percent in 2020 and 4.2 percent in 2030 (International Energy Agency, 2010). These figures are 4.3 percent in 2020 and 5.5 percent in 2030 for developed countries and 2.7 percent and 3.0 percent, respectively, for developing countries. These percentages could, however, turn out to be much higher if specific countries are taken into account (Brazil, the U.S.A.).

but there is a risk that smallholders/subsistence farmers will lose their land to larger landowners who will set up more efficient production resources. However, while bioenergy is not the golden bullet of sustainable energy sources, it will play an important role in the long-term transition process as we move away from conventional energy towards a fully renewable energy mix also containing cleantech, renewable energy options and energy efficiency. This includes more efficient cars (e.g. GHG emission reduction), food & agri waste to energy (pellets for power plants), and 2nd generation technology that is able to convert cellulosic biomass such as trees, grasses and agricultural waste into biofuel and raw materials for large-scale non-food use, including the chemical and pharmaceutical industries, in a transition to a *bio-based economy*.
This is seen as a potential *new* market for agriculture/biomass production, especially when the origin of the current source of the raw materials has a fossil energy base.
It is very important to note that from the start the market for biofuels is consequently strongly *supported* by government subsidies, mandates and energy strategies. Economics play a minor role. So the question arises how long governments will keep supporting the use of biofuels.

Impact of global warming

The impact of global warming and climate change on food security can include greater fluctuation in food production in response to greater weather variability (including day and night temperatures, precipitation, lengths and dates of onset of growing seasons and rainfall) and extreme conditions in the short term (increasing harvest risk).
Long-term food production will be faced with rising earth temperatures and a higher concentration of CO_2 in the atmosphere. Higher earth temperatures affect thermal and hydrological regimes. Existing species and varieties of agricultural crops in traditional planting areas could be affected and there could also be increasing pressure from disease and plagues. Greater CO_2 concentration in the atmosphere has to some extent had a positive effect on existing plant growth/crop yield, but this advantage could be mitigated by other negative effects of global warming in the different regions of the world.

Studies on the long-term impact of global warming on crop suitability and the production potential of rain-fed cereals in current areas lead to the following overall conclusions (Fisher, G., 2009):

- There are a number of regions/crops in relation to which climate change poses a significant threat to food production and opportunities for other regions/crops.
- The global balance of food production potential for rain-fed cereal production of current cultivated land may slightly improve in the short-term; effective agronomic adaptation by farmers to a changing climate and the actual strength of the so-called CO_2 fertilisation effect on crop yields will be decisive factors in realising a positive global balance of food production potential.
- Beyond 2050, the negative impact of global warming will predominate and is expected to cause a rapid decrease in the crop production potential in most regions and the global aggregate.

The most important signal of scenario studies is that further global warming could, in the long term, result in irreparable damage to arable land, water and biodiversity resources and this could have serious consequences for the global food balance. In the short term, global warming could result in a higher frequency of extreme weather conditions that could seriously affect the food supply and human welfare, particularly with respect to vulnerable economies. Global warming is, after all, not an overnight event.
It occurs slowly enough in order to allow adequate responses (mitigation and adaptation measures) to the threats to achieving food security.

Impact of water scarcity and soil productive quality

Both clean fresh water and suitable arable land are indispensable for food production. Agriculture accounts for up to approximately 70 percent of the world's fresh water consumption. Figure 1 illustrates the water and land availability per capita. Water is severely scarce in an increasing number of regions in the world, such as the Middle East and North Africa, and East and South Asia. River basins and fossil water wells are drying up and groundwater levels are declining in many areas[17] of the world due to overconsumption and waste. Desertification continues to gain ground.

As water scarcity increases, competition for water between expanding households (due to expected growing urbanisation) and industry will continue to reduce the share of water available for agriculture. Agriculture/farming will consequently sooner or later enter the 'water market' and will be required to pay for the volume of water used, meaning that water will no longer be a free commodity. Smart water management based on irrigation systems will become vital in farming systems as it will provide a means for saving both scarce water and costs. The use of water for agricultural purposes is also free of charge or is subsidised or protected by the government. A real water price for producing food, which would represent a relatively new element of competition, could, in the long run, lead to a restructuring of the global food system. Countries/regions with rich rain-fed areas and to some extent river deltas are favourable for agricultural production.
Besides scarcity of water, rising cropping intensities could be factors responsible for increasing the risk of soil degradation[18] and thus threatening sustainability, in particular when not accompanied by land conservation measures and good agricultural practices. This includes the adequate and balanced use of fertiliser to compensate for the extraction of soil nutrients by crops. In this regard possible shortage of phosphate (potash) is expected, which will drive up fertiliser prices.

After all, a growing global food trade will create a further imbalance of minerals between countries and regions. Measures to mitigate mineral depletion (exporting countries) and accumulation (importing countries) are needed on a global scale.

2.2 How can food production be increased in order to meet the food demand in 2050?

From a more technical point of view, the three sources of growth in crop production are:
- Expansion of worldwide arable land.
- Yield increases.
- Increases in cropping intensity.

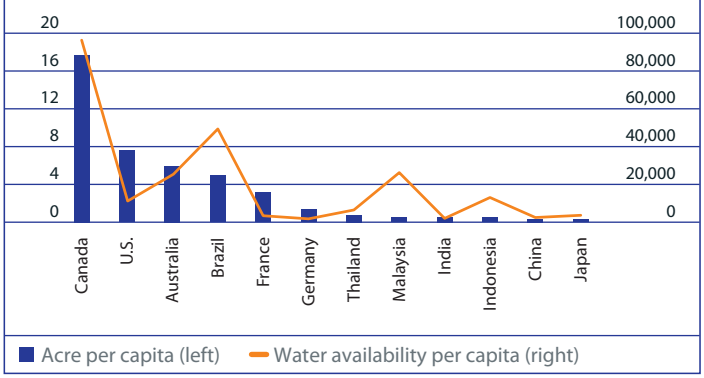
With regard to food security this results in the following three key questions:
- How much arable land is potentially available worldwide?
- How much can agricultural productivity be physically increased?
- How much food can be produced through intensification?

In this paragraph these key questions will be explained using the outcomes of comprehensive long-term expert studies.

17 Compared to global warming, water scarcity and abundance is a local issue. This means among others that water markets are local markets (the price of water will differ between regions).

18 There are growing concerns about the extent and rate of soil degradation in the world (two thirds of which is found in Asia and Africa) and its effect on agricultural productivity and the preservation of natural resources.

Figure 1 Water and agricultural land availability per capita in selected countries



Source: FAO, World Development Indicators & United Nations

1. How much arable land is potentially available worldwide?

Various studies[19] have been conducted over the decades examining how much land on earth is potentially suitable for agriculture. All of these studies provide insight into the potential production capacity for feeding the future world population based on different[20] standards.
The total land surface on earth amounts to approximately 13.4 billion hectares. Around 30 percent (4.2 billion hectares) is potentially suitable for agriculture and more than 1.5 billion hectares, or 12 percent of the world's land surface, is actually under cultivation, while 2.8 billion hectares are potentially available. The potential amount of available arable land is, however, much less than 2.8 billion hectares when natural constraints for agriculture and other claims on land are taken into account. It has been estimated that a net amount of approximately 1.5 billion hectares is available (Koning, N.B.J., et al., (2008) and Bruinsma, J., (2009))
The long-term studies suggest that there is as much potentially arable land available as the amount of land currently under cultivation. But one should bear in mind that a number of steps, including land reclamation, construction, farm infrastructure and investment capital, have to be taken before the available arable land is ready for production. In practice, the amount of arable land worldwide has grown by a net average of five million hectares per annum over the last two decades (FAOSTAT). This means that it could take a number of years before all the potential new arable land could be prepared for agricultural production.
According to the aforementioned study, the long-term projection of global arable land shows that annual growth will slow down dramatically from 0.30 percent in the period 1961-2005 to 0.10 percent in the period 2005-2050[21] due to agro-ecological, environmental and economical constraints and other claims on land. The projected average annual net increase of arable area[22], excluding forest land, in developing countries will be 2.75 million hectares per year over the projected period (120 million hectares over 44 years). The harvest area would increase by 17 percent (160 million hectares) due to cropping intensity. In contrast, the amount of arable land in industrial and transitional countries is expected to decline further in the coming decades from -0.15 percent per annum in the period 1961-2005 to -0.23 percent per annum in the period 2005-2050 (Bruinsma, J., 2009). The long-term forces determining these declines are sustained yields growth combined with continuing slowdown in the growth in of demand for the related agricultural products (this may change due to the impact of possible rapid growth in biofuels and demand for space for non-agricultural purposes).
It is extremely striking that the potentially available arable land is very unevenly distributed among regions and countries across the world. Two thirds of potentially suitable new arable land is located in developing countries and some 80 percent of this amount is found in Latin America and Sub-Saharan Africa. About half of this total is concentrated in just seven countries, namely Brazil, Argentina, Colombia, Bolivia, Democratic Republic of the Congo, Angola and Sudan.
Added to this potentially available arable land is the renewed attention for the 'Black Earth region'[23], which was once the granary of Europe and the former Soviet Union. In contrast, there is virtually no spare land available for agricultural expansion in South Asia and the Middle East and North Africa, which are regions with the highest population growth. This means that, even within the relatively land-abundant region[24], there is a considerable diversity of available arable land among countries, in terms of both quantity and quality.

19 Buringh, P., et al., (1975); Luyten, J.P., (1995); Fisher, G. et al., (2002); Koning, N.B.J., et al., (2008); Bruinsma, J., (2009).

20 Rainfall, water availability, soil condition, phosphorus availability, other claims on land, demand for non-food production including biofuels, global warming and crop yield (yield gap).

21 These figures are 0.67 percent and 0.27 percent per annum respectively for developing countries; 1.01 percent and 0.52 percent per annum for Latin America; and 0.80 percent and 0.55 percent per annum for Sub-Saharan Africa.

22 If all the additional arable land were to come from forest area, this would imply an annual deforestation of 0.14 percent, compared to 0.42 percent in the 1990s and 0.36 percent in the period 2000-2005 (FAO, 2006).

23 Black Earth: very fertile soil. The Black Earth region stretches from Southern Romania to Northeast Ukraine into Central Russia, and from Southern Russia into Siberia.

In conclusion, although there is potentially sufficient arable land to produce food to meet future food demand, the amount of land that is currently under cultivation and the imbalance in the global food supply and demand are set to increase further in the future.

2. How much can agricultural productivity be physically increased?

The 'Green Revolution', i.e. the adoption of modern varieties of food crops witnessed in the 1960s and 1970s was successively followed by a period of input intensification and improvements to technical inefficiency (agronomy), and this has contributed to strong yield growth for food crops. The yields of many crops have, however, slowed down in the past decade around the world (1.7 percent per annum in the period 1961-2007 compared to 1.3 percent per annum during the period 1997-2007). This pattern is expected to continue in the future and may nearly halve the historical annual growth rate of 1.7 percent per annum to 0.8 percent per annum (Bruinsma, J., 2009). Although the growth of the yields of major food crops is expected to slow down, it will remain an important source for additional agricultural production in future.

First of all, food crop yields are technically much lower than the theoretical maximum yield due to differences in practices related to the availability of water and fertiliser, suitable weather/climate conditions, pests and diseases. Part of this lower yield is unavoidable and is calculated at 20 percent of the theoretical yield. Another 20 percent of this yield has been calculated as unavoidable consumer food waste (largely due to lifestyle). The total unavoidable yield gap is calculated at 40 percent of the theoretical maximum yield. Taking this yield gap into account, 16 billion to 24 billion people could be fed in 2050 (Koning, N.B.J., et al., 2008). A scenario with a higher yield gap for developing regions and lower expansion of the assumed irrigated area has also been calculated in this study. This reveals that there is still room to produce food for 8 billion to 10 billion people. This confirms that, taking the constraints into account, enough food can be produced theoretically to meet future food demand of about 9 billion people.

Another possibility for increasing agricultural production is to close the yield gap between countries/regions. The variation in yields among countries/regions is very wide. For example, the world average yield of cereal is 3.2 tonnes per hectare (FAOSTAT). By comparison, the yield is 8.1 tonnes per hectare in the Netherlands and 6.5 tonnes per hectare in Western Europe and North America. This figure is only 2.9 tonnes per hectare in developing countries and 1.8 tonnes per hectare in the least developed countries. Yields of crops do not, however, only differ from country to country, but also within countries themselves and by farms and farm types. According to IIASA (Fisher, G., et al., 2009), the world average cereal yield per hectare could be improved by more than two thirds to 5.4 tonnes per hectare.

The outcomes of scenario studies suggest that world food production could be increased substantially. There are, however, many constraints in practice such as limited resources, lack of physical infrastructure and capital, poorly-functioning distribution and marketing systems and environmental and social factors. Good agricultural practices and farm management could contribute to high yields.

Finally, the development of new genetically modified crops that are more adaptive to stress conditions including drought, salinity and temperature and that are more efficient in terms of energy and fertiliser use could give the declining crop yield a new boost into a possible '*Green Revolution.2*'.

This requires huge investments in new technologies, marketing and system innovations in the supply chain worldwide.

24 The global land balance estimation of suitable arable land could also contain elements of overestimation and much of the land balance cannot be considered a resource that is ready to be used for food production on demand. This land may lack physical infrastructure or consist partially of forest or wetlands that should be protected for environmental reasons. The people who exploit this land could also have either insufficient access to suitable technological resources or a lack of economic incentives to adopt them.

