EU Agricultural Markets *Briefs*

No 8 | November 2015

World agricultural production developments

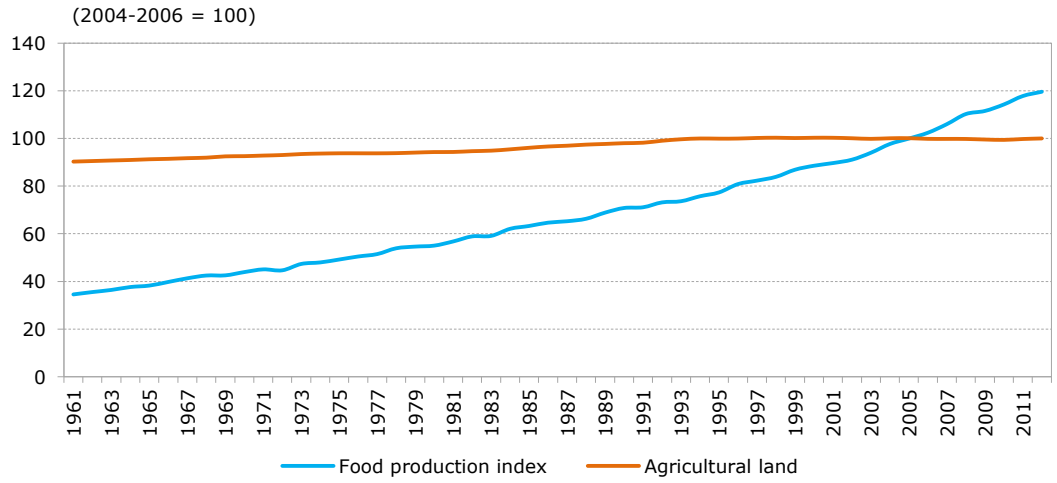
Contents

Since the mid-2000s agricultural and food prices moved to a higher level and in parallel with prices of other commodities – and at times have also been very volatile. These events led to concerns which, in different ways, brought to the forefront a debate about food security. Both developed and developing countries saw their consumers facing the impact of higher food prices, and their producers feeling the pressure from higher input costs.

In a series of *Briefs* (on Demand, Regional influences, Supply and Stocks) we analyse evolutions in different drivers responsible for these price developments separately and bring them together in a concluding *Brief*.

This fourth *Brief* focuses on developments in agricultural production over the last 5 decades.

Graph 1 Evolution of world food production index and agricultural land index



Source: DG Agriculture and Rural Development based on data from FAO (Faostat).

EU Agricultural Markets Briefs are available on Europa:
http://ec.europa.eu/agriculture/markets-and-prices/market-briefs/index_en.htm

Agriculture and Rural Development

1. Introduction

World demand for food is steadily increasing, driven by the combined effect of population and income per capita growth. Supply is currently still able to meet this demand. Is this due to an increase in production area or to an increase in productivity? Are there regional shifts in production? And what can we expect for the future? Is there still room for further agricultural expansion? Can yield growth continue, given important demographic and environmental stresses on the main production factors? This *Brief* tries to shed some light on these questions.

To make the story more tangible, we distinguish between five periods[1] characterized by important macro-economic or geo-political events and between developed and developing countries[2].

2. Changes in supply growth

Food production is growing steadily…

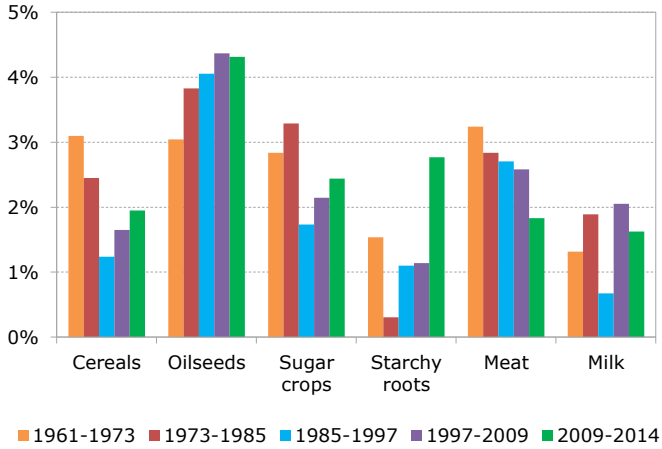
The food production index (based on a basket of weighted food products, Graph 1) shows a steady increase (best fit by an exponential function) over the last fifty years. The growth rate over the different periods is fairly stable around 2.7% per year. As a consequence, production has tripled compared to the 1960's.

… but differences exist between commodities…

The Golden sixties, with the start of the Green revolution, was a period of overall strong production growth. The turbulent late eighties and early nineties, marked by strong political reforms and recession, show overall the lowest production growth. The period of the financial and economic crisis (1997-2009) is not marked by excessive production growth. Realizing strong growth rates from a larger base becomes increasingly resource and technology demanding; yet the current period seems to indicate a period of strong production growth for the majority of commodities.

Zooming in on the different commodities reveals a more diverse picture. Oilseed production shows overall the steadiest and strongest growth, driven by expanding food, feed and industrial demand in both developed and developing regions. Meat production growth is in turn decreasing over the different periods, mainly driven by developments in cattle and pigs, while growth in poultry compensates to some extend the decline in the former two. Dairy shows a continuous moderate growth between 1 and 2% per year (except during the turbulent period of the USSR collapse), while sugar crops, starchy roots and cereals all follow a parabolic growth curve from high growth in the sixties to lower growth in the eighties, with some recovery afterwards.

Graph 2 World production growth for major agricultural commodities



Source: DG Agriculture and Rural Development based on data from FAO (Faostat).

