

GLOBAL TRENDS AND FUTURE CHALLENGES FOR THE WORK OF THE ORGANIZATION

WEB ANNEX

Contextual trends and macro elements

Global Trends:

Trend 1: Food demand is increasing while patterns of food consumption are changing towards more livestock products, vegetable oils and sugar

Trend 2: Growing competition and diminishing quality and quantity of natural resources and loss of ecosystem services

Trend 3: Energy security and scarcity – the landscape and trends

Trend 4: Food price increases and price volatility

Trend 5: Changing agrarian structures, agro-industrialization and the globalization of food production

Trend 6: Changing patterns in agricultural trade and the evolution of trade policies

Trend 7: Climate change will have a growing impact in agriculture

Trend 8: Science and technology as a main source of agricultural productivity and production increases is progressively becoming a private good and the processes are dominated by the private sector

Trend 9: Evolving development environment: increased recognition of the centrality of governance and a commitment to country-led development processes

Trend 10: Increased vulnerability due to natural and man-made disasters and crisis

CONTEXTUAL TRENDS AND MACRO ELEMENTS

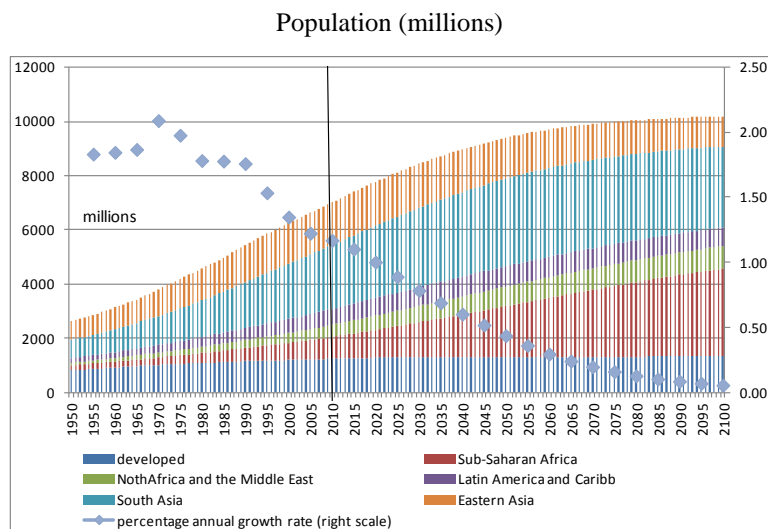
Introduction

1. This section contains a description of trends that are external to the global food and agriculture economy, but that will directly influence the development of it.
2. While agriculture, fishery and forestry tend to reduce their relative size in the economy as countries experience economic growth and income increases, their degree of integration with other economic activities tends to increase. Primary production activities become less isolated, and more exposed to the opportunities and the vagaries generated in other sectors, from technology, to services, to price volatility. A similar dynamic seems to operate across space: trade investment and, more broadly, indicates and increased degree of osmosis among countries and distant regions. As it happens within the economy this builds up both opportunities and potential tensions among heterogeneous stakeholders. Countries and regions where agriculture is still the backbone of an undifferentiated economy are increasingly exposed to complex demands, and the competition of far away primary production systems.
3. In discussing external drivers of agriculture, fishery and forestry, we take the evolution of the macro economy and population as starting points. These variables pave the way to describe other wider trends, including changes taking place in technology, society as well as the environment in which we live, and the associated risks.

This section contains a description of trends that are external to the global food and agriculture economy, but that nonetheless are likely to have a significant economic and political influence in the way agriculture and food production develops. It assumes the evolution of the macro economy and population dynamics as starting points to describe other wider trends.

Population dynamics

4. The dynamic of population is usually assumed to be exogenous, while in fact it is affected (and affects) economic performance and other key variables. Data from the latest UN assessment (2010) under the medium fertility variant indicates that population is expected to reach 9.3 billion in 2050, and to continue growing at decreasing rates until the end of the century.



Source: United Nations, Department of Economic and Social Affairs, Population Division, 2011

5. Virtually all the population increase is expected to take place in developing countries. Developed countries will start declining in the late 2040s. By 2100, the only region where population is still expected to be growing is sub-Saharan Africa, which will have reached some 2.15 billion. Projections for certain African countries show particularly fast increases, reaching up to 3.5 to 7 times their current levels at the end of the century.

6. Moreover, world population is changing in several ways. One aspect worth emphasising is ageing: the proportion of persons aged 60 years and more is bound to increase in the world as a whole. This process, however, is advancing at a faster pace in developed countries – albeit with differences - compared to developing countries.

7. The age composition and the speed of the aging of a population affect its dependency ratio, which is the number of dependent individuals -- younger than 15 and older than 64 -- per working age adult. This indicator is notoriously related both the growth potential (negatively) and the prevalence of poverty (positively).

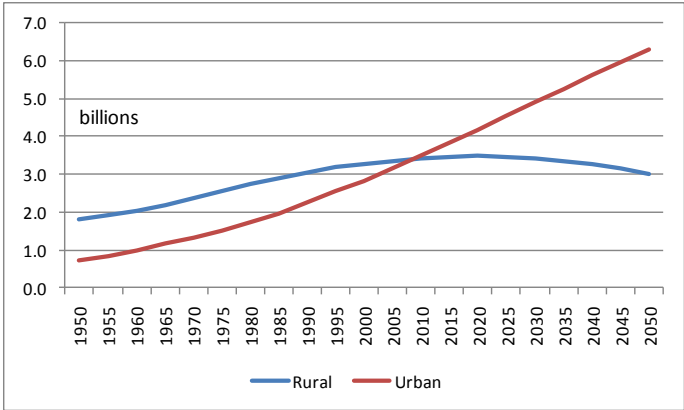
Age composition and dependency ratios

Region	Dependency Ratio		Share of Population (%) under 15		Share of Population (%) over 60	
	Rural	Urban	Rural	Urban	Rural	Urban
East Asia & Pacific	0.75	0.57	38.0	32.5	6.8	5.6
Europe & Central Asia	0.66	0.51	29.2	25.8	15.1	12.2
Latin America & Caribbean	0.84	0.64	39.2	33.3	8.6	8.3
Middle East & North Africa	0.99	0.77	45.2	39.7	6.4	5.7
South Asia	0.91	0.67	43.4	36.8	6.3	5.2
Sub-Saharan Africa	1.02	0.76	45.7	39.8	6.6	4.1
High income: nonOECD	0.65	0.56	31.9	28.9	10.3	9.8
High income: OECD	0.57	0.49	23.5	21.5	17.6	15.7
Unweighted Cross-Country Mean	0.79	0.62	36.5	31.9	10.1	8.6