3. How much food can be produced through intensification?

Higher food production can also be achieved by increasing cropping intensities, i.e. increasing multiple cropping and/or shortening fallow periods. Similar to increasing yields per hectare, cropping intensification has the advantage that no additional new scarce arable land is needed. Producing two crops rather than one a year theoretically equals a doubling of the harvest area. Moreover, water, fertiliser and agricultural equipment can be utilised optimally. Several conditions must nevertheless be met in order to achieve optimum increases in cropping intensities. These conditions include the availability of sufficient inputs such as water, fertiliser and seeds, a farm system that enables optimum control of the growth conditions through means including an irrigation[25]/water management system and pest management plan, and a well-functioning distribution, market and finance system. This type of farming is more knowledge-based, enterprising, market-driven and capital-intensive. While cropping intensification has the potential to be a sustainable solution for increasing food production in the long run, it is not a route to increasing agricultural output that is practicable everywhere.

2.3 Future challenges for global food supply

The overall conclusion that emerges from the different comprehensive studies is that there are sufficient possibilities for increasing food production to feed the future world population. According to the FAO studies, producing the additional food needed to feed more than 9 billion people in 2050 will require a 9 percent expansion of arable land, a 14 percent increase in cropping intensity and a 77 percent increase in yields. The related figures for developing countries are 21 percent, 8 percent and 71 percent, respectively. The expansion of arable land in the world will moreover come mainly from Sub-Saharan Africa (25 percent) and Latin America (30 percent).

The outcomes of these long-term studies do, however, need to be interpreted with *caution* due to a number of considerations, constraints and uncertainties regarding the sustainability of a long-term global food supply system (chapter 4). They do nonetheless provide us with insights into the food security challenges that lie ahead and a rough indication of the potential contribution of the various sources to increase worldwide agricultural production. After all, producing enough food does not mean that it will also be available to fulfil any preferred diet. Nor does it guarantee that all people will at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. In order to address future imbalances in global food demand and supply, food supplies will have to be transported over longer distances and in larger quantities. This will have consequences for both physical distribution and market infrastructure. Storage and post-harvest handling and international transport facilities (ports, bulk handling, storage systems and transport means) will need to be greatly improved and financed.

A threat is the lack of investment in agriculture to meet future food demand.[26] It has been calculated that additional investments in agriculture of at least USD 30 billion annually are needed in developing countries in the coming four decades (Hallam, D., 2009). It has also been concluded that private investments have an important role to play to secure future world food demand, because public investment is

25 Developing countries account for almost a quarter of the world's total irrigated area (68 of 287 million hectares in 2005/07). The expansion of the irrigated area is expected to take place in developing countries. It is expected to be strongest (in absolute terms) in the land-scarce regions that are hard pressed to raise crop production. This includes regions such as East Asia, South Asia and the Near East/North Africa, although further expansion will become increasingly difficult in the latter region due to the scarcity of water (Bruinsma, J., 2009).

26 The resumption of economic and agricultural growth in Africa was not caused by significant investments in infrastructure, the closing of the agricultural technology gap or the provision of better services to smallholders (Binswanger-Mkhize, H.P., 2009).

expected to follow the downward trends over the years. It could also contribute to technological transfer, employment creation and multiplier effects in the local economy, including improved local food supply for the domestic market.[27] After all, to attack private investments (Foreign Direct Investment) a well-functioning financial system and a stable economic and political climate are needed.

To conclude: the pathway to 2050 requires swift, radical and coordinated action at many levels by multiple partners in order to establish the conditions needed to move global growth of food supply onto a more sustainable path. Local and global food supply chains will have to be connected and move as one system in achieving food security.
This transformation of the local and global food supply systems will bring with it huge shifts in terms of regulations, markets, consumer preferences, pricing of inputs and measurement of profit and loss.
All of this will impact business, society and government. Business has had and will continue to have a leading role in terms of connecting food demand and supply while bringing sustainability issues into practice throughout the global food supply chain. Companies are already taking first steps, and Rabobank (box at page 42) is committed to and involved in these developments in the global food supply chain.
This is no easy task, because of differences in legislation, trade rules, food standards, food culture and wealth between countries. After all, food must be transported by means of an international food trade system from the producing countries to the importing countries.
The existence of an effective and efficient international trade system is crucial to ensure the sustainability of global food security now and in the future.

Unilever and Sustainable Palm Oil

Palm oil, or one of its derivatives, is present in a third of all food and household products. Its versatility as an ingredient is matched only by it is efficiency as a crop. Yields from the oil palm plant are 6-10 times greater than those from alternatives like soya, rape and sunflower. Since its cultivation requires little by way of fertilizers or pesticides it should be an ideal crop for a resource constrained world. The problem with palm oil is that 80% of it is produced in South East Asia. Increasing use of the material has been one of the drivers of deforestation in the region. Unilever is committed to draw all of its palm oil from sustainable sources. In 2010 we will purchase over 500,000 tonnes of certified material. Within the Roundtable on Sustainable Palm oil – a body which Unilever helped found – the company is working with growers, NGOs and others to transform the industry into one that is genuinely sustainable.

Paul Polman,
CEO Unilever

27 In the past years there has been a resurgence of interest in international investments across the entire agricultural value chain. Part of these investments are in agricultural land and have attracted the most attention, including some concerns. Different surveys on the land deals, highlighting the benefits and concerns, have been published, including Cotula, L., et al., published by IIED, FAO and IFAD, 2009 and the Trade and Agriculture Directorate of the OECD, 2010. The purchase of lease of land on continents such as Africa, Latin America and Asia by governments in the Gulf States and China is intended to increase those countries' own food security.

3 Characteristics of the international agricultural commodity trade

Food markets and trade play a crucial role in achieving global food security by increasing access to food. Trade allows food to flow from areas of surplus to areas of deficit in local, regional and global markets. After all, a legitimate global market is one in which it is possible to buy food supplies on a regular basis and to utilise trade to supplement domestic supply. A key condition for achieving this situation is that markets properly transmit price signals that allow changes in demand to be met by supply.[28]
Agriculture, i.e. the food supply, does, however, hold an exceptional position within the economy compared to most other sectors. The agricultural sector must face a range of additional risks including weather conditions, seasonal production patterns, diseases and pests and perishable products. Primary agricultural markets furthermore feature perfect competition.[29]
All these extraordinary characteristics of agriculture and the food supply chain are a feeding ground for short-term fluctuations in supply and price. Agriculture and the food trade have also always been among the most regulated and protected sectors of the economy. This is perfectly understandable considering that a lack of food and excessive spikes in food prices upset economic development and create social unrest.

The period since the mid-1970s[30] has seen the emergence of a more globalised food system. Gradual progress has also been made during this period on achieving freer international trade in agricultural products. While North-South trade dominated this trade for a prolonged period, increased market integration, globalisation and rising per capita incomes have now enhanced the role and importance of key developing and emerging economies in international agricultural markets. The related consequences include a shift in traditional international trade patterns and flows and increased competition among all the participants in agricultural commodity markets.
The momentum arising from strong income growth will initially boost food demand and imports in order to feed the large concentrations of people migrating from rural to urban centres and to meet the significant changes in dietary and consumption patterns. A smooth international trade system is key to being able to address the growing imbalance in food demand and supply. The characteristics of the international agricultural commodity market will be clarified in more detail in this chapter in order to provide greater insight into the related sustainability challenges.

28 According to the economist Adam Smith (1723-1790) the 'invisible hand' of markets ensures that 'winners' gain' and 'losers' losses' will be temporary, as entrepreneurs adjust market imbalances. According to this theory, higher prices will induce more production as planted areas increase and available arable land will be used more intensively. Strategic stocks could be essential to limit price volatility in the global agricultural markets, but they are costly and require effective and efficient international coordination.

29 In a perfect market there are large number of buyers and sellers, there are no entry or exit barriers, there is perfect mobility of the factors, i.e. buyers can easily switch from one seller to the other, and the products are homogenous.

30 In the first half of the 1970s food prices were very high (first energy crisis).

3.1 Structure of the global agricultural commodity trade

Share of the global goods and primary products trade

Approximately 8.5 percent of the worldwide goods trade consists of agricultural commodities, while their share in the total trade in primary products accounts for 27.5 percent (2008). This figure does, however, vary from region to region (table 1). The most striking aspect of this discrepancy is the low share of exports and high share of imports of agricultural products, both in terms of total goods trade and primary products trade, held by Africa, the Middle East and CIS countries. This demonstrates these regions' high dependency on food imports.

Table 1 Share of agricultural products in total goods and primary products trade by region (2008)

Share in total merchandise	Exports	Imports
World	**8.5**	**8.5**
North America	10.4	6.1
South and Central America	26.2	9.3
Europe	9.3	9.4
CIS	6.8	10.7
Africa	6.8	14.2
Middle East	2.4	11.8
Asia	6.0	7.6
Share in primary products	**Exports**	**Imports**
World	27.5	27.5
North America	38.0	20.9
South and Central America	38.0	30.5
Europe	44.0	32.6
CIS	9.2	45.8
Africa	8.8	46.2
Middle East	3.1	53.9
Asia	32.5	19.7

Note: Import shares are derived from the Secretariat's network of world merchandise trade by region.
Source: WTP

The share of the international agricultural commodity trade in the world goods trade declined from 9.5 percent to 6.2 percent in the period 1990-2006. This share has recovered since 2006 to 7.5 percent in 2009 (OECD, 2010).

Global top-ten agricultural commodities

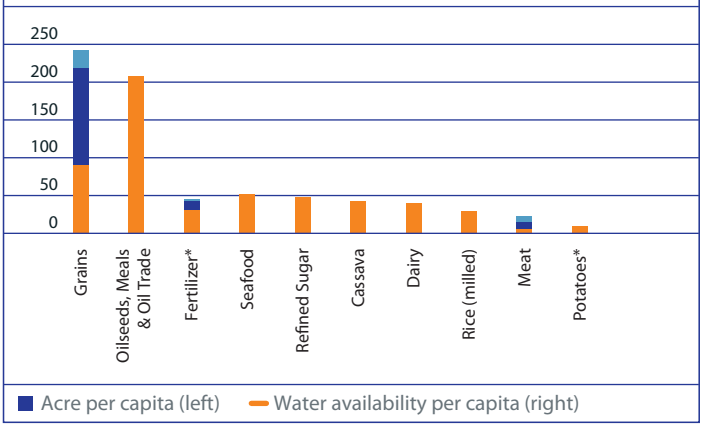
Figure 2 at page 20 shows the top-ten agricultural commodities[31] that are traded on the international market. Grains and oilseeds are by far the largest commodities in terms of volume.

Share of global food production by volume[32]

An average of approximately 16 percent of global agricultural production (in volume) enters international trade. This involves a broad spectrum of different commodities, regions and countries. The top-five commodities traded internationally are oilseeds (57 percent), fish (37 percent), sugar (31 percent), cassava (19 percent) and grains (15 percent) (please refer to figure 3 at page 20)). It must be noted that, in contrast, only 7 percent of rice, which is also a staple food commodity, is traded internationally, thus revealing the characteristics of a remainder market.
In comparison to the previous period 2004-2006, the share of oilseeds (50 percent) has grown substantially, while the shares of sugar (36 percent) and cassava (24 percent) have dropped.

31 Although fertiliser is not a food product, it has been included because it constitutes an indispensable input for agriculture and large quantities of it are traded internationally.
32 Volume instead of value is used to express the availability of the different agricultural commodities for domestic consumption and international trade.

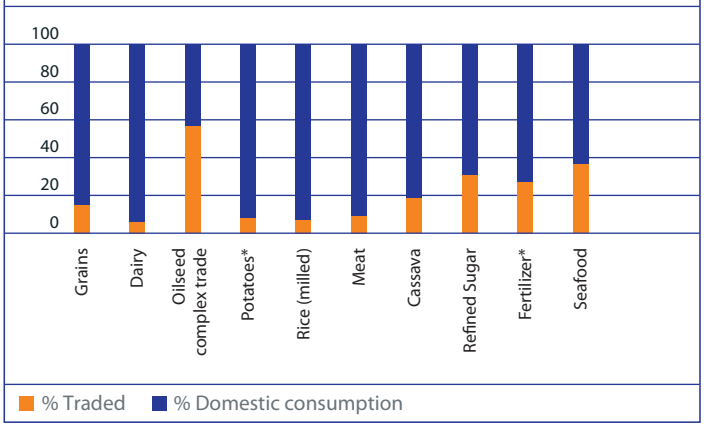
Figure 2 World top agricultural commodities - trade
3 year average 2007/2010(f)



Note: * Potato and fertilizer data 2007 only (potato solana tuborusum variety only)

Source: FAO, USDA, WDS and IFA statistics (FAR/RI)

Figure 3 Agricultural commodity production traded worldwide
3 year average 2007/2010(f)



* = 2004/2006

Source: FAO, USDA, WDS and IFA statistics (FAR/RI)

Leading exporters and importers

Figures 4 and 5 show the leading exporters and importers of the international commodity market and their respective shares. It should be noted that the share of Brazil as an exporter and the share of China as an importer have expanded in recent years and are expected to grow in the decades ahead.