… and between regions

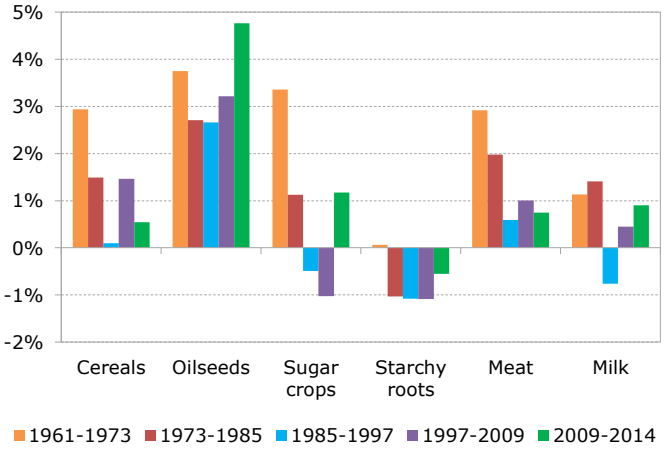
In **developed countries** overall production growth is slowing down since the sixties. This is due to the approaching of physical production limits and/or increased competition from developing regions, making it economically less interesting to grow certain products. The steady replacement of basic grains by other food products is noticeable in the cereal growth rates. Oilseeds demonstrate the most dynamic growth, explained by favourable market and policy conditions. Milk production seriously suffered from the disintegration of the former USSR, while meat production growth is also decreasing over the long run. This can be associated with the attainment of limits to genetic potential, the effect of quality and

[1] The period *1961-1973* is known as the 'Golden sixties' with prosperous economic growth. The period of *1973-1985* started with the first oil crisis and was marked by high oil prices and a general recession. The period of *1985-1997* was, with the fall of the iron curtain, characterized by strong political and institutional reforms. In the period *1997-2009* world economy boomed under the liberalisation of markets and the growth of middle income countries, to end with the bubble of the financial and economic crisis of 2009. The last period, *from 2009 till today*, shows the recovery of the world economy after its major economic crisis. Choosing other periods affects the magnitude of these results but not the main trends.

[2] Following common practice, we have considered Europe, United States, Canada, Australia, New Zealand and Japan as 'developed'. In some cases and for statistical reasons, all former USSR countries have been considered as developed.

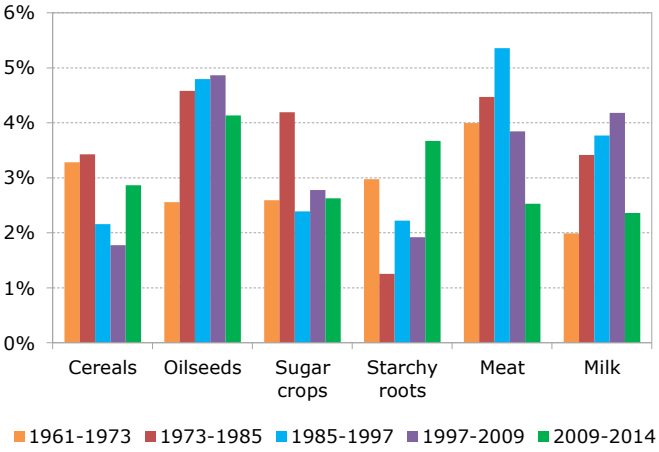
environmental requirements, shifts in the diet, increasing production costs as well as increased competition from the developing countries, most notably Brazil and Argentina. Sugar production also shows a steady retreat, apart from the last period, mainly due to increasing low cost sugar cane production from Brazil and lately replacement in the diet due to health concerns. Starchy roots, mainly potatoes, show a negative growth over the different periods, which can be related to dietary shifts and difficulties to control diseases when intensifying production.

Graph 3 Production growth for major agricultural commodities in developed countries



Source: DG Agriculture and Rural Development based on data from FAO (Faostat).

Graph 4 Production growth for major agricultural commodities in developing countries



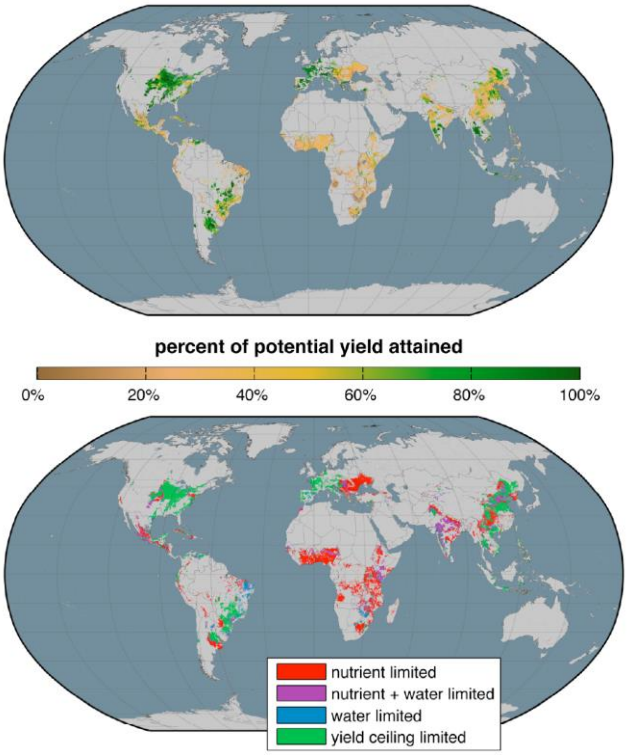
Source: DG Agriculture and Rural Development based on data from FAO (Faostat).

The **developing world** shows a more dynamic picture. Growth rates are much higher, but production starts from a lower base. These numbers point out that future production expansion could mainly be expected in the developing world. As in developed countries, growth rates for meat also show a steady retreat over the last periods, while dairy is recovering.

Strong production expansion in the eighties and nineties in China, Brazil, India and the far South East can explain this. Starchy roots production growth is increasing, driven by cassava for food and industrial use, as opposed to the more developed countries, where potato production growth shrunk over the last few periods. Maize production increase is mainly responsible for the recent higher cereal growth number after periods of declining growth.

The higher growth rates in developing regions can be partly explained by the wider yield gap remaining. The maps below show the yield attainment for maize and factors limiting a further yield increase of 50%. In the US, Europe, Brazil and Argentina full yield potential is achieved, while mainly in Sub-Saharan Africa, India, Ukraine and South-East Asia, there is still scope for further improvement, however hampered by lack of nutrients and/or water.

Map 1 Percent of total maize yield attained and limiting factors



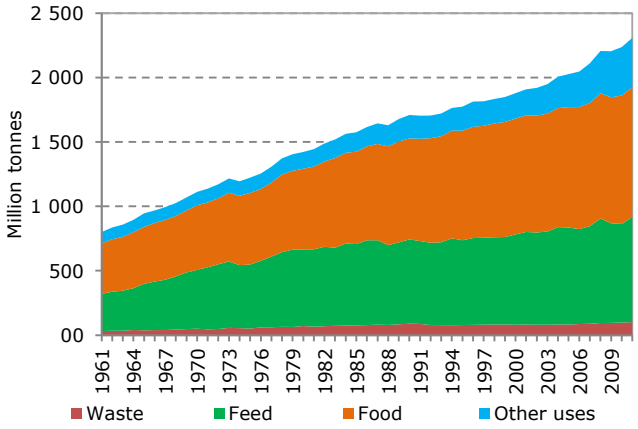
Source: Foley *et al.,* 2011[3].

[3] Foley, J.A. *et al.* (2011). Solutions for a cultivated planet, Nature, 478, 337-342.