Source: Anriquez and Stloukal, 2008

8. Most of the population increase which is expected to take place over the next decade will be concentrated in urban areas, especially in developing countries. Rural-urban migrations will likely remain by far the most important component in terms of population movements, mostly driven by income differentials. About 67 percent of world’s population is expected to be concentrated in urban areas by year 2050. Urban dwellers tend to change consumption habits, and consume more manufactured goods and service, while increasing the amount of good that they purchase from specialized producers, as opposed to what they produce within the household.

Population (billions)



Source: United Nations, 2009

9. The evolution of world population, given the above picture, may also contribute to a shift of importance towards today’s emerging economies. The higher proportion of working age adults is historically correlated to high growth potentials, both from the supply side, given the higher availability of manpower, and from the demand side, given that younger populations tend to consume more and higher quality products.

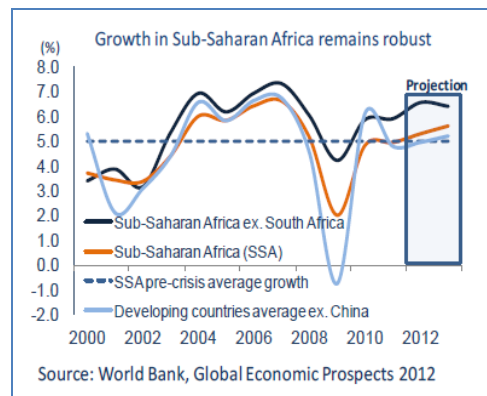
10. Population growth, ageing and urbanization affect consumption - and food consumption - habits through different channels, as well as the development of agrifood production activities.

Global financial crisis, economic growth and poverty

11. The current macroeconomic outlook is characterized by a high degree of uncertainty. The global financial crisis is having a profound impact on real economies in key countries of the OECD, which have recently undergone a downturn, and may undergo an even deeper recession in the coming years.

12. To date, most large emerging economies such as China, Russia, Brazil, South Africa, India and other large Asian economies have maintained relatively high growth rates. Prospects of other developing countries in Latin America and Asia seem to have been affected only marginally by the current downturn. In recent years, relatively fast economic growth seems to characterize also Sub-Saharan Africa as a region, notwithstanding serious difficulties in specific countries and the low starting point of the region.

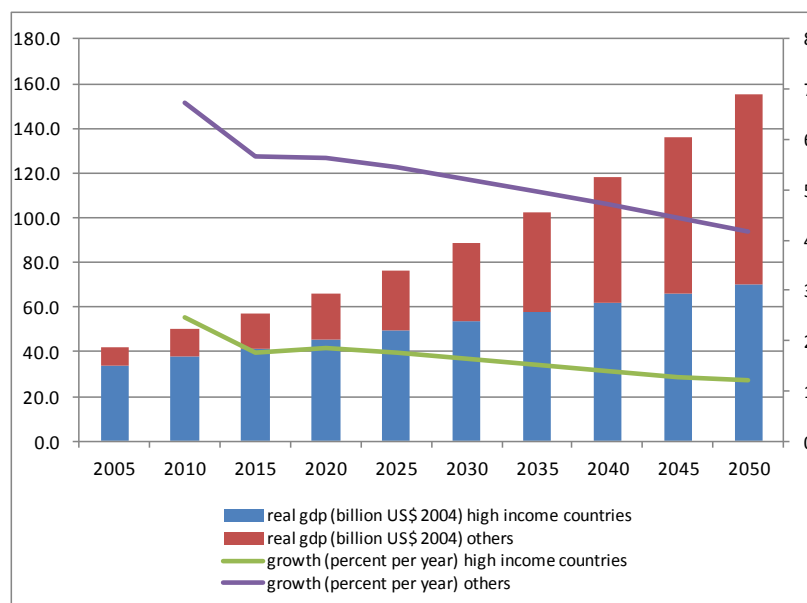
13. Much uncertainty in the global outlook, however, stems from the possibility that the current downturn of a large and interconnected market such as Europe may spread to other regions along real and financial channels, both in the OECD and elsewhere, thus resulting in a wider and deeper global recession. According to the latest report of the World Bank Global Economic Prospects “Europe appears to have entered recession. At the same time, growth in several major developing countries (Brazil, India and, to a lesser extent, Russia, South Africa and Turkey) is significantly slower than it was earlier in the recovery, mainly reflecting policy tightening initiated in late 2010 and early 2011 in order to combat rising inflationary pressures. As a result, and despite a strengthening of activity in the United States and Japan, global growth and world trade have slowed sharply. Additional risks to the outlook include the possibility that political tensions in the Middle East and North Africa disrupt oil supply and the possibility of a hard landing in one or more important middle-income countries”.



14. Few years ago, after the first financial downturn of 2008, prospects indicated a likely recovery within few years; hence the long terms outlook for economic growth was assumed to be almost unaffected. Developing countries as a group were already expected to grow at a higher speed compared to OECD countries.

15. In 2009 the World Bank was indicating that global economic growth would average 2.9 percent per year between 2005 and 2050, corresponding to 1.6 percent per year in high income countries and 5.2 percent per year in developing countries. In 2050, according to this projection, developing economies would account for about 55 percent of world Gdp, while they were accounting for about 20 percent in 2005.

16. Some of the poorer and less diversified developing economies, where agriculture is still the predominant activity, the fast increase in population will likely result in an excessive pressure on resource; local Malthusian traps may arise, for instance, in some countries of Sub-Saharan Africa whose population is increasing at a fast pace. One likely consequence, in these cases, could be an acceleration of international migrations.