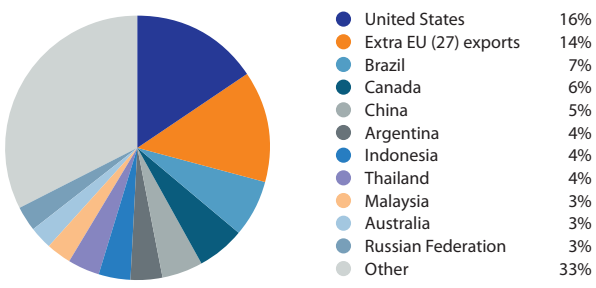
(Real) agricultural commodity prices

Figure 6 at page 21 shows the long-term development of the real prices of the four most important bulk commodities in the period 1957-2008. The declining trend in the real price of agricultural bulk commodities was possible due to high growth in productivity and efficiency. However, as stated above, this growth in productivity is expected to slow down, while production costs (energy inputs) and food demand are forecast to rise in the coming decades. It is more realistic to expect an upward trend in real commodity prices in the decades ahead than a continuation of the past trend. In the medium term (2010-2019), prices for agricultural commodities are projected to exceed the levels of the decade prior to the 2007/2008 peaks, both in nominal and real terms (OECD-FAO, 2010).

A note which has to be made here is the increased interest in agricultural commodity futures and options in the stocks and bond markets, especially during the recent commodity boom. Normally, agricultural commodity futures and options provide insurance against price risk for farmers and food processors. This is fundamental to food price formation, and anything that adversely affects the performance of these markets can impact food prices (FAO, 2010).
However, the advent of large investments by commodity funds has raised new issues about the utility of organised exchanges such as risk-transfer mechanisms, and about the role of unfettered speculation in persistent price rises. Commodity futures and options offer an attractive vehicle for portfolio diversification that reduces the volatility of portfolio returns for speculators.[33] After all, speculation has been a regular feature of all commodity markets for more than two centuries.

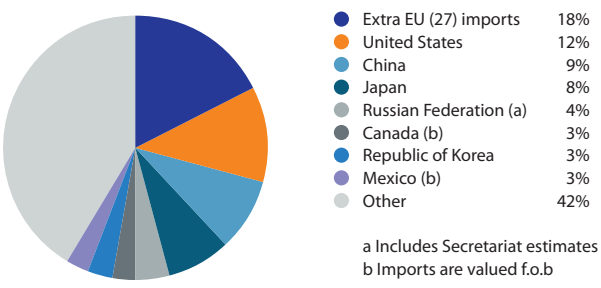
33 Any agent who buys a contract for a commodity with the intention of selling it later for a profit can be considered a speculator.

Figure 4 Leading exporters of agricultural products and their respective shares 2008



Source: FAOSTAT (FAR/RI)

Figure 5 Leading importers of agricultural products and their respective shares 2008



Source: FAOSTAT (FAR/RI)

Organised commodity exchanges are designed to improve market transparency as well as transferring market risk from physical markets to speculators, and they guarantee transactions via the underlying clearing houses.

3.2 Developments in the global food trade

Agricultural trade North-South and South-South

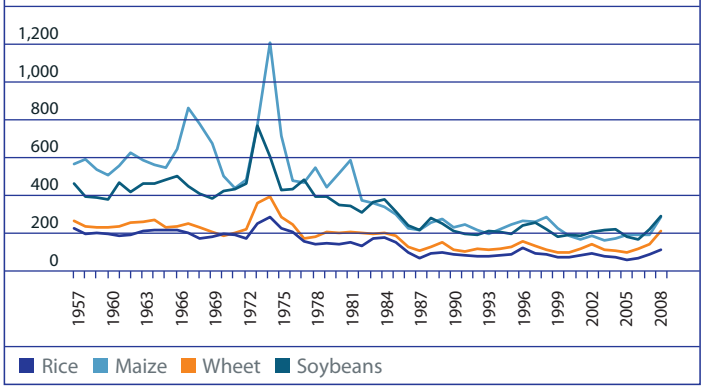
Another development in the international goods trade (including food) that has occurred over the past two decades is that the traditionally dominant North-South trade from developed to developing countries has lost ground in favour of South-South trade from developing to developing countries (Kowaski, P. and Sheperd, B., 2006). South-South trade has also become relatively more important as a share of the total trade involving the South, rising from less than 10 percent to approximately 14 percent in the period 1985-2002. More recent figures on trade in the regions show that the shift in the traditional trade pattern is continuing due to growth of food demand in Asia on the one hand and the expansion of the food supply in Latin America on the other (figure 7).

An important structural factor that underlies these trends is the fact that the scope for growth in consumption and imports of their traditional exportable agricultural products to developed countries is limited, while food demand in developing countries is growing due to expected relatively higher income growth in the decades ahead.
It was also estimated in the aforementioned study that the overall trade barriers facing South-South trade would be much greater than those facing North-North trade. Individual tariff rates may, however, vary widely across the South. It was furthermore concluded that countries would benefit most from liberalised trade with their geographical neighbours.

Medium-term outlook for the agricultural commodity trade

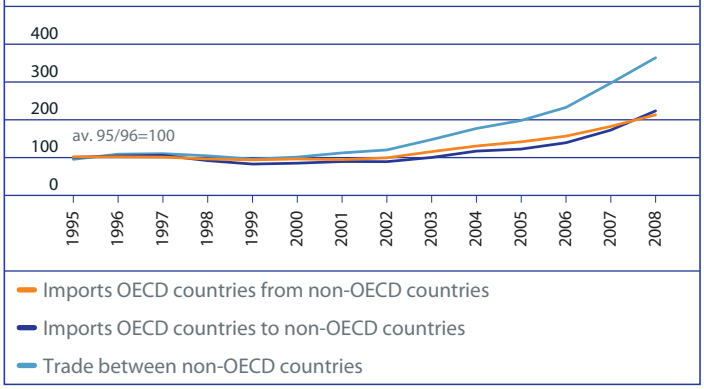
Medium-term trends in trade in food commodities imply a changing landscape of international trading patterns (OECD-FAO, 2010). Developing countries are expected to continue to experience significant expansion in net trade from Latin America, most notably Brazil and Argentina, while the Asia Pacific and Africa regions will see a widening of their net import position. Brazil's net food surplus has increased by nearly 400 percent since 2000 and is expected to grow another

Figure 6 Real prices of bulk commodities (1957-2008)
USD/ton



Source: FAO Trade and Markets Division

Figure 7 Development of the trade in agricultural products in OECD and non-OECD countries (1995-2008)



Source: Comtrade HS data (Rabobank)

50 percent in the decade ahead. The CIS countries are expected to emerge as net suppliers of food, reversing their position from net importers to net exporters (see paragraph 2.2, end of question 1).
With relatively slow growth in agricultural production and stagnating food demand, real net food commodity exports from industrialised countries are not expected to change in the medium term.
Trade flow and trade patterns in agricultural commodities will continue to evolve with increased South-South trade in addition to the traditional North-South trade in the coming decade (OECD/FAO, 2010).

3.3 Future challenges for the global food trade

Developing countries are predominant in relation to both import and export growth and becoming increasingly integrated into world agricultural trade and regional markets. This development comes as other countries with a well-established presence on the international markets, such as China, are seeking to diversify their sources of supply. This is resulting in new economic interaction and trade flows to ensure food security. The front runners are assuming greater prominence in international trade as well as in trade negotiations.
The consequence of lower growth prospects, higher costs and the more limited resources of the OECD[34] countries is that their contribution to global food balances will continue to decline and they will have an increasingly greater orientation towards the higher value-added components of the food supply chain in the coming decades.

Similarly, the major structural change in the global food market involves both the emergence of large powerful multinational companies and the dominance of supermarkets in the supply chain. They have moved themselves into a market position that enables them to meet the challenges and risks of the future global food supply system.
The global food system must, however, also establish rules and facilitate the means for ensuring a more stable and balanced food trade. Regional or bilateral co-operation and arrangements based on comparative advantages and mutual interest including the long-term perspectives of participants appear to be more effective means for achieving this than global arrangements, which are often the result of numerous compromises. Global coordination of trade will, of course, continue to be indispensable in order to support and ensure a highlevel international trade system.
A point of main concern is that producers/farmers are in a most vulnerable position, because they are the least concentrated link of the global food supply chain despite its rapid concentration, which leaves them at a comparative disadvantage[35] in terms of bargaining power. Methods are required to define an appropriate price for farmers' crops in order to enable them to earn enough money to improve and grow their own business and to make a livelihood.
The future food challenge is unfortunately not an easy task in light of the fact that today's agriculture and food markets are, more than in the past decades, an integral part of the global economy. The volatility of agricultural prices will increase due to the interconnection with other parts of the ecomomy.
The consequence of a more developed and open global food system will be that competition between exporters will grow and the winners will be the more efficient and inventive suppliers. From this perspective, food security will be linked increasingly to overall economic development and will become more driven by business than policy.

34 In the medium-term outlook (OECD, 2010), dominant trade shares for OECD countries are projected for wheat (54 percent), coarse grains (60 percent), pork (80 percent), butter (79 percent), cheese (65 percent) and milk powder (70 percent), while developing countries (non-OECD countries) will hold dominant positions in rice (89 percent), oilseeds (57 percent), protein meals (81 percent), vegetable oils (92 percent), sugar (89 percent), beef (56 percent) and poultry meat (66 percent) in 2019.
35 Added to this position is the risk of the perishability of agricultural products and the production volatility, which are typical for agriculture.
36 Particularly from middle and high-income classes.
37 Hence, sustainability issues are (partly) product and country specific.

4 Sustainability challenge for the global food supply chain

Macroeconomic progress, modern transport and communication systems and freer international food trade have contributed to the emergence of a dynamic global food supply system in recent decades that has become stronger and more intertwined with or influenced by other sectors of the economy.

This system essentially provides food to anyone and as such contributes to food security and improves access to food. The core foundation of a global food system is, after all, formed by the food systems in different countries/regions which are comprised of numerous stakeholders that face different standards of living, food culture, standards and national/regional food policies. A side effect of the globalisation of the food system is the integration of regional differences in food standards, diets, taste, habits, etc. While each 'actor-player' (consumers, companies, governments, bankers) within and related to a supply chain holds a different role and position in the supply chain, they all share a common goal and responsibility, namely to provide consumers with food in a dynamic market that features a certain quality standard at a certain price. Driven by individual consumer preferences and growing concerns[36] relating to responsibilities concerning health, the environment, global warming, animal welfare, labour conditions and the interests of local populations, the economics of food production and trade are being transformed slowly but irreversibly. Transparency, track and tracing, labelling, certification, code of conduct/business principles and co-operation with NGOs have rapidly become elements of the business strategy and marketing policies of food and agribusiness companies within the global supply chain. All of the above elements instil consumer confidence in the integrity and sustainability of the foodstuffs consumed. Moreover, there is growing awareness of the impact and dependency of companies on scarce natural resources and loss of ecosystem services that affect their future growth potential and the quality of life. A big challenge is to bridge the differences between countries.

A number of overriding questions do, however, remain, such as: 'Are we trying to change lifestyles or making the existing way of life more sustainable?', 'Is the market always the answer?', 'Is our business model sustainable?', 'What impact do the scarcity of vital natural resources and the loss of ecosystem services have on the long-term growth potential of our company?'. To answer these questions a long-term perspective of business development for companies must be created with a view to discovering new opportunities within the transformation process that all parties will go through in the decades ahead.

This chapter will first focus on the key characteristics of the global supply chain and then provide a brief description of the different elements of sustainability from the perspective of food security. In order to present the challenge of achieving sustainability within the food supply chain in more concrete terms[37], two global supply chains – the soybean supply chain between Brazil and China and the Norwegian farmed salmon supply chain will be examined.

4.1 Main characteristics of the global food supply chain

A global food supply chain starts with agricultural input supply companies[38] that provide supplies to farmers in *producing* countries (including post-harvest, storage, basic processing and trade) and to end consumers in *importing* countries. Bulk commodities are not limited to agricultural products such as grains and oilseeds, but can also include products that have undergone basic processing. Soybeans could, for example, first be crushed into oil and meal/cake. Paddy can also first be milled and polished into white rice and rice bran in the producing/exporting country. The various products are exported as bulk commodities/raw materials, while some are destined for the home market.

The agricultural commodities are further processed on arrival in the country of import. The products are traded to end consumers (including export) or enter the value chain of the importing country as input for other industries.[39]

Stakeholders of this kind of 'Farm to Fork' chain include, among others, farm input suppliers, farmers, collectors, intermediaries, processors, transporters/shipping companies, retailers/food service providers, bankers/investors and the governments and authorities of both the exporting and importing countries.

Driven by increasing globalisation[40], food supply chains are highly dynamic and important for supporting the stable economic development of countries. In recent decades, companies in the private sector have constantly tried to seize market opportunities and to manifest themselves as a competitive connection to the global food supply chain. This has resulted in a dynamic process of up-scaling, concentration and internationalisation of companies in order to gain not only the benefit of economies of scale, but also to strengthen their bargaining power in the supply chain within a rapidly expanding and changing global food market. Today, many stakeholders within the global food supply chain are multinational or international companies[41] that provide farm inputs, food processing and retail and food services. Some have strong brands while others use their large scale and flexibility as a market pull. Only the farm sector is relatively small-scale, with a fragmented structure and generally a national basis.

Food supply chains do, however, differ by country and product and even by seasonal market in some cases. In order to reflect these diversities, a distinction can be made between non-processed food (fresh products, commodities), processed food (stockable), and retailers and food service providers. Box 1 is an example of a developed and matured regional food market.