Production for industrial use is gaining importance

World cereal production for food use has steadily increased during the last fifty years, while feed use expanded more rapidly in the sixties to follow a more moderate growth after the first oil crisis. Cereals for other uses (seed, processing, biofuel and other) also show a steady growth path until the beginning of 2000, after which they started expanding rapidly, nearly doubling in 10 years. The strong demand from emerging economies and the biofuel sector are the main driving forces. In the case of vegetable oils, industrial use now matches food use, with growth rates of 9% in the 1997-2009 period and 7.1% in the 2009-2013 period compared to 2.5% and 2.9% for food use. We thus see an acceleration of agricultural production for industrial uses.

Graph 5 Different uses of world cereal production



Source: FAO (Faostat).

3. Main ways to realize supply growth

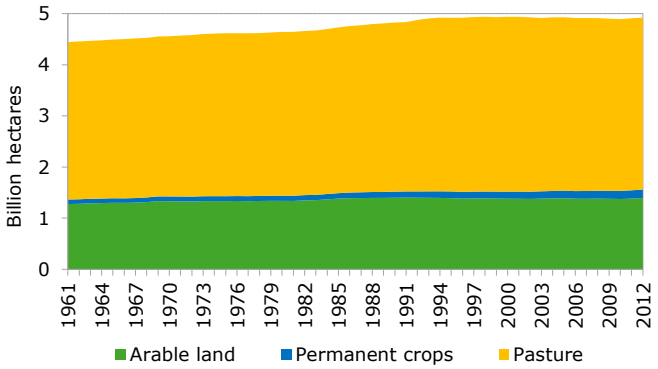
When production follows the demand developments, prices remain stable. The increasing demand (see Markets *Brief* No 6) can either be met by higher yields (or more intensive animal production), increased cropping intensity and/or bringing more land into production.

Agricultural area is no longer expanding…

Currently, nearly 38% (4.9 billion ha) of global land surface (13 billion ha) is used for agricultural production, compared to 34% in 1961. The permanent meadows and pastures area has increased most in absolute terms (+281 million hectares), but its growth rate has dropped to around zero after 2000.

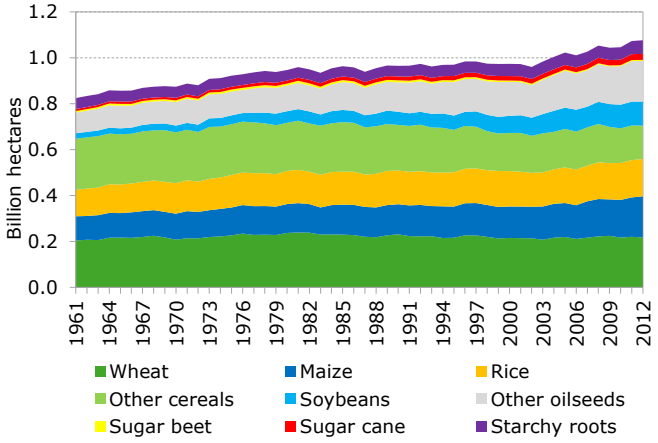
Permanent crops increased most in relative terms (+85%), but their share in total area remains marginal. The total irrigated area has grown steadily over 1% per year to reach 324 million hectares currently. The world agricultural area is no longer increasing due to increased competition from other uses (urbanisation, industry, transport infrastructure, nature restoration), low fertility of remaining land and environmental concerns.

Graph 6 Evolution in world agricultural area



Source: FAO (Faostat).

Graph 7 World crop area evolution of major commodities



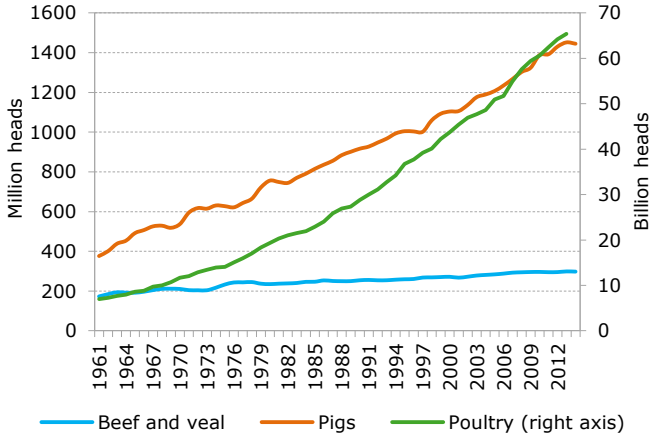
Source: FAO (Faostat).

World area for the major crops (not including permanent crops, vegetables and permanent grassland) has increased by about 300 million hectares over the last 50 years. The majority of the cropped area is devoted to cereals (about 650 million hectares). Of these cereals, wheat has the largest and most stable share, while maize is the most dynamic, especially in the last decade. Other cereals, such as oats and barley, account for the largest decrease in cropped area.

Oilseed area expansion is most explicit, especially for soybean, which has increased more than five-fold. Sugar crops are marginal in the total area, but, within the sugar crops, sugarcane is most dynamic, with the area quadrupled in five decades, while sugar beet area shrunk. The area of starchy roots, such as potatoes and cassava, has slightly increased, mainly due to cassava in the developing regions.

Land use is also influenced by the number of animal heads, which has also increased exponentially, especially for pigs and poultry. The earth is now populated by 1.4 billion pigs and 64 billion poultry birds. Compared to 50 years ago, we now count an additional billion pigs and more than 50 billion poultry birds. Beef and veal did not experience such a huge increase, from a little over 170 million in 1961 to 300 million heads now. It is clear that this expansion of animal heads has drastically transformed our agricultural and cropping landscape. As indicated by Foley *et al.* (2014), North America and Europe devote only about 40% of their croplands to direct food production, whereas Africa and Asia allocate typically over 80% of their cropland to food crops. Averaged across the globe, 62% of total crop production (on a mass basis) is allocated to human food, 35% for animal feed (which produces human food indirectly, and less efficiently, as meat and dairy products) and 3% for bioenergy crops, seed and other industrial products.

Graph 8 Evolution of world number of animal heads



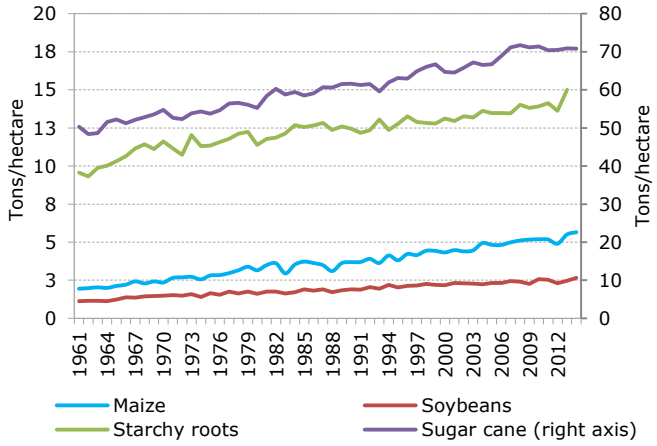
Source: FAO (Faostat).