Source: World Bank, Van der Mensbrugge, 2009

17. Global per-capita incomes are expected to rise at 2.2 percent per year between 2005 and 2050, and absolute poverty, based on a \$1.25 PPP/day would be reduced from 21.9 percent in 2005 to 0.4 percent in 2050. In sub-Saharan Africa, the reduction of poverty would be substantial, from 51.7 percent in 2005 to 2.8 percent in 2050.

18. Convergence between developing and developed countries and declining global inequality are expected to be accompanied, however, by higher inequality among countries and regions. For instance, the ratio of per capita GDP in sub-Saharan Africa on that of developing countries in East Asia would rise from about 1:2.5 in 2005 to 1:5.7 in 2050.

Global income inequality				
Index	2	2	Disper only	Converg only
Gini	0		0.701	0.616
Theil	1	0.	1.059	0.719
Mean log deviation	0	0.	0.954	0.723

Income inequality, by region						
Region	Gini		Theil		Mean Log Dev	
	2005	2050	2005	2050	2005	2050
Developed countries	0.394	0.378	0.270	0.245	0.277	0.257
Developing countries	0.552	0.588	0.623	0.664	0.529	0.629
East Asia and Pacific	0.421	0.479	0.311	0.399	0.293	0.411
Eastern Europe and Central Asia	0.394	0.513	0.257	0.441	0.280	0.490
Latin America and Caribbean	0.599	0.605	0.714	0.707	0.699	0.719
Near East and North Africa	0.399	0.405	0.284	0.298	0.261	0.271
South Asia	0.297	0.326	0.156	0.183	0.141	0.176
Sub-Saharan Africa	0.495	0.488	0.499	0.481	0.425	0.410

Source: Van der Mensbrugge et al, 2011

19. Even in developed countries, inequality seems to be increasing. According to the OECD, in its member countries the ratio of the average income of the richest 10 percent to that of the poorest 10 percent has reached 1:9 today.

20. Compared to this 2009 outlook, one likely outcome of the most recent financial turbulence could be a further slow-down in the growth of high income economies. In any case, this will likely imply an acceleration of the tendency emerging from the above chart, leading developing countries, and especially the larger emerging economies, to assume a wider role in the world economy. Global agri-food production and consumption will be increasingly affected by what happens in these countries. Food consumption will probably continue to grow following population increase, but its growth will also continue to slow down, due to saturation of individual requirements.

Changing geo-economic balances

21. Emerging economies are likely to continue expanding their market shares of manufactured products - both in terms of production and consumptions - and will likely continue to demand increasing amounts of commodities. This may bring about changes in the shares of global trade and investment. Foreign direct investments from countries like Brazil, China, Russia or India are expected to increase, especially those directed towards developing countries in which the demand for manufactured goods is expected to be more dynamic.
22. All may result in a change of the current distribution of power across countries and continents. In the coming decades, the international community may become more diverse, and characterized by a larger number of major actors compared to what is the case today. New and different opportunities will likely arise for South-South relations, including trade and, more generally, economic and cultural integration and collaboration.
23. In the OECD, given that many difficulties originate in the lowered credibility of sovereign debts, public expenditure is likely to shrink, especially where fiscal pressure needs to increase in view of paying back existing debts. Adjustment will likely be painful in countries where the public participation in the economy is high, which need to reallocate considerable amount of resources across sectors; here unemployment may increase at least over the short to medium run.
24. At the same time, the private sector may continue gaining space and increasing its scale of operation. This may result in more foreign direct investment, and the downsizing of further direct public intervention in the economy. The contrary seems to be happening in the large emerging economies of Asia and Latin America; especially in the first region, direct public involvement in large industrial corporation seem to be high
25. Contribution to foreign aid also seems set to undergo a substantial re-distribution, given the tight budget of traditional OECD donors. The recent start-up of a foreign aid program in India, along with the increasing importance of foreign capital flowing from Asia towards other regions and mainly Sub-Saharan Africa, seems to point in this same direction.
26. The growing role of the private sector and its increasingly trans-national character will likely call for international and public institutions to continue playing an active role in shaping the economic environment, both at national and international levels. This is especially the case of regulatory policies and their enforcement. Increasing efforts may be required to counteract market failures in the area of competitiveness and anti-trust, to manage information asymmetries between consumers and producers, as well as to protect the environment and address global environmental challenges such as climate change, and to manage resources such as land, water and biodiversity.
27. The increased degree of economic interdependence seems to be affecting the scale and number of urgent global issues on the table. The demand for international public goods appears on the raise, despite the growing importance of the private sector and the increasing difficulties of nation states to reconcile electoral cycles with fiscal discipline.

Structural unemployment, especially of young population

28. While growing working age populations in emerging and developing countries represent a huge growth potential, this could be hampered by the high structural unemployment levels and the continued jobs crisis which emerge clearly among the most burning challenges for the decade. Not only because, in the short run, high unemployment and underemployment and low wage growth are escalating social discontent, reducing household consumption and therefore constraining recovery. But also because the increasing levels of long-term unemployment and inactivity, affecting especially women and youth, will represent a serious disinvestment in human capital development and negatively affect the prospects for medium-term growth.
29. According to the most recent ILO estimates, in 2011, after three years of crisis conditions in global labour markets, global unemployment remained high. More than 197 million people are unemployed, 27 million more than in 2007. In many countries, the situation appears even worse when looking beyond unemployment. Global labour participation rates are declining, meaning that more people are deciding to stop looking for work and remain outside the labour force. This is particularly true for many countries in South Asia, the Developed Economies and especially the European Union region, as

well as the Middle East and North Africa. Globally, there were 29 million less people in the labour force in 2011 than expected based on pre-crisis trends. Overall, the decline in the participation of adult women accounts for two-thirds of the overall decline.