Figure 8 gives a detailed overview of the players in the global food supply system. It also stresses the strong strategic position of the processors, traders, retailers and investors that have enormous leverage in transforming the supply chain into a sustainable value chain.

4.2 Sustainability of the global food supply chain

Today's world is characterised by access to internet communication technology, a rapid transport system, expanding food knowledge and consumer concerns about living conditions. This will make it increasingly difficult to ignore the negative external effects without finding an effective solution in transferring food production and consumption to others. The companies' image and trust will be at stake.

38 Fertilisers, chemicals, seeds and equipment are mostly imported or are produced locally based on imported raw materials.

39 Soybean meal and cake, which are by-products after crushing of the grains, are used as feed in pig, poultry and aquaculture farming.

40 Drivers of globalisation are: macroeconomy, trade liberalisation, imbalance in food demand and supply and changing diets and food habits.

41 Large companies that also provide services to the food supply chain, such as transport and shipping companies, are not mentioned as a special stakeholder here.

Figure 8 Structure of a food supply chain

Source: Rabobank

BOX 1: EU food supply chain structure

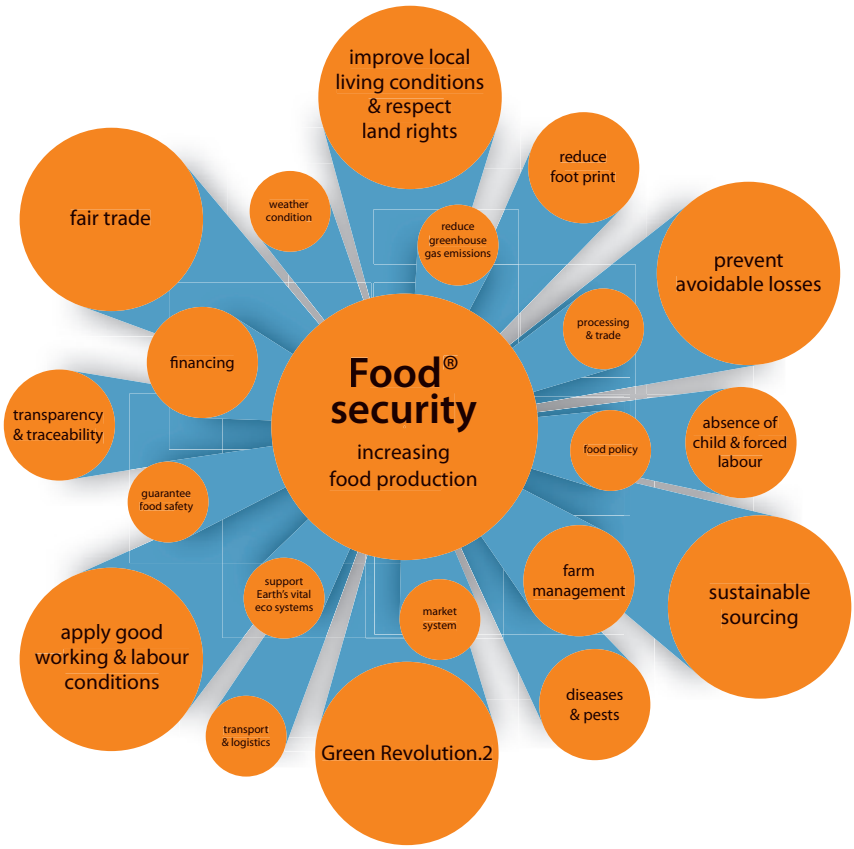
Within the European Union[42] as a whole, the non-processed food sector is mainly characterised by a fragmented structure with numerous producers and intermediaries that intervene at various stages. Producers are the least concentrated sector in the food supply chain. In some European countries producers join forces within producers' organisations (POs). More than 70 percent of all fruit and vegetables were marketed through POs in the Netherlands, for example, while the percentages were much lower in the three most important producing member states at 30 percent for Italy, 50 percent for Spain and 55 percent for France (2003). Given the wide differences between member states and sectors, it is impossible to draw common conclusions across regions and product markets. The supply chains for processed food in the EU are characterised by the interplay between a concentrated food-processing industry often consisting of large industrial multinationals and the retail sector. The food-processing industry and retailers are more concentrated than agricultural producers, particularly if large multinationals are included. For example, the top-three suppliers on the French breakfast cereals market in 2007 held a market share of just over 75 percent. Similar high market shares were reported in 2005 for the Spanish soft drinks market of nearly 90 percent, beer market of 75 percent and pizza market of 75 percent.

The retail sector has undergone intense concentration over the last two decades, which has resulted in the recurring image of retailers as gatekeepers to mass consumers. The Finnish top-two retailers account for 65 percent of the market, the UK top-four for 65 percent, the Slovenian top-three for 63 percent, the Dutch top-three for 83 percent, the Portuguese top-five for 63 percent and the German top-five for 90 percent.

Source: Commission of the European Communities, 'Competition in the food supply chain', COM (2009) 591, Brussels 2009.

42 Commission of the European Communities, 'Competition in the food supply chain', Commission Staff Working Document, COM (2009) 591, Brussels, 2009.

Figure 9 Sustainability and security of the global food supply chain



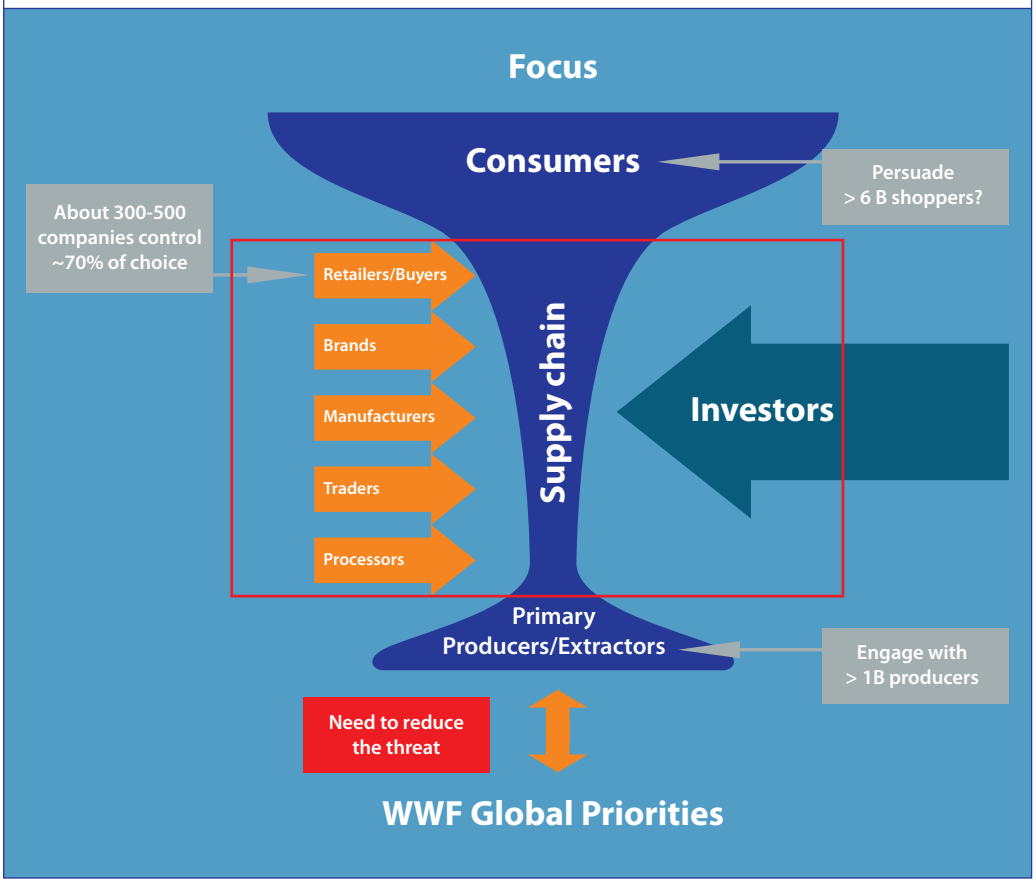
Source: Economic Research Department, Rabobank Group (2010)

As stated in paragraph 4.1, the global food supply chain is long and complex and numerous stakeholders are involved. This intricacy is logical considering that food is transferred from one country/region to another country/region within a globalising food system. Food consequently travels more and more miles across the world before it reaches end consumers, especially when other ingredients are also used in the processed foodstuff or processing steps involve more countries. To produce additional food a number of measures need to be implemented and risks have to be taken. A number of uncertainties and hurdles[43] must be overcome in the supply chain, both upstream (production) and downstream (trade, storage, processing), before reaching the end consumer (figure 9). An example is the imbalance that can be caused by the international transfer of mineral resources across the globe. This imbalance could have negative long-term environmental effects on both the exporting and importing countries/regions. Sooner or later we will all be confronted with the cost of mitigating these effects. The global economy is consequently undergoing a change whereby prices are now being paid for the use of relatively scarce natural resources and ecosystem services. Increasing scarcity will gradually affect the current economic value system and the allocation of the means of production. The key point in this regard is that companies' long-term growth prospects will be threatened. For this reason, a growing number of companies worldwide are now conscious of the impact that scarce natural resources (and the related dependency) and loss of biodiversity have on their future growth potential (Bishop, J., et al., 2010).

Other examples of societal and environmental issues – apart from imbalance and scracity of resources – are food safety, fair trade, and labour and working conditions. These social and environmental issues can be resolved and food security can be guaranteed by deploying sustainability drivers that add sustainable value to the elements of the supply chain – and hence transform it into a value chain – e.g. sustainable sourcing, prevent avoidable losses, improve local living conditions and respect land rights, fair trade, guarantee food safety, support Earth's vital ecosystem's, and reduce Greenhouse gas emissions. Figure 9 gives, besides uncertainties and hurdles of food production, also an overview of important sustainability drivers, which are essential in achieving global food security. The pertinent issues are not just where something is grown, how it is transported, how it tastes, how much it costs and who supplies it, but also how it is grown, stored and prepared, and who is responsible in the case of uncertainty. It is also important to consider factors such as the supplier's integrity, who is making a profit, and to what extent sustainability issues are covered.

An explanation of the 'drivers' towards a sustainable value chain that set out in figure 9 is provided in box 2. The 'drivers' have a positive impact

Figure 10 Position and impact of the participants on the food supply chain



Source: World Wildlife Fund (edited by Rabobank)

on the supply chain elements (inner circle of the figure). It should be noted that the sustainability drivers mentioned in figure 9 are of a general nature but the explanation, experience and pace of implementation per country or region may differ based on welfare level, development, etc. and due to the absence of global standards. This can be a barrier to achieving sustainability of the global food chain.

As mentioned above, various sustainability issues may be at stake during the different phases of the international food trade system. However, more prior conditions must be fulfilled before steps forward can be taken. Examples include transparency, tracking and tracing, risk management and control, sustainability standards, trade conditions, discipline and mutual interest for all parties.
The only fair option in the long term is to ensure that the prices of the food and goods we consume cover the costs of making the supply chains sustainable by reducing the tangible and intangible costs of the footprint on social, environmental and animal welfare in the country of origin. A simple labelling system is an interesting option to inform consumers on how the product is reducing poverty and regarding other sustainability issues which are at stake. This gives consumers the opportunity to 'pull' these aspects into the supply chain by choosing more sustainable products, which will urge companies to implement sustainability in the supply chain.

The trend towards increased concentration[44] in the different stages, i.e. from the gene to the retail outlet, of the global food supply system is expected to continue in future. Globally-orientated companies and their alliances seem to have attained a scale that is large enough to play a leading role in achieving sustainability of the global food chain.
This means that all participants bear responsibility for the entire supply

43 Such as: Weather conditions, diseases & pests, water, fertilizer & equipments, farm management, application of good agricultural practices, transport & storage, processing & trade, retail marketing, financing and food policy.

44 Both horizontal and vertical integration through ownership and strategic alliances with other firms involved in additional stages of the supply chain are utilised in an effort to exert more influence over the production, processing and distribution of food.

chain, although processors, traders, manufactures and retailers have a greater impact on the transformation of the food supply chain due to their size and reach, as figure 10 shows. They can exert increasing pressure on their suppliers based on demands downstream in the supply chain.

Initiatives to transform the supply chain into a value chain

Several initiatives have been taken to establish a sustainable value chain. Mainstreaming the sustainability of international agro-industrial supply chains is the objective of various sector-wide initiatives such as fund and/or platform-providing initiatives that include the Dutch Sustainable Trade Initiative (IDH), the Schokland Fund[45] and multi-stakeholder initiatives in the form of round tables. Examples are the Round Table on Sustainable Palm Oil (RSPO), the Round Table on Responsible Soy (RTRS), the Better Sugar Initiative (BSI) and the Aquaculture Dialogues covering twelve species. Initiatives such as IDH and the Schokland Fund operate programmes that are designed to improve the sustainability of international supply chains. Their related focus is on tackling the bottlenecks faced by the first chain actors in developing and emerging economies often through certification standards based on governance, social and environmental principles and criteria developed by the members of a round table (RSPO, RTRS, BSI and Aquaculture Dialogues). The members are key players from industry (producers, traders, processors), financial institutions, NGOs, unions and governmental agencies in a number of food and agribusiness supply chains. In each of these chains, there are serious, sensitive issues that must be resolved in order to transform into mainstream sustainably. The bottlenecks within one supply chain can even differ per country or region. These initiatives and round tables assist front-runner companies to move even faster and support other actors in overcoming thresholds.