... and yield growth is also not increasing

Crop yields have substantially increased since the 1960s. This achievement resulted from a combination of advances made in technology and farm management. Improved seeds, more investments in soil fertility, better pest pressure reduction, irrigation, optimized breeds, economies of scale, better machinery for planting and harvesting, more skilled farmers with access to better data and advisory systems all contributed to higher yields.

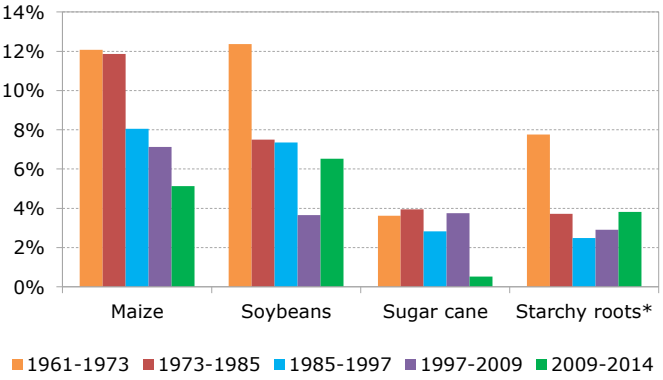
Graph 9 shows the steady yield improvement for four different commodities (maize, soy, sugar cane and starchy roots). While serious improvements have been made (1.5 to 3 times the 1961 yield), differences in yield increase between crops are still huge. Also within crops, regional differences are important. Yield variation (Graph 10) also varies between commodities, but generally seems to be trending down over time.

Graph 9 Yield evolution for major crops



Source: FAO (Faostat).

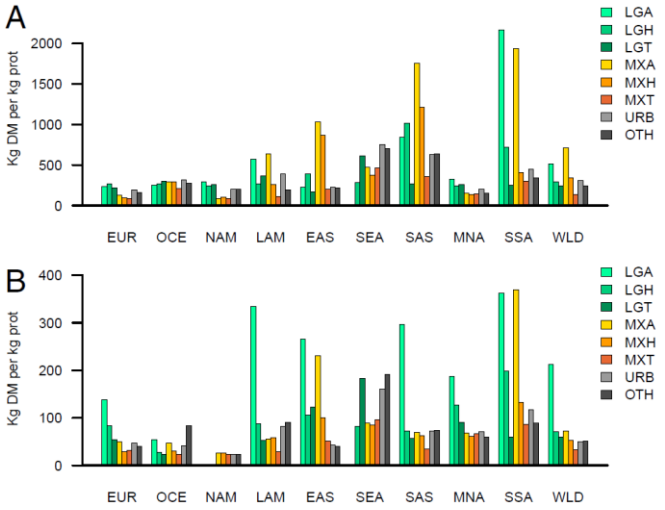
Graph 10 Yield volatility



Source: DG Agriculture and Rural Development based on data from FAO (Faostat). *Data until 2013

Part of the crop production is devoted to animal feed. Graph 11 shows the feed use efficiency (expressed as kg dry matter necessary to obtain 1 kg of proteins) of meat (A) and dairy (B) cattle across different regions and systems. The graphs confirm the leading position of the more developed regions (Europe, Oceania and North America), while Sub-Saharan Africa has the least efficient conversion of dry matter into animal proteins. Depending on the region, the type of system also differs in feed use efficiency.

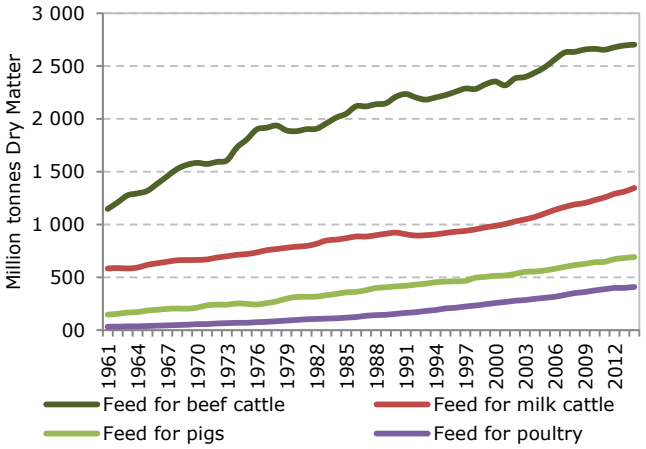
Graph 11 Feed use efficiency of cattle meat (A) and dairy (B) in different regions* and systems



* EUR = Europe; OCE = Oceania; NAM = North America; LAM = Latin America; EAS = Eastern Asia; SEA = Southeast Asia; SAS = South Asia; MNA = Middle East-North Africa; SSA = Sub-Saharan Africa; WLD = World.
Source: Herrero *et al.,* 2013[4].

As indicated by Herrero *et al.* (2013), globally, livestock consumed about 4.7 billion tonnes of feed biomass in 2000, with ruminants consuming the bulk of feed (3.7 billion tonnes compared with 1 billion tonnes by pigs and poultry). Overall, grasses comprise some 48% (2.3 billion tonnes) of the biomass used by livestock, followed by grains (1.3 billion tonnes, 28%). These numbers, and Graph 12, entail that ruminants still outcompete monogastrics with respect to total grains consumption (1.3 billion tonnes versus less than 1 billion tonnes).

Graph 12 World dry matter feed use for animal production



Note: There is some double counting between beef and milk as part of the feed for milk also results into muscle growth.
Sources: Feed conversion ratios from Globiom and Animal production data from Faostat.