30. In emerging and developing countries, employment recovery has been faster than in developed economies and many countries only suffered a temporary slowdown in job creation. Unemployment rates remain high, however, with rates exceeding 10 per cent in urban areas. In general, the main challenges that those countries will be facing, both in urban and rural areas, relate to the quality of the jobs available, reflected in the high shares of underemployed and poorly paid workers, vulnerable employment and poor access to social protection. Overall, according to the most recent ILO estimates, one in three workers in the labour force is currently either unemployed or poor. Among the 900 million working poor (workers living with less than USD2 a day) slightly more than half are living in extreme poverty. Most jobs simply do not ensure adequate levels of income for workers to afford decent livelihoods and to access food for themselves and their families. This is due to low productivity, low levels of pay, underemployment or various forms of exploitation. Not surprisingly, shares of working poverty (less than USD2 a day) remain high in predominantly rural regions such as sub-Saharan Africa (62 percent) and South Asia (67 percent) where the workforce is mostly engaged in the agricultural sector (up to 75 percent in Eastern Africa and more than 50 percent in Central Africa and South Asia). Nearly eight out of ten working poor at the USD1.25 level live in rural areas, compared with four out of ten non-poor workers. They are mainly employed in the agricultural sector and in own-account or unpaid family work. Women in particular are more likely than men to be in vulnerable employment¹, especially in North Africa (55 per cent versus 32 per cent), the Middle East (42 per cent versus 27 per cent) and Sub-Saharan Africa (nearly 85 per cent versus 70 per cent).

31. Overall, the high levels of youth unemployment and underemployment represent the main challenge. Between 2008 and 2009, the youth (15-24 years old) unemployment rate saw its largest annual increase over 20 years, reversing the pre-crisis trend of declining youth unemployment rates since 2002. According to ILO estimates, in 2011, the youth unemployment rate was still at 12.7 percent corresponding to 75 million unemployed young people, 4 million more than in 2007. In both Middle East and North Africa, youth unemployment rates exceed 25 percent and these rates have been constant over the past 20 years.

32. In low-income economies, where most of the world's young people live, the unemployment rate however does not capture the main challenges faced by young people in the labour markets. High youth employment-to-population ratios often mask poverty and lack of social protection that force youth into low-productivity vulnerable employment, often in subsistence agriculture and in the informal economy. According to the ILO, globally, there are by far more young people stuck in circumstances of working poverty² than there are without work and looking for work. The challenge of youth employment has also an important gender dimension, since young women encounter even more difficulties finding decent jobs than young men. Cultural traditions, but also the lack of social infrastructure and reward for unpaid care work undertaken mainly by women and young girls hamper their participation in formal labour markets. Even if the gaps have narrowed over the past decade, labour force participation rates for young women are still lower than for young men in all regions except East Asia. Differentials are still huge in South Asia (37 percentage points) and the Middle East and North Africa (around 29 percentage points).

33. While participation rates have declined in many countries and discouragement is rising, young people will continue to enter the labour market. The latest ILO global estimates indicate that the global labour force will expand by 400 million over the next decade. The Middle East, North Africa and Sub-Saharan African regions are projected to experience the fastest growth in the labour force; every year these regions will need to create nearly 15 million new jobs. On top of this challenge, developing

¹ The ILO defines workers in vulnerable employment as the sum of own-account workers and contributing family workers. They are less likely to have formal work arrangements, and are therefore more likely to lack decent working conditions, adequate social security and 'voice' through effective representation by trade unions and similar organizations. Vulnerable employment is often characterized by inadequate earnings, low productivity and difficult conditions of work that undermine workers' fundamental rights.

² Youth are disproportionately among the working poor. In the 52 countries with available data, youth accounted for around 23 per cent of the total working poor, compared with only 18.6 per cent of non-poor workers (ILO, 2011a).

countries will need to drastically improve labour productivity to enable the world's 900 million working poor to find in their jobs a pathway out of poverty. In rural areas of developing countries, in the absence of better farm as well as non-farm employment opportunities, which are at least equally remunerated as earnings in informal urban employment, many youth will continue to move to urban areas in search of a better future. Since, over time, industrial employment will account for a decreasing share of total urban employment, rural-to-urban migrants risk to increasingly adding pressure to the already saturated job markets in the service sector and increasing informal employment in urban areas.

The emerging global middle class, democracy and transparency

34. Analyses of the evolution of global poverty and demographic patterns looking at the 2050 horizon have highlighted the emergence of what was called a new global middle class in many developing countries and emerging economies. The global middle class is estimated to grow from about 450 million in 2005 to 2.1 billion in 2050, corresponding to 8.2 to 28.4 percent of the global population (van der Mensbrugge et al, 2011).

35. A growing global middle class implies that in the coming decades an increasing number of individuals will be healthier, more educated, and will develop higher expectations about their role in life, including the interest in a greater political participation and increasingly complex needs. Their life will probably be more homogenous across countries of residence compared to what happens today.

36. This phenomenon is of high importance, as it is already determining and will determine in the future not only changes in global consumption patterns, but also in the characteristics of societies. Consumption patterns seem to be moving toward more homogeneity. Among these, food is one item that may retain more regional specificities. However, at least part of diets is expected to be driven by common trends. From a broader perspective, a more homogenous society, combined with increasing information flows, is bringing about an increasing demand for democracy.

37. In terms of technology development, the past three decades have been characterized primarily by progress in the area of information technologies and their application. Notoriously this has fostered labour productivity to a great extent, while at the same time magnifying opportunities to generate information flows and reduce the impact of physical distance. Beyond the impact that this is having in the economy, the increase in information flow and the decentralization of information sources brought about by the spread of computers and access to the internet has facilitated change in all aspects of societies, including politics. This trend may very well continue and accelerate in the future, exerting a large influence on the generation and the spread of collective knowledge and democracy.

38. One non-marginal by product of the information technology is the change that it has brought about in the diffusion and utilization of analytical results and scientific achievements. Faster information flows are facilitating integration among individual scholars and work programs operating in physically distant institutions. All resources, including data, results and publications can today be shared at decreasing costs. In sciences this has enhanced the possibility to communicate, verify and replicate experiments and re-generate results under different conditions.

39. A wider diffusion of scientific evidence is also facilitating the relation between science and policymaking. Despite remaining inevitably anchored to value judgement, the need to base policy decision upon verifiable evidence is becoming more widespread in both national and international institutions. And the ability of citizens to verify both the evidence and the impact of decisions is also increasing. Hence the massive amount of information available, despite driving up high selection costs, is likely to facilitate transparency and accountability, and to promote democracy.