45 The Schokland Fund is an initiative of Project 2015, which is part of the portfolio of the Dutch Minister for Development Cooperation and aims to make up for the delays encountered in achieving the Millennium Development Goals. Realising that it cannot accomplish this single-handedly, the Dutch government sought to involve the rest of Dutch society in this endeavour, including private companies, non-governmental organisations, religious institutions, trade unions and members of the general public. The Ministry for Development Cooperation has also set up the Schokland Fund, which has total assets of 50 million euros, to support this initiative.

46 Contribution from the Rabobank Nederland CSR Department.

BOX 2[46]: Explanation of sustainability drivers (figure 9)

Reduce greenhouse gas (GHG) emissions

18 percent of total global GHG emissions are caused by the agricultural sectors. A large part of these emissions is a result of land use change, methane and N_2O emissions. Companies can improve energy efficiency and reduce GHG emissions to values that are below the industry average by drawing up a reduction plan aimed at improving energy efficiency and GHG emission reduction in production. A GHG Management Plan sets targets for reduction in GHG emissions and sets out the GHG emission reduction initiatives to achieve these targets.

Reduce foot print

Companies should use (scarce) resources very efficiently by diminishing the amount of resources in their production processes (cost-effective processes, material reuse and renewable energy), which results in lower costs, and applying the 'Waste is Food' approach. In a nutshell, this means reducing their footprint while increasing their profit growth.

Sustainable sourcing

Companies should have a purchasing policy in place with specific conditions that focus on the sustainability issues in food production which suppliers should be aware of and should manage.

Prevent avoidable losses

Companies should have a logistics system in place to prevent or minimise food losses during food production, including post-harvest, transport, storage and processing.

Guarantee food safety

Companies should apply food safety standards to guarantee food safety. These standards include 1) the safe, effective and minimal use of therapeutics (including antibiotics), hormones, drugs and other chemicals for animal health protection and 2) the consideration of the legality, appropriateness of the type and amount of agrochemicals in relation to possible environmental and social impacts (health and safety). All this is recorded to facilitate tracing the end product to its origins.

Transparency & traceability

Companies should be transparent in their food production and their plans to increase the proportion of sustainably produced food. They should also organise a sound traceability system in their procurement to trace the source of the food ingredients and develop information and accounting systems to manage the impact on environmental capital.

Fair trade

Companies should develop methods for defining an appropriate price for farmers' crops in order to enable them to earn enough money to develop and improve their business and make a livelihood.

Green Revolution.2

Companies should develop next-generation food crops that are more adaptive to stress conditions (drought, salinity, temperature and new diseases and pest) and more efficient (less use of energy, water and nutrients) with shortened growing cycles and new hybrids to give the declining crop yields a new boost.

Application of good agricultural practices

Farmers can adopt good agricultural, social and environmental management practices that optimise and enhance biodiversity and soil conservation, the maintenance of water quality and quantity and the creation of safe and healthy working conditions.

Support Earth's vital eco systems

Businesses impact biodiversity and ecosystem services if they affect the quantity of a given service through consumption, emissions, pollution, land conservation and other activities. At the same time, businesses depend on ecosystems if the service functions as an input or if it enables, enhances or influences environmental conditions required for successful corporate performance. Agribusiness, for example, relies on natural purification of water supplies and the creation of drainage systems, moderation of floods, nature's pollination, pest control, nutrient cycling and erosion control services (healthy agricultural lands and soils). It is therefore important to realise that companies should take into account the rules of nature while carrying out their activities.

Absence of child & forced labour

Companies can avoid any form of work that is forced upon an individual through the threat of physical, financial and/or other punitive measures and that the employee has not offered to perform voluntarily. Companies must avoid situations in which children under a certain age work for them and/or are forced to perform work that is very dangerous or hard for children.

Improve local living conditions & respect land rights

Companies can improve and contribute to the livelihood and well-being of local communities to ensure that local citizens have sufficient funds to buy enough food, pay the rent and send their children to school. In the case of land rights, companies must comply with the local laws and regulations. Companies must also involve affected stakeholders before establishing new operations. This implies that they respect the legal rights, land tenure and use of land of indigenous peoples and local communities. Furthermore, companies must design and engage in a process of free, prior and informed consultation with affected stakeholders and must duly record this process. An effective grievance mechanism is in place and stakeholders and local communities are informed about the possibilities of this mechanism.

Apply good working & labour conditions

Companies should avoid getting into situations in which the fundamental rights of employees are seriously violated. This specifically concerns situations in which an employer consciously exposes employees to unhealthy or unsafe working conditions by failing to take adequate protective measures (such as clothing, shoes, masks, etc.) or failing to provide information or training in situations in which employees have to work in dangerous places and/or with dangerous machinery, substances or processes. In light of the foregoing, companies should furthermore give their employees the opportunity to voice their opinions on the working conditions or make proposals for improvements.

Chart 3 Worldwide soy trade map 2009

Soybeans Soybean oil Soybean meal

Flows: Beans/Meal > 1,000,000 tonnes, Oil > 100,000 tonnes
The width of the arrows is related to the volume of either beans, meal or oil, but not mutually comparable.

Source: Food & Agribusiness Research and Advisory, Rabobank International (2010)

4.3 Case study: Soybean supply chain between Brazil-China[47]

Introduction

Today's food systems are spread around the world and have become a complex global supply chain. Chart 3, for example, shows the world-wide trade flows of soy. The world's three main exporters are the U.S.A., Brazil and Argentina, while the largest importers are China and the EU.

Brazil is the world's second largest soybean producer after the U.S.A. Production is concentrated in the southern and central western regions of the country and is now also expanding into the north-western part. Nearly 40 percent (2009) of the total soybean production is exported, with China accounting for 60 percent (16 million MT) of this amount. This represents close to 38 percent of China's total soybean imports. Brazil is China's second largest soybean supplier after the U.S.A. Figure 11 at page 32-33 shows the extensive supply chain from Brazil (shown in blue) to China (shown in orange).

The supply chain starts with input supply companies that provide fertilisers, chemicals and equipment to farmers. Following production, some of the soybeans are transported to processors where they are

47 Contribution from FAR Brazil and Asia/Rabobank International.

Sustainable supply chains need conviction, cooperation and new knowledge

Nutreco is committed to sustainability; reporting annually since 2000. We believe the population of 2050 can be fed sustainably. This conclusion is supported by opinions of leading experts presented at the Agri Vision conference we organised in 2009, with the support of Rabobank, and published in our 2010 booklet Feeding the Future. Nutreco intensified its sustainability programme in 2010. It set targets to reduce its CO_2 footprint, to develop sustainability criteria for purchasing and new product development, and to prepare sustainability action plans for every operating company. Established sustainability actions include our SEA programme, towards Sustainable Economic Aquafeeds, and participation in the Round Table for Responsible Soy. SEA programme actions include purchasing the important marine raw materials fishmeal and fish oil derived from fisheries certified to be responsibly managed and from trimmings from processing of wild fish for human consumption. Other actions target waste and emissions. Skretting R&D progressively reduces the feed required to grow fish to market size and its marine raw material content, by substituting essential ingredients from sustainable vegetable resources. The latest advance, MicroBalance™, means the need for fishmeal is so low that salmon farmers can produce more fish protein than is in the feed they use.

Wout Dekker,
CEO Nutreco

crushed into oil for human consumption and into meal/cakes for animal feed, while others are exported.

Upon arrival in China, the soybeans are crushed into oil and meal/cakes. After the crushing process, the oil is destined for human consumption, while the meal and cakes are processed into animal feed by the feed-manufacturing industries. The feed enters the supply chain of the pork, poultry and aquaculture industries.[48] While a proportion of fish products are exported, the majority of the products produced by the meat and fish industries are consumed domestically.

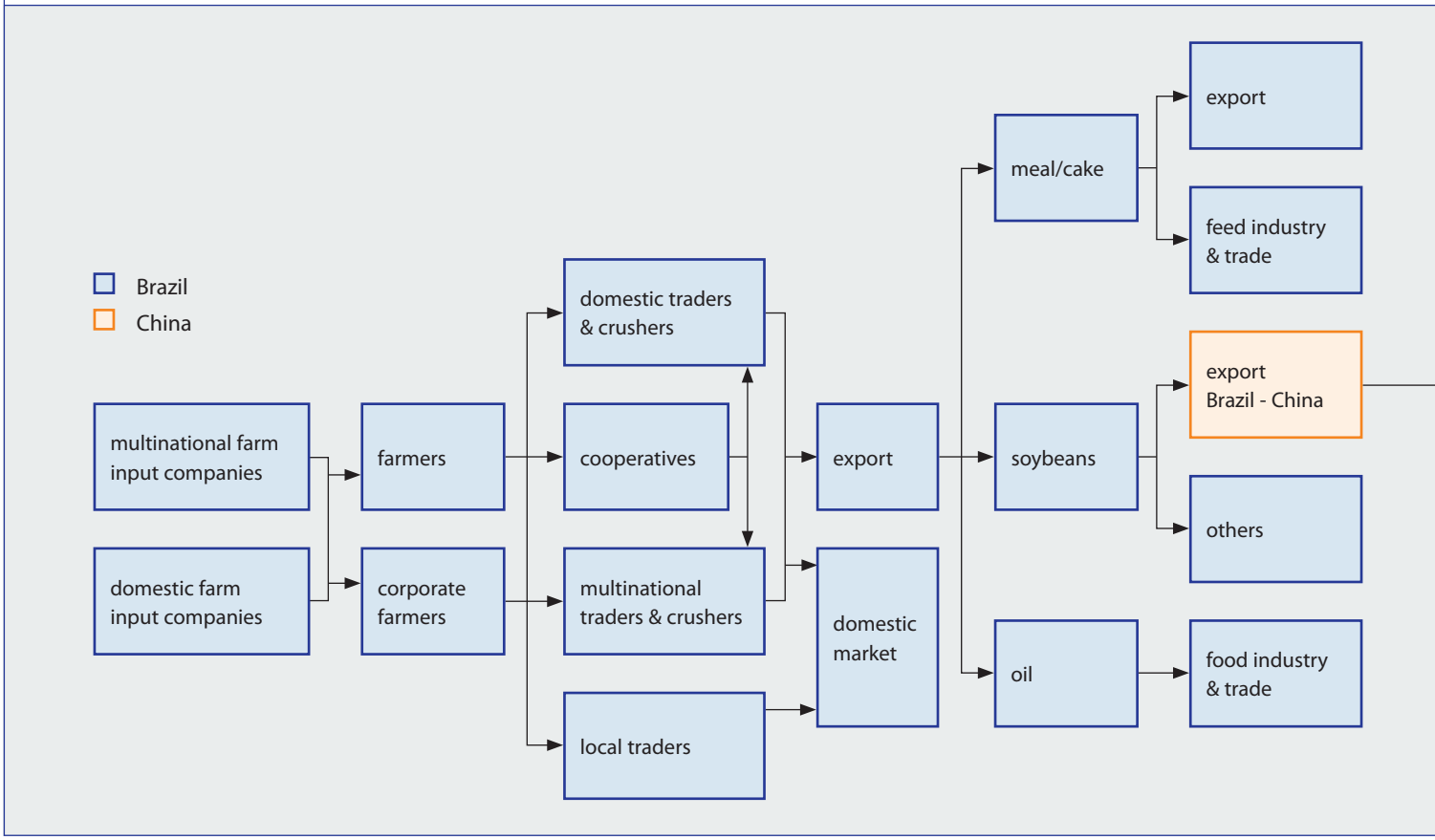
There are numerous participants/stakeholders within the supply chain, including a number of large integrated and multinational companies that control different stages of the total supply chain. Production/farmers constitute the most fragmented stage of the supply chains.