Land use intensity increase is limited

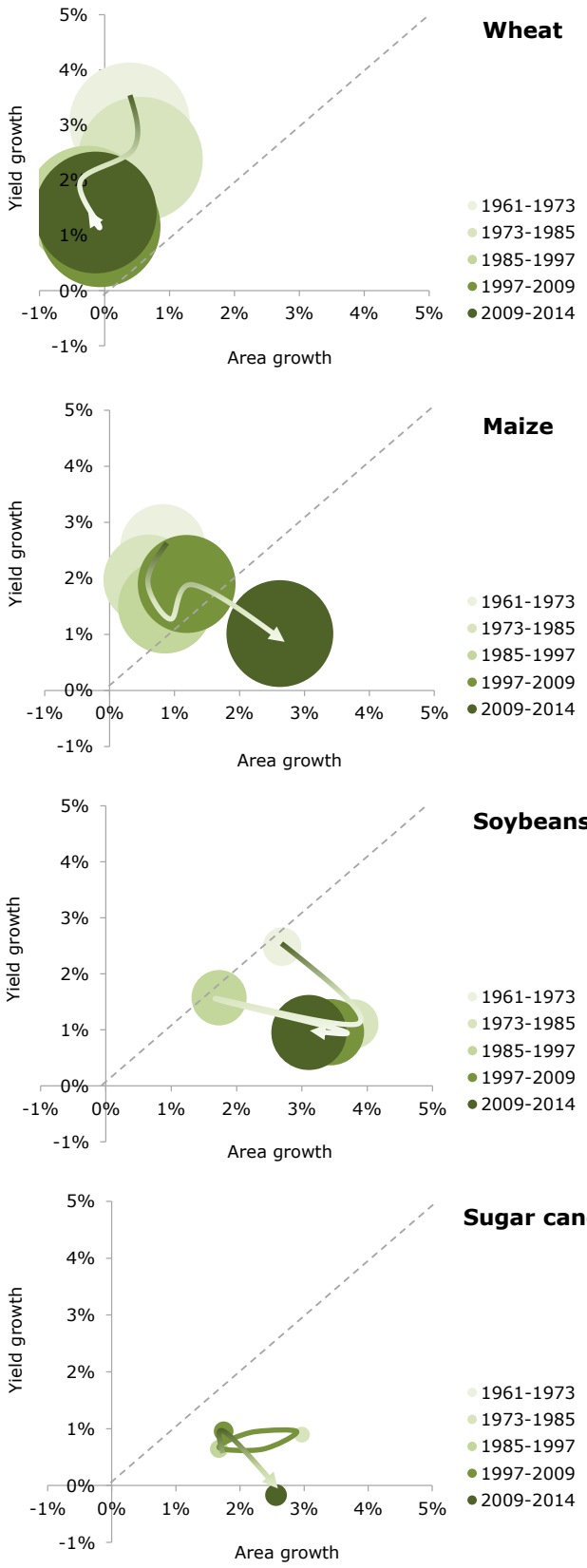
FAO (2012) reports that over the last 50 years, increases in cropping intensity (i.e. more plantings/rotations per hectare per year) account for about 9% of world crop production growth, while yield increases accounted for 77% of the increase and arable land expansion for 14%. The share of cropping intensity increase in production growth is expected to shrink further in the coming years. In some developing regions, such as Sub-Saharan Africa, the share was 31%, while in others, such as East Asia, cropping intensity even decreased (-6%).

Yield versus cropland growth

The different crops however show different dynamics (see Graph 13). Wheat area growth is steadily declining across the different periods. Yield growth declined as well, to pick up again in the current period, outpacing area growth. Production growth is thus mainly realized through yield growth. Maize shows a different dynamic, with yield growth declining over time while the area is increasingly expanding. The question remains whether the area expansion triggered the reduction in yield growth due to the use of less fertile land or whether the natural yield ceiling is approaching.

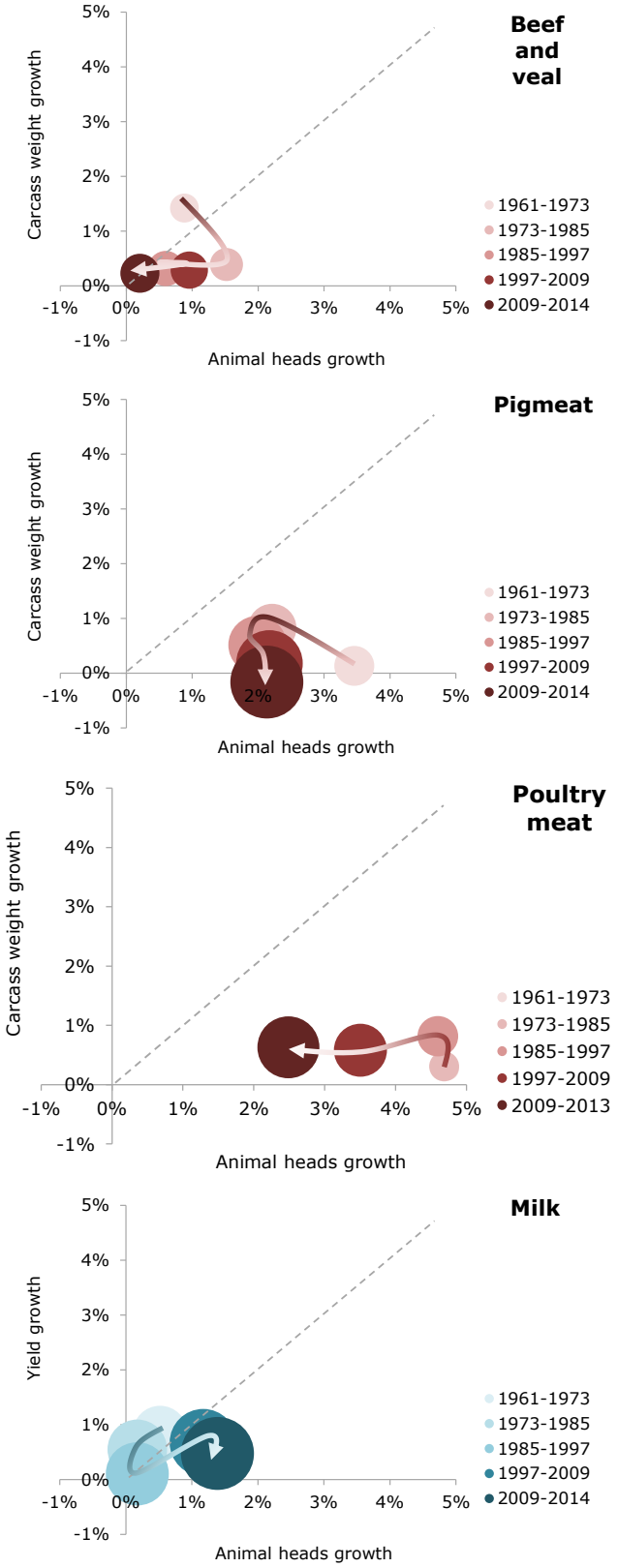
[4] Herrero *et al.* (2013). Biomass use, production, feed efficiencies, and greenhouse gas emissions from global livestock systems. PNAS, 110(52), 20888-20893.