40. There are many examples of recent international policy processes involving agriculture in which the discussion among countries made considerable use of analytical results, larger than what was happening in the past. Multilateral trade negotiation offer one example: the wealth of information available during the Doha Development Agenda was certainly larger than one available in previous Rounds; and access to analysis and information was far wider. The same could be of the recent G20 process, or the negotiations on GHG emissions. The ability to generate and process such information is becoming increasingly important for countries to be able to participate effectively.

Disasters³ compounded by political instability

41. Disasters have continued to wipe out the lives and livelihoods of millions over the past years. The impacts of the catastrophic earthquake in Haiti in January 2010 and floods in Pakistan in July 2010 show how disaster risk and poverty are closely interlinked. The 2011 Horn of Africa drought crisis also stresses the inter-connection between natural disaster and conflict situations, magnifying the impact of the drought. Meanwhile, in 2011, floods in Australia, the earthquake in Christchurch, New Zealand, and the earthquake, tsunami and nuclear disaster wreaking havoc in north-eastern Japan are a stark reminder that developed countries are also very exposed. Less visible internationally, hundreds of smaller disasters associated with climate variability have caused enormous damage in Benin, Brazil, Colombia, the Philippines and other countries. These events reveal how risks are continuously constructed through existing development gaps and growth in economic and population exposure. Moreover, as the Japan disaster highlighted, there are emerging risks and new vulnerabilities associated with the complexity and interdependency of the technological and ecological systems on which modern societies depend. Large scale or mega-disasters with interactions between physical and technological hazards and the exposure of countries to a wide range of emerging risks and new patterns of vulnerability can trigger cascading and concatenated system breakdowns at different scale which are difficult to model or to prepare for, but which can exponentially magnify negative impacts.

42. The vast majority of losses and impacts are extensive in character, occurring throughout a country's territory. A rising number of localized disasters, are responsible for significant damage to housing, crops, livestock and local infrastructure, and particularly affect low-income households and communities⁴. The past 20 years have seen an exponential increase in the number of local areas reporting losses (see graphs in appendix). Increasing extensive risks is closely related to the challenges low- and medium-income countries face in addressing underlying risk drivers and reducing vulnerability. Most governments have yet to find effective ways of reducing and managing natural and man-made disaster risks.

43. Existing assumptions about disaster are being increasingly challenged, as new drivers of risk emerge and interact. A growing number of potential and plausible risks are either so difficult to identify or have such profound potential consequences, that it is difficult to find an entry point for risk modelling and analysis⁵. There may be no precedent for the emerging risks associated with low probability hazards as research reveals the increasingly complex vulnerabilities related to the growing interconnection and interdependency of modern societies. The risks associated to increased incidence and spread to new geographic areas of transboundary plant pest and animal diseases, are also looming ahead.⁶ As such, there is a growing probability of 'simultaneous crisis' where different hazards occur at the same time, 'sequential crisis' where hazards trigger cascading disasters in a range of interlocked systems, and 'synchronous failures' (i.e. the March 2011 Japan earthquake-tsunami-nuclear crisis) where different risks converge and interact.

44. Countries with weak governance, political instability or in conflict (complex emergencies or protracted crisis) are likely to find it difficult to address the underlying risk drivers (such as badly managed urban and regional development, degradation of hazard-regulating ecosystems such as wetlands, mangroves and forests, and high levels of relative poverty). Extreme hazards and events are not synonymous with extreme risks. When similar numbers of people are affected by hazards of similar

³ Extracted from UNISDR 2011 Global Assessment Report on Disaster Risk Reduction. This second edition of the United Nations Global Assessment Report on Disaster Risk Reduction provides a current resource for understanding and analyzing global disaster risk. Drawing on a large volume of new and enhanced data, it explores trends and patterns in disaster risk globally, regionally and nationally. In parallel, more than 130 governments are engaged in self-assessments of their progress in implementing the Hyogo Framework for Action (HFA), contributing to what is now the most complete global overview of national efforts to reduce disaster risk.

⁴FAO in its "save and grow" policy guidance indicates that about 2.5 billion of small holders are particularly at risk with vulnerable livelihoods.

⁵ Between 1601 and 1603 Russia suffered the worst famine in the country's history. It is estimated that over two million people starved to death in Russia as a whole. It was only recently, however, that climate researchers established a conclusive link between the failure of harvests in Russia in 1601 and the ash cloud produced by the catastrophic explosion of the Huaynaputina Volcano in southern Peru on 19 February 1600.

⁶ As seen with the bird flu-H5N1 and H1N1 pandemics.

severity, wealthier and poorer countries generally experience radically different losses and impacts. Poverty is both a cause and consequence of disaster risk.⁷ Across all the major hazards, poorer countries with weaker governance⁸ tend to experience far higher mortality and relative economic loss compared to wealthier countries with stronger governance. Mortality risk, for example, is approximately 225 times greater in low-income countries compared to OECD countries, when similar numbers of people are exposed to tropical cyclones of the same severity.⁹ Whereas relative wealth is a key determinant, governance factors such as the strength of democracy and voice and accountability, all play roles in the social construction of risk. The quality of a country's governance appears to have a significant influence on the underlying drivers of risk. Risk drivers and increasing poverty and inequality, interact through multiple feedback loops and together translate hazards into disaster risk. Mortality is still rising in the countries with the weakest risk governance capacities!

45. Food insecurity is significantly worse in countries in protracted crises than in the rest of the developing countries in four out of six key food security indicators: proportion of undernourished, proportion of children stunted, mortality rate of children under five years old, and the Global Hunger Index. The level of under nourishment in this set of countries is estimated to be more than three-fold when compared with the rest of developing countries (excluding India and China). They represent 166 million people, roughly 20 percent of the world's undernourished people (or more than a third of the global total if China and India are excluded). In countries in protracted crises the Millennium Development Goal 1 and the World Food Summit goal are very unlikely to be met by 2015. These poor food security outcomes are long-lasting and are closely related to recurrent natural disasters and/or conflict, the number of years in crisis, the breakdown of livelihoods, weak governance or public administration and most importantly the overall insufficient capacity to react to the crises (in some of these countries crises are localized to only certain areas or regions).¹⁰

46. As with disaster risk management in general, the additional challenge of adapting to climate extremes requires increased attention to underlying risk drivers, reducing vulnerability, and strengthening risk governance capacities. If disaster risks can be reduced, then the magnifying effect of climate change will also be reduced and adaptation will be facilitated. Short, medium and long term humanitarian and development policies/strategies/programmes and actions must urgently be redefined to take into account and reduce the various and interconnected risks to reach millions of risk-prone citizens.