Sustainability issues in the soy supply chain

There are sustainability issues at every stage of the supply chain. A tentative list of issues can be found in table 12. These issues can have a downside (unsustainable) and an upside (sustainable) connotation. An upside connotation means the issue can be seen as a driver to positive transformation of the chain. An important note to be made here is that the sense of urgency as well as the interpretation of and experience with the sustainability issues may differ by countries/regions

48 The sustainability issues of the meat and fish sectors in China are not included in table 12.

Figure 11 Global soybean supply chain between Brazil and China



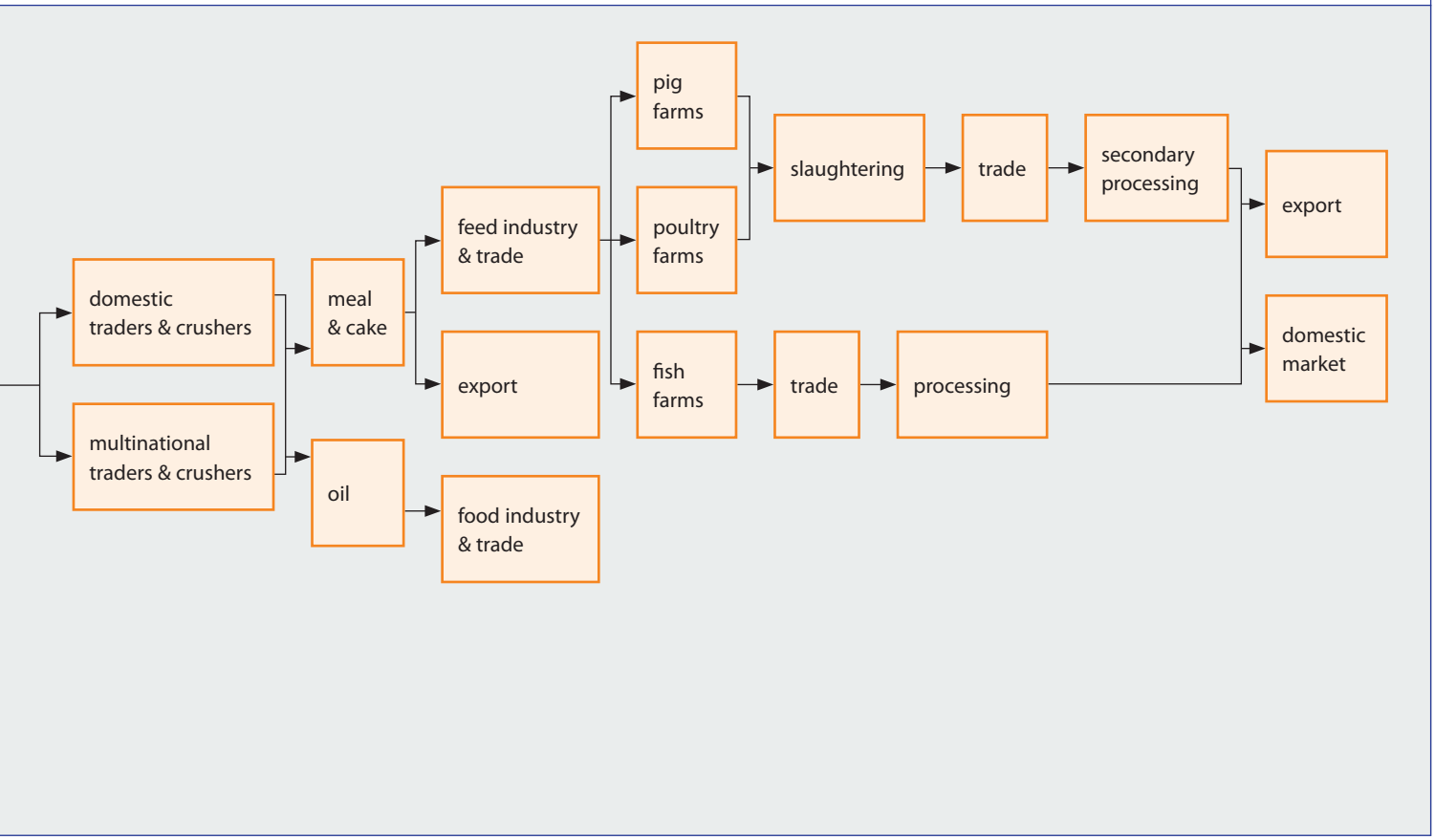
Source: Food and Agribusiness Research and Advisory, Rabobank International (2010)

due to differences in socioeconomic, cultural and food standards. The driving force behind transforming the soy supply chain into a sustainable value chain is the Round Table on Responsible Soy (RTRS). The RTRS is a global platform composed of the main soy value chain stakeholders with the common objective of promoting responsible soy production through collaboration and dialogue among the sectors involved in order to foster economic, social and environmental sustainability and overcome the sensitive issues upstream in the supply chain (producers and mills; see figure 12). The various RTRS participants (producers, industry, banks and civil society actors) have collaborated closely in developing a RTRS standard.

4.4 Case study: Norwegian farmed salmon supply chain[49]

Fisheries represent an important sector as a provider of animal proteins, minerals, micronutrients and essential fatty acids in human diets (16 percent of total global animal protein, 2008). 80 percent of the total fishery production is used for direct human consumption, while the remaining 20 percent that is obtained entirely from wild catch is destined mainly for feed (fishmeal and fish oil). Currently 46 percent of fish for human consumption is derived from aquaculture and this figure is estimated to reach 50 percent within the next decade (OECD/FAO, 2010).

49 Contribution from FAR Netherlands/Rabobank International.



China's aquaculture is the world's largest, accounting for more than two third of global aquaculture output. Global fish consumption per capita is estimated at about 17.1 kg. Approximately 38 percent of production (from wild catch and aquaculture) enters international trade, which makes fish the largest traded animal protein.

There are many species of fish (wild and aquaculture) and every species tends to have a specific supply chain and (international) market. In this study the supply chain of farmed salmon was studied and is presented as an example because of specific features relating to sustainability issues.

About 60 percent of the world's salmon[50] production is farmed; the other 40 percent is wild catch. The salmon are farmed in large nets in sheltered quiet waters (fjords, bays) or in tanks on land. A key feature of the production process is its long cycle, which is close to three years if measured from egg to final product. The key seawater stage is approximately one year. Salmon are fed a mixture of fish meal and fish oil, as well as a number of vegetable ingredients such as soybean meal, rapeseed oil and micro-ingredients. In recent years the industry[51] has succeeded in reducing the content of fish meal and oil (derived from wild-catch pelagic fish) in the feed in favour of vegetable ingredients.

Atlantic salmon is, by volume, the largest species of salmon in the world. This species is mainly farmed in Norway, Canada, the UK and Chile. These countries represent approximately 95 percent of the total harvest. All commercially available Atlantic salmon is farmed.

50 Salmon is the common name for several species of fish in the Salmonidae family (e.g. Atlantic salmon, Pacific salmon); other species in the family are called trout (e.g. brown trout, seawater trout). While several of these species are both wild and farmed, all commercially available Atlantic salmon is farmed. Typically, salmon are anadromous: they are born in fresh water, migrate to the ocean and then return to fresh water to reproduce.

51 According to industry data, approximately 1.2 kg of fish meal is used to produce 1 kg of salmon, compared to 4 kg several years ago.

Table 12 Sustainability issues of the soybean supply chain Brazil-China

Farm input	- Use of authorized/regulated pesticides - Use/storage/transport of pesticides according to law - Disposal of pesticides packages according to law - Disposal of waste with no soil/water contamination - Appropriate workplace safety & health conditions - Labour force (hiring, payment) according to law
Production	- Transparency of land ownership - Land use with licenses - Legal deforestation - Water use with licenses - GHG emission reduction - Disposal of waste with no soil/water contamination - Efficient energy consumption - Labour force (hiring, payment) according to law - Lodging/refectory adequate conditions - Absence of child & forced labour - Appropriate workplace safety & health conditions
Logistics & Origination	- Trusted product origin - Traceability - GHG emission reduction - Efficient energy consumption - Labour force (hiring, payment) according to law
1st Degree Processing **Trade & Exports**	- Environmental licenses - Disposal of waste with no soil/water contamination - GHG emission reduction - Chemical use according to law - Appropriate workplace safety & health conditions - Labour force (hiring, payment) according to law
Export Brazil-China	
Soybean imports	- GHG emission reduction - Appropriate workplace safety & health conditions - Labour force (hiring, payment) according to law
Crushing **Trade**	- GHG emission reduction - Chemical use according to law - Efficient energy consumption - Appropriate workplace safety & health conditions - Labour force (hiring, payment) according to law - Hygiene standards
Feed, meat and fish sector	- GHG emission reduction - Appropriate workplace safety & health conditions - Labour force (hiring, payment) according to law - Hygiene standards and quality control - Label requirements
Retail	- Tracking and tracing of sources - Labeling - Transparency - Certification
End-users	

Source: Rabobank

One of the key business risks in the salmon industry is disease outbreak. The most recent large-scale outbreak was the Infectious Salmon Anaemia (ISA) outbreak in Chile in 2007/08. The production of Atlantic salmon in Chile was reduced substantially, but currently ISA is considered to be under control and the industry is in the process of recovery. Moreover, the structure of the industry and the legislation were changed dramatically in order to prevent future outbreaks.
As stated, every fish species has a specific supply chain structure, which is also true for salmon. Figure 13 shows the long global supply chain structure of Norwegian farmed Atlantic salmon.

In the different stages of the supply chain different sustainability issues are at stake (figure 14). As before, the complex challenge in achieving sustainability in the global salmon supply chain is evident. In addition, large globally operating companies are in a strong position to anticipate global farmed salmon sustainability issues.

An important standard-setting initiative addressing the sensitive issues upstream in the supply chain is the Salmon Aquaculture Dialogue. This forum was created in 2004 with the objective of developing measurable, performance-based standards that minimise or eliminate seven key environmental and social impacts of salmon farming. The Dialogue is a 500-person round table that includes salmon aquaculture industry leaders, scientists and representatives from non-governmental organisations. To gain a better understanding of how to address the impacts, the Dialogue Steering Committee created geographically diverse and balanced technical working groups. These were given the task to research each impact in more detail, including with regard to disease, sea lice, escapes and feed. The standards of the Salmon Aquaculture Dialogue will be the first global standards for salmon aquaculture created through an open, transparent process that is aligned with the International Social and Environmental Accreditation and Labelling Alliance's renowned guidelines for creating standards.

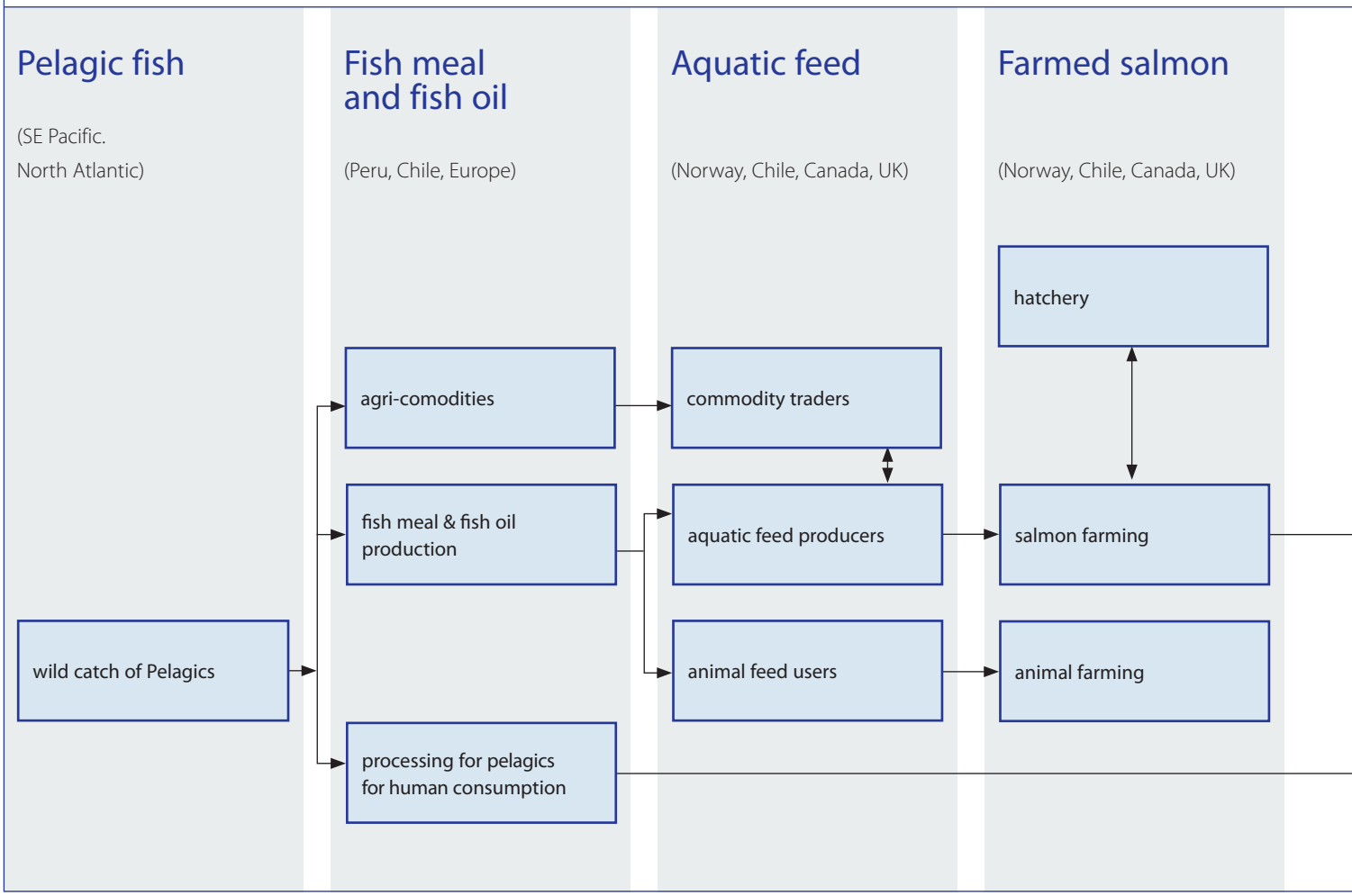
Sustainable development: a daily challenge

André Maggi Group has the vision to be a reference company for sustainable development. The inclusion of this challenge to our strategic planning was a bold decision, because we know that this is only possible through a continuous process that involves all our employees, as well as all our entire supply chain.
Our suppliers are strategically important and essential for the continued development of our business and, therefore, must be aligned with the principles and values of the Group. The challenge is to mobilize and commit our supply chain to these proper practices.
One example is the Qualification Program for the soybean suppliers of André Maggi Group, which seeks to advance responsible agricultural production, encouraging producers to grow their crops using best agricultural methods and sustainability as a reference point. The goal is to interact with producers whose production is commercialized by the Group, leading to a gradual improvement in terms of legal framework and socio-environmental performance standards.
Sustainable development is a core Group value, which leads to decision making challenges on a daily basis. The result of these efforts will be, with no doubt, an evolving society to which we are pleased to contribute. We also take pride to say that with the participation of our employees and stakeholders, we may help to transform it into a even better society!