Graph 13 Yearly area growth versus yield growth for different commodity crops



The size of the bubble shows the relative importance of crop areas.
Source: DG Agriculture and Rural Development based on data from FAO (Faostat).

Graph 14 Yearly carcass weight growth versus number of heads growth for beef/veal, poultry, pigs and milk yield for milking cows



The size of the bubble shows the relative importance of total production for beef/veal, pigs and poultry.

Source: DG Agriculture and Rural Development based on data from FAO (Faostat).

When focusing on oilseeds, in more recent periods area growth is high but steadily decreasing while yield growth is stabilizing around 1% per year. The sugar cane area is marginal compared to the other commodities depicted, but it is growing around 2 to 3% per year. Yield growth is rather volatile with a 0% growth in the last period accompanied by a significant area increase.

For beef and veal both growth of carcass weight and animal heads declined over time to nearly reach a stand-still in the current period (see Graph 14). The number of pigs keeps steadily increasing by about 2% per year, while carcass weight is no longer growing. The latter is due to genetic potential and technical limitations (e.g. slaughterhouses), meat quality/ weight trade-offs and new market entrants reducing the average carcass weight. Poultry in turn shows a steady decline in animal heads growth since the sixties, but growth rates still surpass those of pigs. With carcass weight growing at a fairly constant 1% per year, poultry meat will surpass pigmeat as the most popular meat type at around 2020. Growth in number of milking cows has revived after 2000 to a little over 1% per year, while milk yield growth has remained fairly stable over the years around 0.5% per year.

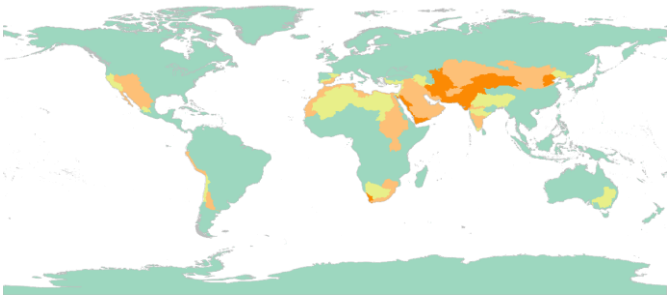
Change in inputs other than land

Agriculture accounts for about 70% of total global **water use** and up to 90% in developing countries (FAO Aquastat). Water is crucial for food production: over the last 50 years, more than 40% of the increase in food production came from irrigated areas. While total land increase has stabilized, irrigated land keeps on growing steadily.

The Middle East and North Africa, Central Asia, western India and northern China are particularly affected by water stress, as are the western Great Plains and parts of the west coast of the US, parts of the Andes in South America, South Africa and Southeast Australia. Many of these areas are densely populated: an estimated 80% of the world's population currently live in areas with high levels of threat to water security.

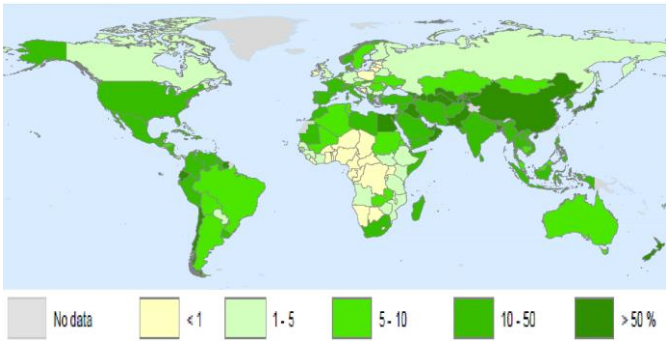
Agriculture is also a major source of water pollution, from nutrients, pesticides, soils and other contaminants, leading to significant social, economic and environmental costs in many regions.

Map 2 ***Global distribution of physical water scarcity by major river basin***



Green: Evapotranspiration due to irrigation < 10% of total renewable water resources; Yellow: between 10 and 20%; Orange: >20%.
Source: GAEZ, FAO-IIASA.

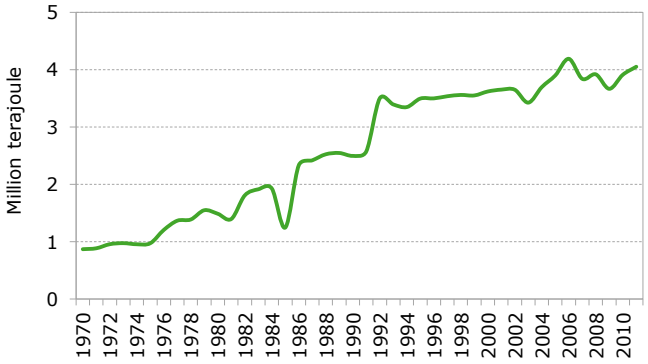
Map 3 ***Part of cultivated area under irrigation***



Source: FAO-Aquastat.

Energy use in agriculture is characterized by steady growth (apart from spikes due to the 1985 oil crisis and the 1992 collapse of the Russian Federation) from 1 million Terajoule in 1970 to over 4 million Terajoule today. In the onset of the recent economic crisis energy use in agriculture increased substantially, to decline afterwards. The recent recovery will probably be further propagated due to low oil prices.

Graph 15 ***Energy use in agriculture (gas-diesel-oil)***

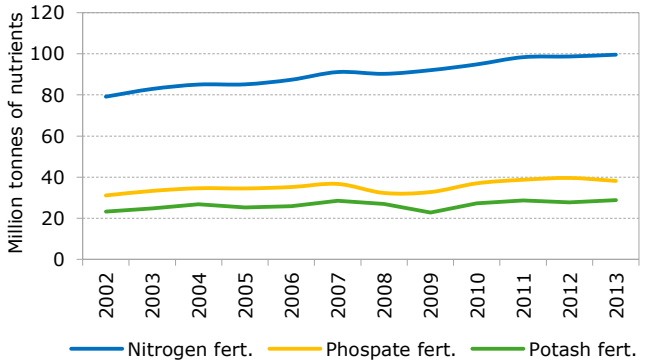


Source: FAO (Faostat).

Agriculture's share in total energy use steadily increased with about 2% per year to nearly 2.4% in 1985. After 1994 the growth rate started declining (average 0.6% growth rate per year in the period 1985-1997). In the period 1997-2009 the share contracted with 1.7% per year to reach 2.1% in 2009. So agriculture is consuming relatively less.

Regarding **fertilizer use**, world nitrogen fertilizer consumption (expressed in tonnes nutrients) is stabilizing after a decade of steady increase. This is also the case for phosphates and potash, although important regional differences occur. At the same time serious doubts exist whether key nutrients (especially rock phosphate) will remain available and accessible (as reserves are in the hands of a few producing countries).