⁷ Extracted from UNISDR 2009 Global Assessment Report (GAR).

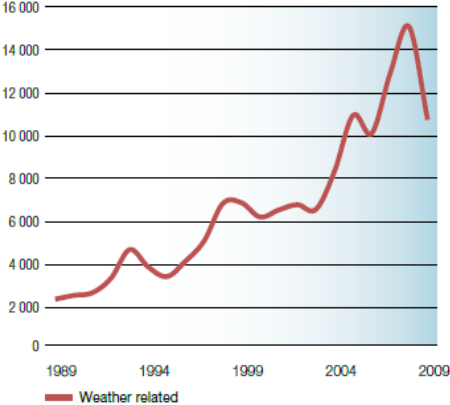
⁸ Governance refers to the actions, processes, traditions and institutions by which authority is exercised and decisions are taken and implemented.

⁹ Extracted from UNISDR 2011 GAR.

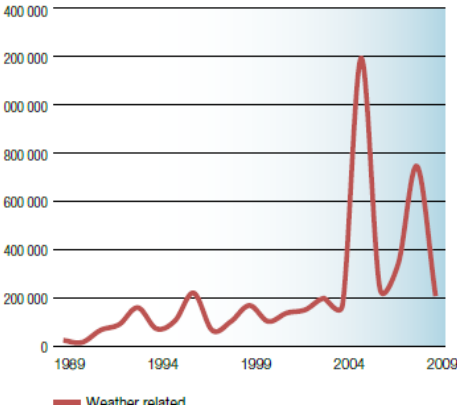
¹⁰ Extracted from "Addressing Food Crises - Towards the Elaboration of an Agenda for Action in Food Security in Countries in Protracted Crisis, High-Level Expert Forum (HLEF), Introduction –setting the context of 36th CFS recommendations on further analysis and actions on food security in protracted crisis. SOFI, 2010 report.

Appendix: Extensive risk trends by indicator (for the 21 countries and states included in the GAR11 analysis)

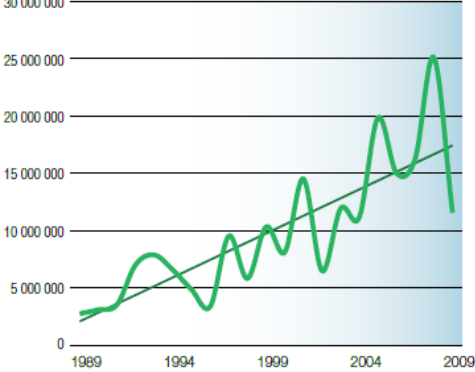
Number of reports per year



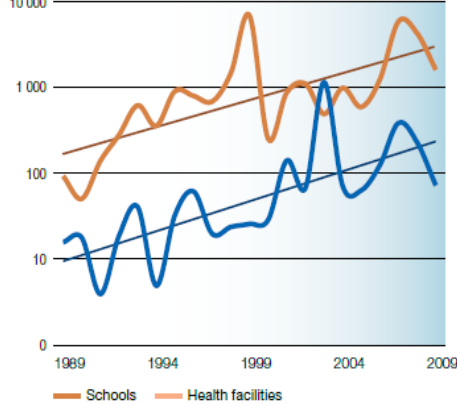
Number of houses damaged



Number of affected people per year



Number of schools and health facilities affected



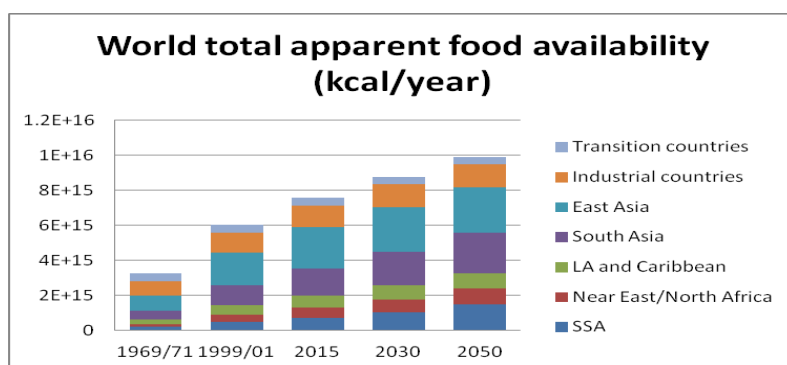
TREND 1: FOOD DEMAND IS INCREASING WHILE PATTERNS OF FOOD CONSUMPTION ARE CHANGING TOWARDS MORE LIVESTOCK PRODUCTS, VEGETABLE OILS AND SUGAR

1. Global food demand is increasing driven by of population, economic growth and urbanization, particularly in developing countries. At the same time dietary patterns are changing towards more livestock products, including fish, vegetable oils and sugar; a trend that is accentuated by the increasing homogeneity of life habits between urban and rural population facilitated by communications technology. In spite of these global trends there still are vast numbers of undernourished and malnourished people and at the same time there are also a growing number of overweight and obese people. The new consumption patterns also imply a larger role for processed foods which create new opportunities for value added and income generating activities.

2. As a consequence of urbanization food insecurity will increasingly appear as an urban problem which will make it more visible and politically sensitive and will require different types of intervention.