Pedro Jacyr Bongiolo
CEO
André Maggi Group

GRUPO ANDRÉ MAGGI

Figure 13 Norwegian farmed salmon supply chain



Source: Food and Agribusiness Research and Advisory, Rabobank International (2010)

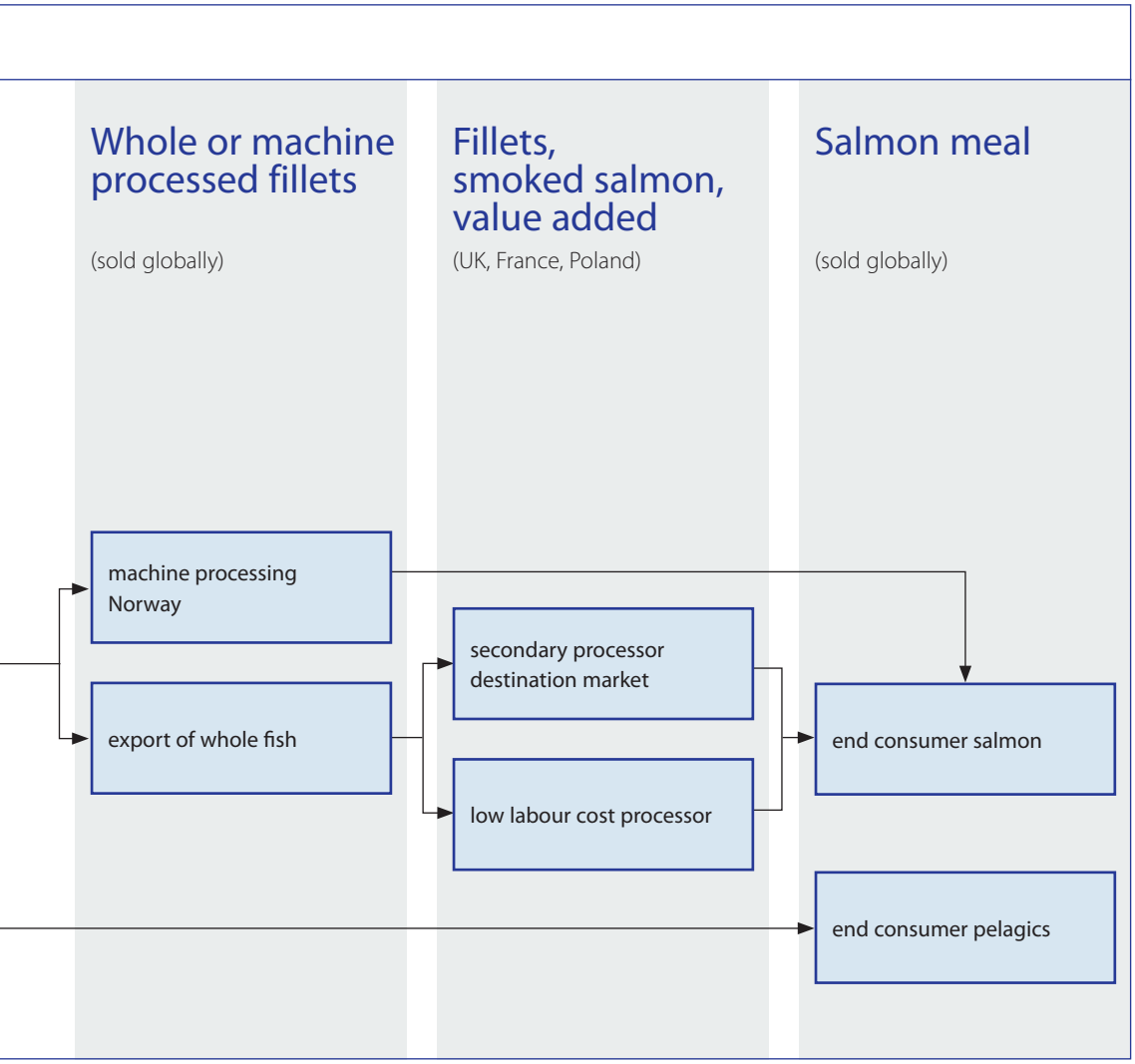
4.5 Conclusion

Different comprehensive surveys about Earth's potential to feed more than 9 billion people confirm that this could be possible under certain conditions. However, there are also uncertainties (impact of non-food use on food production, global warming and scarce water and nutrients) to be calculated and bottlenecks to overcome.

First of all, additional available land and water, two essentials for food production, are relatively scarce and unequally distributed in the world. In addition, there is much more room to raise food production by improving current crop yields and increasing crop intensification rather than large-scale expansion of scarce arable land. To improve crop yields (particularly in developing countries), many practical constraints – such as limited farm resources, lack of physical infrastructure and investment capital, farm management, poorly-functioning storage and marketing systems – have to be resolved.

As welfare and population grow, the current global unbalance of food supply and demand will increase and a shift in diet will occur. To bridge the resulting food gap an efficient and smooth international trade system is essential.

Food will consequently travel more and more miles across the world before it reaches the end consumers. Throughout this journey, several sustainability issues are at stake during the different phases of a supply chain. A consequence of the international food trade is that social and environmental concerns regarding food production in the country of supply have also become part of the international food trade system. For this reason, sustainable food supply chains are vital for the mid-term survival of producers and companies, especially because the world is on an unsustainable track (chapter 1). This means that all participants bear full responsibility for the sustainability of the entire food supply chain. The large trading, processing and retailing corporates can in addition exert their role as chain leaders and put extra pressure on their suppliers



by demanding sustainably produced products. In addition, consumers should take their responsibility and consume sustainable products. One complication is that there are a number of players that hold different positions in the food supply chain while the explanation of and experience with sustainability issues could differ per country or region (due to the absence of global standards). The most vulnerable link in the food supply chain are the producers/farmers, while agricultural input supply, processing, and retail and food service are increasingly dominated by multinationals. This imbalance of power in the food chain reflects the distribution of leadership and responsibility with regard to the sustainability of the global food supply system. That is why multi-stakeholder round tables and other initiatives have an important role as facilitators of the paradigm shift towards a sustainable value chain.

Table 14 Sustainability issues of the farmed salmon supply chain

Wild catch of pelagics species	- Overfishing is a key problem with pelagic species - Some species like Blue Whiting are migratory across different international waters. Some areas, like the SE Pacific are still unregulated Legislation has been inadequate to control fishing - 'Olympic style' fishing regulation needs to be replaced with ITQ or other quota systems where possible - Bottom of the food chain target species, like krill, should be exploited only when considering the impact on the entire food chain
Fish meal and fish oil	- Fish meal and fish oil is increasingly expensive as the volume of pelagic species harvested is at a maximum - Direct human consumption of pelagics or of fish oil for the production of omega 3 food ingredients is increasingly competing for the raw materials available to the aquaculture sector - The industry is focusing on producing fish meal from trimmings of seafood processing to increase the volume of production
Aquatic feed production	- Aquatic feed producers are key to the development of the aquaculture industry - The feed formula changes with prices of commodities. Particularly fish meal and fish oil are increasingly scarce and are being replaced with alternatives, such as soybean meal - Other sustainable alternatives are being developed based on algae, single cell protein, food processing waste, beer brewing waste, farmed insects and many more
Aquaculture	- Pollution and disease: aquaculture can spread pollution (feces and chemicals) and disease to the local water environment - Escapes: escaped fish and crustaceans can breed with the wild population deluding the genetic code - FCR: farmers need to limit mortality and improve FCR to limit waste and improve efficiency - Animal suffering: the fish and crustaceans need to live in a disease free, stress free environment with sufficient space
1st Degree Processing	- Animal suffering: fish (and crustaceans) need to be transported and slaughtered in a humane, painless and stress free way
Trade & Exports	- Due to demand of fresh seafood increasingly more products are transported by plane particularly fresh salmon and tuna. These products have a huge carbon footprint - Refreshing (defrosting) and transport in high CO_2 environment are increasingly becoming alternatives to plane transport - Cheating, like including large volumes of water or mixing certified product with uncertified products is damaging to the industry
2nd Degree Processing	- A large part of secondary processing is being done in low labour cost countries. This may result in fish being transported long distances to the processing destination such as China or North Africa - Hygiene standards need to be maintained which can be challenging in some regions - Appropriate workplace safety & health conditions - Labour force (hiring, payment) according to law
Retail	- Tracking and tracing of sources - Labeling - Transparency - Certification
End-users	

Source: Rabobank

5 Conclusion and discussion

There is sufficient global potential to produce the food required to feed the world population that will total more than nine billion in 2050. Balancing global food surpluses and shortages between the different regions/countries, and meeting the needs of dietary change do not consequently constitute the foremost challenge for future food security. The main challenge instead involves working incrementally towards enhancing the sustainability of the global food system. Achieving sustainability within the long supply chain that encompasses different countries and numerous participants and stakeholders is, however, not an easy task. Moreover, there are numerous uncertainties and constraints that must be tackled on time in order to produce the 70 percent more food that will be needed to feed the world in 2050. New challenges and opportunities must in turn be seized and stimulated.

5.1 Sensitivity of long-term projections of global food production

Referred studies and articles concluded that there are sufficient potentials on earth to produce enough food to feed the world. Behind the long-term food projections entail, however, numerous uncertainties, constraints and challenges.

The main uncertainties include:

- Level and speed of income growth (increasing food demand and dietary shift).
- Global warming (greater fluctuation in food production).
- The use of biomass for the production of biofuels and raw materials for non-food applications, particularly for the chemical and pharmaceutical industries, which will consequently compete for agricultural production capacity, water and nutrients.
- Development of other sectors, such as the energy sector, that are linked to agriculture and that will consequently affect food prices.

These uncertainties could have a significant impact on crop production levels and food security in the long term.

The main constraints include:

- Limited and unevenly distributed suitable arable land and fresh water around the world.[52]
- The fact that crop yields will continue to grow, but at a slower rate than in the past.
- Limited carrying capacity of the vital ecosystems.
- The increasing scarcity of water and nutrients and decreasing soil productive quality, leading to lower food production.

52 Much of the suitable land that is not yet in use is concentrated in a few countries in Latin America and Sub-Saharan Africa and much of the land also suffers from constraints (chemicals, lack of infrastructure, endemic diseases, etc.). In contrast, a number of countries in the Middle East/North Africa and South Asia have reached the limits of land and water availability.

- The available resources, such as investment capital for upstream and downstream agricultural activities and entrepreneurship and support services that are required for additional food production also vary by country/region. The countries of Sub-Saharan Africa are lagging behind the most, while the conditions in Latin America (Brazil and Argentina) provide scope for expanding agricultural production to a more efficient level.
- Agriculture is one of the largest contributors to global warming due to the use of fossil fuels and chemicals and the emission of methane from particularly rice fields and dairy cattle.

On the demand side, demographic and economic growth and a shift to an animal protein diet will lead to an approximately 70 percent increase in food demand in 2050 in comparison to 2005/07 levels. The food demand of emerging economies, particularly China, is expected to grow exponentially. Current food-importing countries will expand their food imports because they lack the natural resources (additional suitable land and water) required to expand their food production.

The main challenges include:

- The local food supply chains of individual countries should be integrated into a sustainable global food supply system.

As a consequence of these geographical inequalities on both the supply and demand side, the food gap between countries/regions will grow and the international food trade will expand further in the future.
Local and global food supply chains will have to be connected and function as one system in order to achieve food security in a sustainable manner. This will be accompanied by huge shifts in terms of trade patterns, regulations, markets, consumer preferences, pricing of inputs and outputs, risk management and measurement of business profit and loss. Sustainability issues will, however, be at stake during every stage of the global supply chain. In addition, the sense of urgency, interpretation and experience of sustainability issues could vary by country/region owing to differences in socio-economic, cultural and food standards. Institutions and organisational structures will have to be adapted in order to support and facilitate these shifts.

- The global food trade needs price signals and rules in order to maintain stable global agricultural markets based on the future trends and outlook.

Markets and trade also play a crucial role in achieving global food security by increasing access to food. Well-functioning markets transmit price signals that make it possible for changes in demand to be met by supply. Governments have a role in creating the conditions for sustainable food systems and supervising the results in order to enable the market to operate.
The recent global food crisis highlighted the fact that current national agricultural policies and the current world trade rules may not be adequate to prevent such a crisis in the future. The drivers and needs of a long-term global agricultural trade consequently need to be reviewed. Improving the international mechanisms for preventing and/or managing sudden extraordinary food price spikes is one of the suggestions for improvements being put forward. Agricultural trade among developing countries (South-South trade) is seen as a promising component for economic growth. Integrated regional markets could increase food availability, decrease price volatility and provide greater incentives for private investment.[53]

53 United Nations Conference on Trade and Development, 'Development and Globalisation: Fact and Figures', UN, Geneva, 2008.

- Huge investments in current agriculture[54], especially in developing countries, are needed in order to meet the future needs for food.