Graph 16 Evolution of world fertilizer use between 2002 and 2013

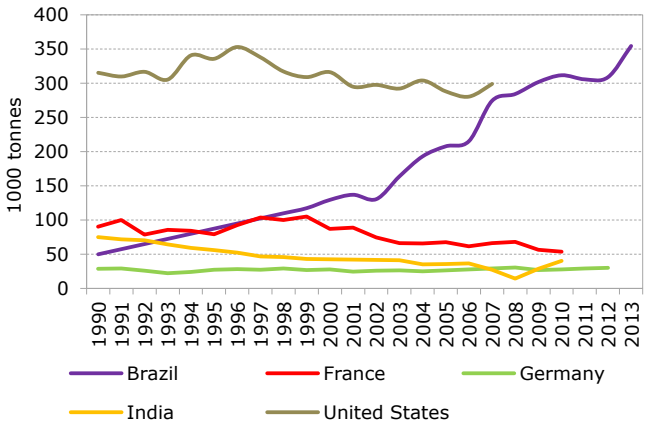


Source: FAO (Faostat).

The developments in energy and fertilizer use do not account for the potential impact of the new energy price mix, the growth path in natural gas and uncertainties surrounding the future price path of both crude oil and natural gas.

For **pesticides** we see two opposing trends: the majority of developing economies show strong growth in pesticide use, while in the developed economies pesticide use (in tonnes of active ingredients) is decreasing. The US remains one of the main players. For a number of developing economies pesticide use sharply increased prior to the economic crisis, after which it quickly reduced again to prior-crisis levels.

Graph 17 Evolution of pesticide use in key countries between 1990 and 2012

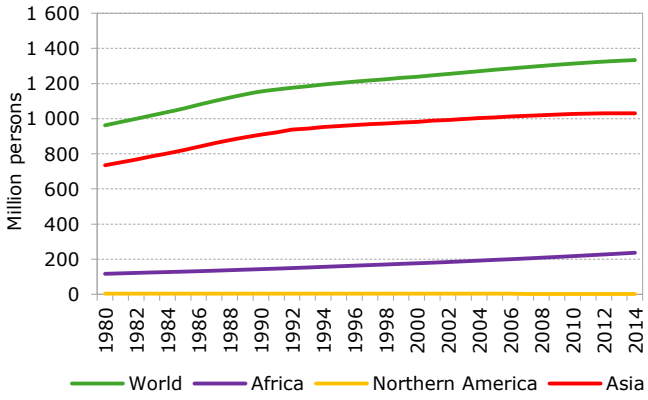


* Estimated data for Brazil 1990-1998.
Source: FAO (Faostat).

Cereals **feed use** amounts to a steady 55% of total cereals feed and food use, while starchy roots feed use has slightly increased from 34% in 1961-1973 to 36% today. Oilseeds are more difficult to distinguish, but the majority is crushed into oilmeals, either as main or by-product.

As for **labour**, about one out of 7 of world inhabitants is economically active in agriculture. The growth rate has steadily declined over time from 1.2% in the 1985-1997 period over 0.6% in 1997-2009 to 0.4% in the 2009-2014 period. Significant structural changes continue to take place. While the more developed countries reached a plateau, in developing countries structural change is leading labour away from agriculture.

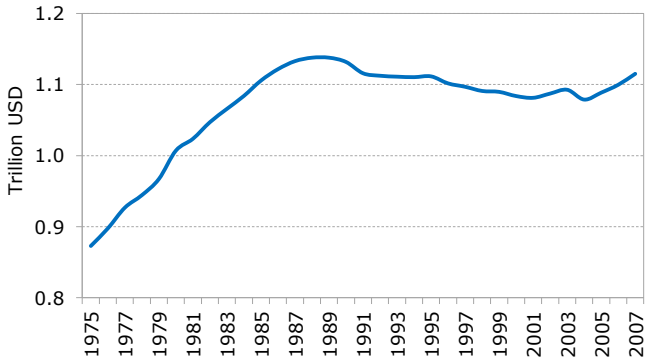
Graph 18 Agricultural labour force evolution between 1980 and 2014



Source: FAO (Faostat).

Regarding **capital use**, net machinery and buildings capital stock (in constant 2005 prices) has been expanding strongly until the end of the eighties after which it slowly contracted until the mid 2000s. Before the economic crisis, capital stock growth became positive again.

Graph 19 Evolution of world net machinery and buildings capital stock (2005 prices)



Source: FAO (Faostat).

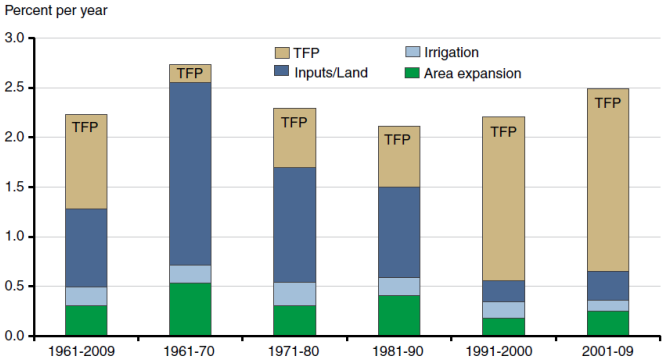
For **biodiversity**, studies (e.g. Rockstrom et al., 2009) state that the current rate of extinction of species is estimated to be much more than what could be considered natural. Changes in land use, including the conversion of natural ecosystems into agriculture, and the introduction of new species into land and freshwater environments are amongst those factors exerting the most significant effect.

TFP growth explains most progress

Yield growth is only a partial indicator, while total factor productivity (TFP) growth is more comprehensive. TFP compares total outputs relative to the total inputs used in production of the output. It reveals the joint effect of many factors including new technologies, efficiency gains, economies of scale, managerial skill, and changes in the organization of production.

As an analysis of Fuglie (2012)[5] shows, over time, an increasing share of output growth was due to improvements in TFP rather than input accumulation. Input growth slowed significantly, from over 2.3% per year in the 1960s to only 0.74% per year during 2000-2007. Regional differences however exist, with resources being increasingly withdrawn from agriculture in developed countries, resulting in a decreasing TFP growth, while in developing regions productivity growth accelerated from the 1980s onwards, with Brazil and China being the main engines for growth.

Graph 20 Sources of growth in global agriculture



TFP = Total factor productivity.
Source: USDA, Economic Research Service using data from Fuglie (2012), p. 350.

Source: USDA based on Fuglie, 2012.