An increasing demand

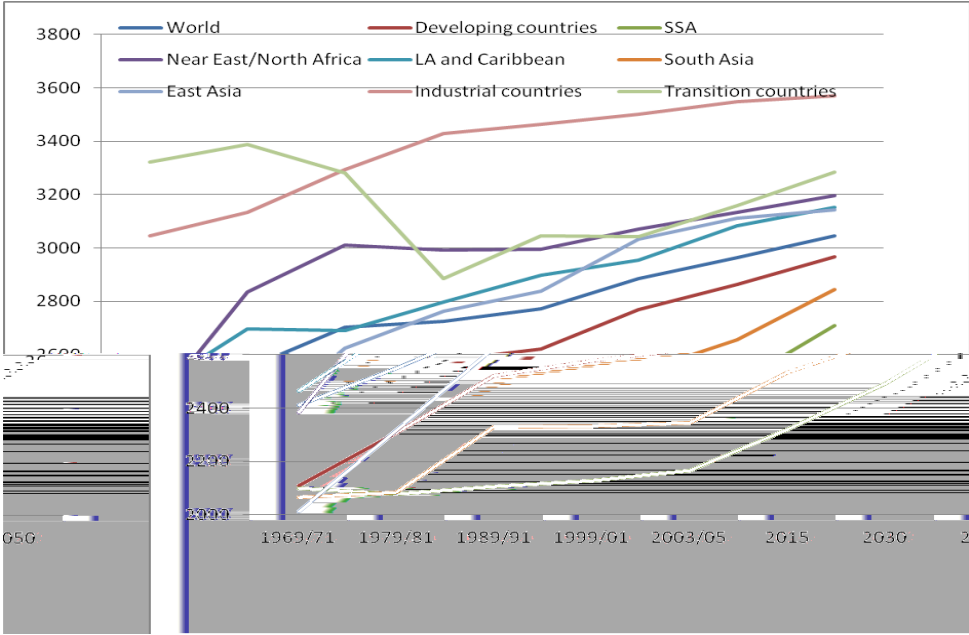
3. Increase of global demand. Since the 1960s global food consumption is increasing (Fig 1). This is the consequence of the increase of the population (see major trends) and of per capita food consumption in kcal/person/day (as estimated by the national average apparent food consumption) rising worldwide (Fig 2).



Data from FAO 2009.

4. The increase in food consumption per capita is mainly due to overall economic progress of the developing countries. However, the world figures are decisively influenced by the significant gains made in some of the most populous among them, especially China, Indonesia, Brazil and Mexico (FAO 2006).

Apparent food availability per capita

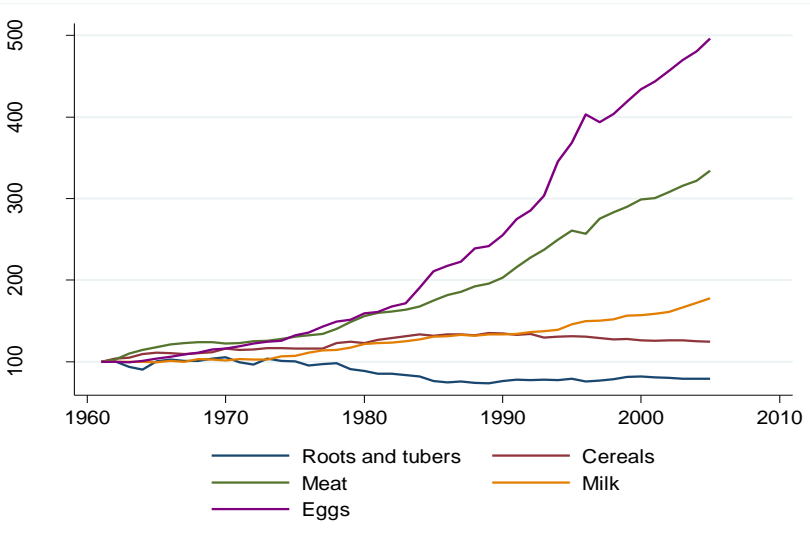


Source FAO 2006, FAO 2009a

Changing consumption patterns

5. As per capita food consumption has increased there has been a parallel change in dietary patterns, at least in the countries that experienced such growth. Much of the structural change in the diets of the developing countries concerned the rapid increases of livestock products (meat, milk, eggs), vegetable oils and, to a smaller extent, sugar, as sources of food energy (Fig 3). These three food groups together now provide 29 percent of total food consumption (i.e. dietary energy supply) of the developing countries, up from 20 percent three decades ago. Their share is projected to rise further to 35 percent in 2030 and to 37 percent in 2050 (in industrialized countries the share has been around 48 percent for several decades now). However, these changes have not been universal and wide inter-country diversity remains in the share of different commodity groups in total food consumption (FAO 2006).

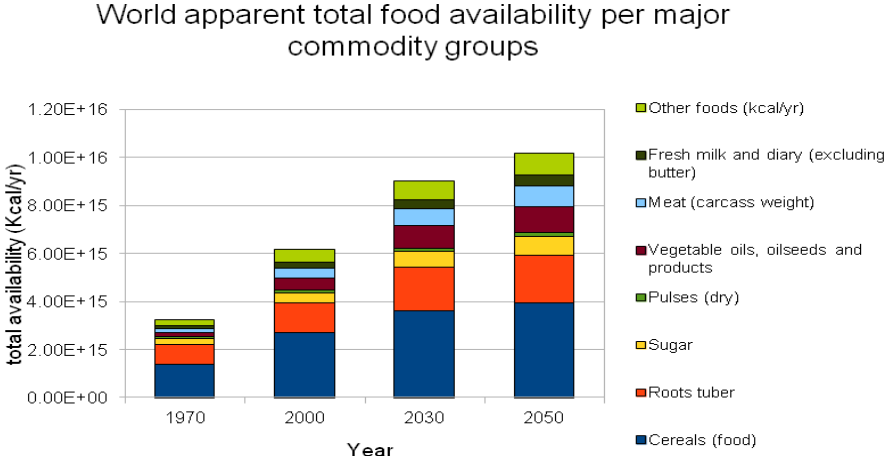
Per capita consumption of major food items in developing countries, 1961-2005



Source FAO 2009b

6. Demand for livestock products have considerably increased since the early 1960s in the developing countries. Consumption of milk per capita has almost doubled, meat consumption more than