Huge investment capital is needed for improving farming conditions including post-harvest, transport and logistics facilities in order to minimise yield losses and the reclamation or renovation of farmland. The enabling environment will, however, need to be improved with a view to attracting private investment to developing countries (primarily Africa). Furthermore, large investments will have to be made to bring about a 'Green Revolution.2' in order to improve the resource efficiency of crops. Plant, animal and food systems will have to be adapted rapidly to changing temperature, nutrient and water conditions. Many times more investment will be required in order to apply and market innovations worldwide.

- More sustainable consumer behaviour must be promoted.

In addition to pricing, consumers should be better informed regarding the consequences of their behaviour (which is basically their own free choice) on the environment, animal welfare and the Earth's long-term productive capacity.

5.2 Sense of urgency

The sense of urgency for taking action to secure future food security is becoming increasingly clear. Besides demographic and economic growth, natural resources such as fertile soil, clean water and air, rainforest, plant extracts and genes are the key drivers behind the transformation of the global food supply system. A price will sooner or later have to be paid for the use of these vital resources for agriculture, which have been known as 'free goods' since ancient times. The prices of water, minerals, nutrients, fossil energy, genes, etc. will rise as strategic reserves become more and more exhaustible or as a means of mitigating the high cost of environmental pollution and the effects of global warming. The existence and emergence of various emission trading systems around the globe, which are currently only operated in the developed world, are the first examples of this development. These include the New South Wales Greenhouse Gas Reduction Scheme in Australia, the EU ETS and the Regional Greenhouse Gas Initiative in the U.S.A.

It must furthermore be noted that not only threats, but also new business developments and particularly new industrial processes, products and markets for agriculture and agribusiness based on this new situation will arise during the transition process. For example, higher fossil energy prices or costs for these emission trading systems will stimulate both the use of biofuels by the transport sector and the use of biomass as a raw material for the non-food industry (chemical, pharmaceutical, etc.). The development of second generation biomass conversion technology is expected[55] to open up new market opportunities for biomass (agriculture) in the long term.

All these developments will affect the current economic and business models and even the long-term strategies and competitive/market positions of companies of the global food supply chain. The valuation of scarce natural resources will, sooner or later, be factored gradually into companies' balance sheets. In this view new business opportunities will arise as part of the build-up to the internalisation of the new costs of resources. Private sector companies in the global food supply chain

54 Securing a sustainable global food supply requires more than only increased commodity trade, although this would certainly help to mitigate demand-supply imbalances. New technologies and system innovations that can improve the efficiency of resource usage and reduce adverse impact are needed.

55 It could induce a transformation of the current fossil-based economy into a bio-based economy.

should take the lead in exploring new opportunities and implementing them into their business models as a means of transforming supply chains into value chains. They should furthermore be at the vanguard of anticipating tomorrow's global food & agribusinesses in order to meet the long-term food security challenge. Governments in turn have a role to play in creating and facilitating the conditions for sustainable food systems and supervising the results. They are, after all, ultimately responsible for the food security of their countries.
In conclusion, business has had and will continue to have a leading role to play in terms of connecting food demand and supply worldwide in a sustainable manner. 'Business must lead this transformation by doing what business does best: cost-effectively creating solutions that people need and want.' (World Business Council for Sustainable Development, 2010).

The key questions that must be addressed going forward are:

1. To what extent are individual businesses and the worldwide business community prepared to meet the long-term food challenges?
2. What impact will the scarcity of vital natural resources and the loss of ecosystem services have on the long-term growth potential of individual companies? How can this be factored into the balance sheet?
3. What lessons can be learned from the experiences so far and what implications do these findings have for the own business strategy and model?
4. In view of the fact that the global food supply chains consist of numerous players, which ones are going to take the initiative and are the others willing to co-operate and take risk?

Final word

To quote Nelson Mandela, former president of the Republic of South Africa:

'Vision without action is only dreaming.
Action without vision is merely wasting time.
But vision with action can really change the world.'

Box 3: Rabobank Group

Rabobank - A global food & agribusiness bank

Rabobank has a unique co-operative organisational structure. As a co-operative bank we are not shareholder driven. Rabobank is comprised of the 143 independent local member banks located in the Netherlands. The Rabobank Group is made up of this network of independent banks together with the centralised organisation Rabobank Nederland and its subsidiaries including Robeco, Sarasin, De Lage Landen and Rabo Real Estate Group. More than 1.8 million clients are members of their local co-operative Rabobank. This organisation structure lies at the heart of the bank's core strengths. Rabobank combines a global outlook with a local focus. By operating collectively, the Rabobank organisation has gained vast expertise and genuine economies of scale that are the driving force behind its continual improvement of products and services in the Netherlands and abroad. The Rabobank Group serves the entire food supply chain from input suppliers, (primary) producers and processors to traders and retailers.

"The food & agribusiness is firmly anchored in the bank's origins and is what we are best at. The sector offers numerous opportunities. With a growing world population, the demand for food and food-related products will only increase," explains Sipko Schat, Member of the Executive Board of Rabobank Nederland.

Rabobank has a proven track record in the food and agricultural sectors. Through its long history it has grown from a local Dutch agricultural co-operative bank into a financial institution that provides financial services to major food and agricultural clients around the world. Rabobank adds value to its clients' businesses across the food chain. Whether they are a primary producer seeking financing for crop development, a global trader wishing to hedge commodity risks or a processor with plans for international expansion, they can all turn to Rabobank for the required expertise, services and products.

Sustainability is not a free choice, but rather a precondition for future prosperity

Rabobank's added value extends far beyond traditional banking services. Thanks to its origins and history, the bank clearly recognises the food & agri sectors' vulnerability to high-risk trends such as the increasing scarcity of natural resources and growing pressure on available land that can endanger food security. Rabobank fully understands the enormous impact these global issues could have

on its clients' businesses and believes that solutions to these issues can be found in an integrated approach that provides guidance and direction pointing to a sustainable and profitable future. The bank's Food & Agribusiness Principles form the guidelines for this approach. It is vital that supply chains become sustainable in order to be able to address the risks related to global environmental change and resource scarcity. Rabobank's clients in the food & agricultural supply chains face a number of challenges and issues in their business operations. Innovative solutions consequently need to be integrated into their day-to-day business. Sustainable resource management will be key to their businesses' long-term viability. The positive and negative impacts that clients' activities could have on society and the environment throughout the supply chain must be taken into full consideration as part of the bank's decision-making processes. Rabobank is convinced that sustainability is not an option, but rather a precondition for the future prosperity of the bank, its clients and society.

Client engagement: Solving CSR-related issues in partnership

Our commitment to join forces with our clients to secure a sustainable future is reflected in our conscious decision to make respect, integrity, professionalism and sustainability our core values. We provide our clients with local insights based on knowledge of the major F&A sectors worldwide, relevant issues and trends. Rabobank is dedicated to contributing to the sustainable economic, social and ecological development of society.

Rabobank seeks to contribute to the realisation of value chains by client engagement based on supply chain policies for supporting sustainable practices. The philosophy behind engagement is based on entering into constructive dialogue with clients to identify and and to find solutions. The objective of engagement is to solve CSR-related problems in partnership with the client and to meet the challenges for the future.

Rabobank works on the basics of sustainable value food chains

As this study reveals, sustainable increases in production and economies of scale can be achieved in the food & agri supply chains through an integrated approach with a local focus on crops. This will in turn make it possible to safeguard food security. The drivers behind this transition are access to knowledge and financing, efficient and intelligent utilisation of scarce resources such as fertile land and clean water, a developed infrastructure, good conditions for business, a link between products and market players (a better product for a better price) and improved access to sales markets. Another important development is that new players are focusing more strongly than traditional farmers on the industrial (bio)synthesis of among others proteins and biopolymers. Sustainable production chains are emerging in which the generation of sustainable energy (including energy from refuse) and the concept of cradle to cradle are integrated. The connection with the product's origins and adding value to the product is becoming increasingly important for consumers. What role can Rabobank play in this respect? Rabobank is committed to contributing to this development by carrying out the following activities based on its co-operative strength and expertise relating to the food & agri sectors:

- Setting up a robust financial-economic infrastructure via Rabo Development in developing countries through participating interests in banks in rural regions such as Tanzania, Mozambique, Rwanda and Zambia.
- Providing technical assistance via the Rabobank Foundation to co-operatives of poor farmers with respect to organising corporate governance, financial management and trade transactions that are focused on realising quality and yield improvements and ultimately a better standard of living.
- Playing an active role in sector-wide alliances, such as the RSPO, RTRS and BSI round tables, that are aimed at promoting a transition of food & agri production chains into sustainable value chains.
- Strengthening partnerships and coalitions in the food & agri chains by expanding the involvement in the Dutch Fair Trade Initiative (IDH) or by initiating alliances such as the Corporate Leadership Coalition for Smallholder Farmer Livelihoods in the role of co-founder. These initiatives form excellent platforms for joining forces with clients (large corporates) to increase the sustainability of F&A sectors such as the cocoa, cotton, fishery and meat production sectors.
- Financing innovative developments in both the food & agri sector and in the energy and transport sectors.
- Working with partners to explore how new non-traditional products from proteins, carbohydrates or chemical plant compounds can be approached and organised in a different manner.

These activities will enable the Rabobank Group to provide its expertise for both the present and the future. They also reflect the long-term vision that is crucial for success, especially in the food and agribusiness industry. This commitment and forward-looking perspective will give our clients a competitive advantage.

References

1. Alexandratos, N., (2009), 'World Food and Agriculture to 2030/2050, Highlights and views from mid-2009', FAO, Rome.
2. Bishop, J., et al., (2010), 'The Economics of Ecosystems & Biodiversity, Report for Business', Executive summary, London.
3. Bruinsma, J., (2009), 'The resource outlook to 2050: By how much do land, water and crop yields need to increase by 2050?', FAO expert meeting on How to Feed the World in 2050, Rome.
4. Diepen, K., van, Bolck, C., Koning. N., Loffer and Sanders J., (2009), 'Het technisch potentieel voor de wereldproductie van biomassa voor voedsel, veevoer en andere toepassingen', LEI-report 2009-086, Wageningen.
5. FAO (2006), 'World agriculture: towards 2030/2050', Interim Report, Rome.
6. FAO (2009), 'The state of food and agriculture', Rome.
7. FAO (2010), 'Food outlook', Rome.
8. Fischer, G., et al., (2001), 'Global agro ecological assessment for agriculture in the 21st century'. IASA/ FAO, Vienna.
9. Fisher, G., (2009), 'World food and agriculture to 2030/2050: how do climate change and bioenergy alter the long-term outlook for food, agriculture and resource availability', FAO Expert Meeting on How to Feed the World in 2050, Rome.
10. Fisher, R.A., Buyerlee, D., Edmeades G.O., 'Can technology deliver on the yield challenge to 2050?' (2009), FAO Expert Meeting on How to Feed the World in 2050, Rome.
11. Fresco, L.O., (2009), 'Challenges for food system adaption today and tomorrow', Environmental Science & Policy 12 (2209) 378-385, Elsevier, Amsterdam.
12. Hallam, D., (2009), 'International investments in agricultural production', FAO Expert Meeting on How to Feed the World in 2050, Rome.
13. Hebebrand, Ch. and Wedding, K., (2010), 'The role of markets and trade in food security', Center for Strategic and International Studies, Washington.
14. Hoekstra, A.Y., (2010), 'The water footprint: water in the supply chain', In: The Environmentalist, March.
15. International Food Policy Research Institute and Asian Development Bank (2009), 'Building Climate Resilience in the Agricultural Sector in Asia and the Pacific', Manila, Philippines.
16. Koning, N.B.J., Van Ittersum, M.K., Becx, G.A., Van Boekel, M.A.S.J.S., Brandenburg, W.A., Van den Broek, J.A., Goudriaan, J., Van Hofwegen, G., Jongeneel, R.A., Schiere, J.B. and Smies, M., (2008), 'Long-term global availability of food: continued abundance or new scarcity?' In: NJAS Wageningen Journal of Life Sciences 53 (2008) 3. pp. 229-292.
17. Kowalski, P. and Shepherd, B., (2006), South-South Trade in Goods, OECD Trade Policy Working Paper no. 40, Paris.
18. Mensbrugghe, D. van der, Osorio-Rodarte, I., Burns, A. and Baffes, J. (2009), 'Macroeconomic environment, commodity markets: A long-term outlook', FAO Expert Meeting on How to Feed the World in 2050, Rome.
19. Msangi, S. and Rosegrant, M., (2009), 'World Agriculture in an Dynamic-Changing Environment: IFPRI's Long-term Outlook for food and agriculture under additional demand and constraints', FAO Expert Meeting on How to Feed the World in 2050, Rome.
20. OECD-FAO (2010), 'Agricultural Outlook 2010-2019', Paris.
21. Sarris, A., (2009), 'Evolving structure of world trade and requirements for new world trade rules', FAO Expert Meeting on How to Feed the World in 2050, Rome.
22. Schmidhuber, J., Bruinsma, J. and Boedeker, G., (2009), 'Capital requirements for agriculture in developing countries to 2050', FAO Expert Meeting on How to Feed the World in 2050, Rome.
23. Stephenson, J., (2010), 'Livestock and climate policy: less meat or less carbon?', Round Table on Sustainable Development, General Secretariat, OECD.
24. World Bank (2010), 'World Development Report 2010, Development and climate Change', Washington D.C.
25. World Business Council for Sustainable Development (2010), 'Vision 2050, the new agenda for business', Geneva.

Colophon

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