Waste and losses are important

According to FAO (2011)[6], about one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. Other studies (e.g. Institution of Mechanical Engineers, 2013[7]) confirm this number, so there is clearly an issue. Overall, on a per capita basis, much more food is wasted in the industrialized world than in developing countries. FAO (2011) estimates that the per capita food waste by consumers in Europe and North-America is 95-115 kg/year, while this is only 6-11 kg/year in sub-Saharan Africa and South/ Southeast Asia. The causes of food losses and waste in low-income countries are mainly connected to financial, managerial and technical limitations in harvesting techniques, storage and cooling facilities in difficult climatic conditions, infrastructure, packaging and marketing systems. The causes of food losses and waste in medium/high-income countries mainly relate to consumer behaviour as well as to a lack of coordination between different actors in the supply chain.

[5] Fuglie, Keith, Sun Ling Wang and V. Eldon Ball, eds. 2012. Productivity Growth in Agriculture: An International Perspective. Wallingford, UK: CAB International, 450 pages.

[6] FAO. 2011. Global food losses and food waste – Extent, causes and prevention. Rome.

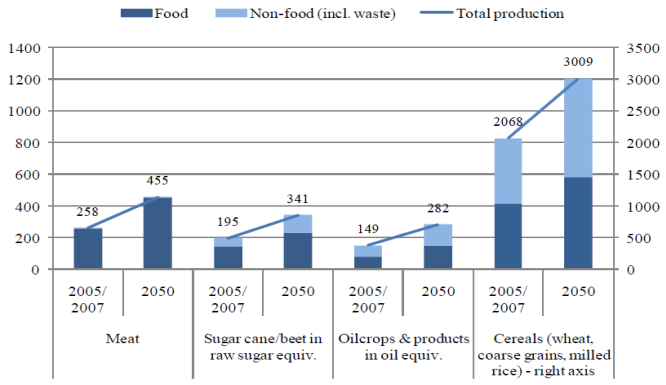
[7] Institution of Mechanical Engineers (2013). Global Food Waste not, want not.

4. Some supply projections towards 2050

Supply changes in the future are on the one hand driven by changes in demand, and on the other hand constrained by evolutions on the input side. As we pointed out in our earlier *Brief*, and confirmed by the OECD-FAO outlook 2015, the major changes in demand reside in developing countries, where continued but slowing population growth, rising per capita incomes and urbanisation all increase the demand for food. Diets will be more diversified in the direction of animal proteins at the expense of starches. Production of meat and dairy is thus expected to increase further. In the next 10 years, OECD-FAO projects that additional agricultural production in Asia, Europe and North America will be driven almost exclusively by yield improvements, whereas in South America yield improvements and additional agricultural area are projected. Modest production growth is expected in Africa, although further investments could raise yields and production significantly.

In the longer run, to meet demand, Alexandratos and Bruinsma (2012)[8] predict that global production in 2050 should be 60% higher than that of 2005-2007. While this is still substantial, it implies a considerably lower growth rate than the past 50 years. World cereals production for example, is projected to grow at 0.9 percent per year from 2005-2007 to 2050, down from the 1.9% per year of 1961-2007. The graph below projects the expected changes for the main commodities.

Graph 21 World production and use for major products (million tonnes)



Source: FAO, 2012[8].

Increasing stress on resources will make it more challenging to realize this production increase. Total arable land use is projected to reduce in the developed countries (from 635 million hectares in 2005-2007 to 587 million hectares in 2050), while cropping intensity is projected to increase further (from 74% to 81%). In developing countries both land use (from 966 to 1 086 million hectares) and cropping intensity (from 95 to 99%) are expected to increase further (Bruinsma *et al.,* 2009). Globally, water resources are expected to be sufficient to produce the food required in 2050, but many regions will face substantial water scarcity (FAO WWC white paper). Also for the other inputs, such as energy and fertilizers, increasing scarcity and competition is expected.

Climate change

Climate change and measures to address its adverse effects are expected to impact heavily on agricultural production, as on-farm emissions account for about 8% of total greenhouse gas emissions in OECD countries[9]. The potential impacts of climate change, such as temperature change, changing rainfall, higher weather variability and increased incidence of extreme weather events, are likely to be felt most strongly in agriculture. Temperature increases and reduced precipitation are likely to result in increasing water scarcity in many parts of the world. Climate change is also expected to accelerate desertification in many arid regions, which is already claiming agricultural land at an estimated 12 million hectares a year[10]. Global temperature rises are also exerting a significant drag on yields growth. These impacts will be felt most strongly in developing countries, especially in Sub-Saharan Africa, where much of the remaining uncultivated arable land are located. In contrast to this, climate change is expected to have a benign impact on yields in the more temperate regions of Canada and central and northern Eurasia over the medium term. The reduction in emissions has to be realized against the backdrop of increasing production to meet the growing demand. Available estimates[9] show that, on average, OECD countries have reduced their agricultural emission intensity by approximately 2% annually between 2000 and 2010, as a result of a combination of the uptake of improved technologies and farm management practices, and incentives to lower emissions supported by a range of policies and policy reforms introduced by individual OECD countries.

[8] Alexandratos, N. and J. Bruinsma. 2012. World agriculture towards 2030/2050: the 2012 revision. ESA Working paper No. 12-03. Rome, FAO.

9 OECD. 2015. A review of the literature on the cost-effectiveness of greenhouse gas mitigation measures for agriculture. COM/TAD/CA/ENV/EPOC(2014)44/FINAL

10 Cooke, R. and Grainger-Jones, E. 2010. Desertification. IFAD. http://www.ifad.org/pub/factsheet/desert/e.pdf

5. Conclusion

Although production growth remains fairly stable at around 2.7% per year, dynamics differ between commodities and regions. For the majority of crops growth rates are increasing over time, while for meats production growth is decreasing. Developing regions show high growth rates, starting from a lower base, compared to the more developed regions.

Shifts in land use are characterized by crop production expansion at the expense of pasture and meadows. While total agricultural area expansion was important in the past, main production gains are now achieved through yield growth. Shifts also take place between commodities, with maize area for example expanding while wheat stabilizes. In animal production both carcass weight growth and the number of heads are stabilizing, if not decreasing.

With respect to other agricultural inputs, water, energy and N fertilizer use increased over time. Areas with irrigated crops are also those with most water scarcity. Pesticide use developments differ between countries, with emerging economies expanding their use (in absolute quantities), while in developed countries use is contracting. They now however use products with different active ingredients. Labour force growth is declining over time, and so is capital growth. The main production increase is now realized through technological change.

An important part of total production still goes to waste and losses, but causes differ considerably between developing and developed countries.

Production is expected to increase further by more than 60% in the coming 25 years. Main improvements should come from yield increase, but uncertainties from the effects of climate change add to this challenge.

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