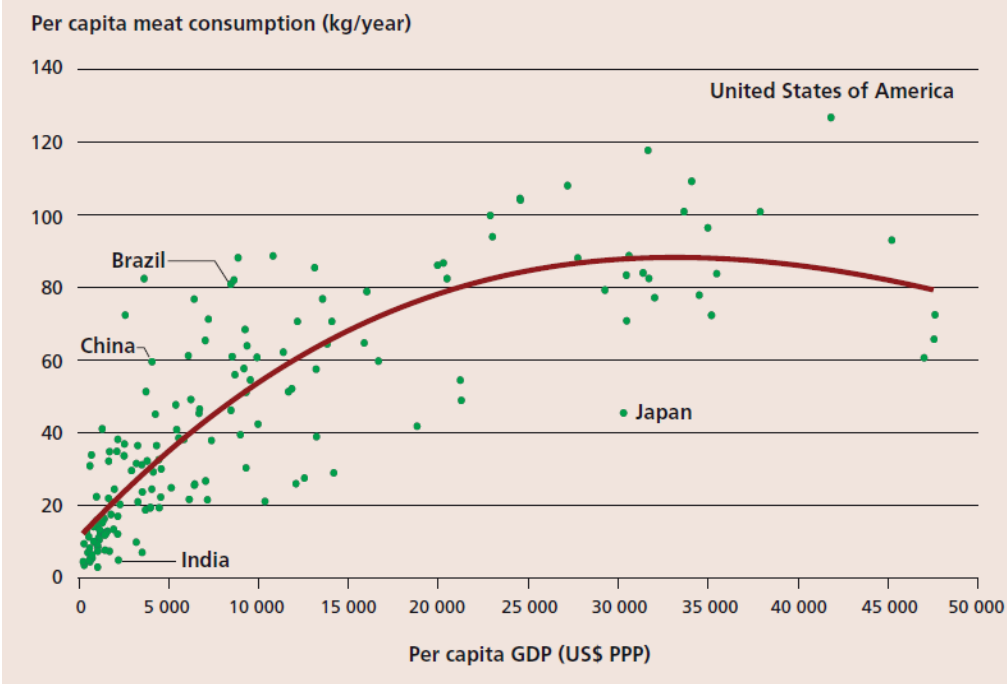
tripled and egg consumption increased by a factor of five. The most substantial growth in per capita consumption of livestock products has occurred in East and Southeast Asia. China, in particular, has seen per capita consumption of meat quadruple, consumption of milk increase tenfold, and egg consumption increase eightfold between 1980 and 2005. Among the developing-country regions, only sub-Saharan Africa has seen a modest decline in per capita consumption of both meat and milk (FAO 2009b).



Data from FAO 2006

7. Increase of global demand for food (Fig 4) is directly driven by the increase of total population and changing patterns of consumption. These are driven by global increase of income, influence of diet patterns of industrialized countries and urbanization.

Per capita GDP and meat consumption by country, 2005



Source FAO 2009b

- 8. These factors also apply at national levels, with strong cultural differences.
- 9. Demand for fish and fishery products is driven by two main factors, income and population growth. Other drivers linked to this are increasing urbanization, improved distribution and logistics and a growing emphasis on more healthy foods, of which fish is one of the more prominent given its unique nutritional qualities.

10. Because of state of the world oceans, unsustainable fishing and depleted fish stocks, any rise in world demand cannot be met by increased captures of fish, but will have to come from increased production in aquaculture. This is testified by the recent stabilization of the ocean’s catches at around 90 million tonnes annually, and the spectacular growth of aquaculture over the last two decades (now counting around 50% of all fish and fishery products in direct human consumption), which correlated product innovation, innovation in distribution and logistics.

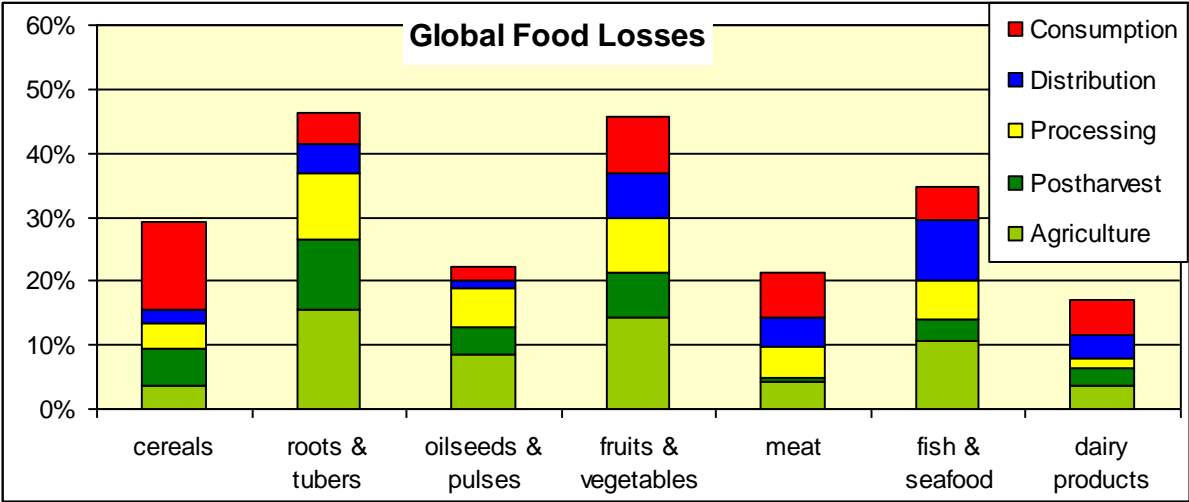
11. Fisheries is increasingly globalized, with almost 40% of all fish produced now entering international trade, with a production for the most part in developing countries (50% of all exports in value). Interestingly, growing demand for fish in the developing countries in particular of freshwater species (first in Asia, subsequently in South America and more recently in Africa) is now a major driver of developing countries’ aquaculture.

Food losses and waste

12. Roughly one third of the food produced in the world for human consumption every year — approximately 1.3 billion tons — gets lost or wasted (Gustavsson et al. 2011). Losses and waste happen all along food chains, with important differences according to regions and products.

13. Food losses — occurring at the production, harvest, post-harvest and processing phases — are most important in developing countries chiefly because of inadequate harvest techniques, poor post-harvest management and logistics, lack of suitable infrastructure, processing and packaging, and lack of marketing information which would allow production to better match demand.

14. *Food waste* is more specific of industrialized countries, most often caused by consumer behaviour but also from lack of coordination between different actors in the supply chain. There are also important differences between types of products (see figure below).

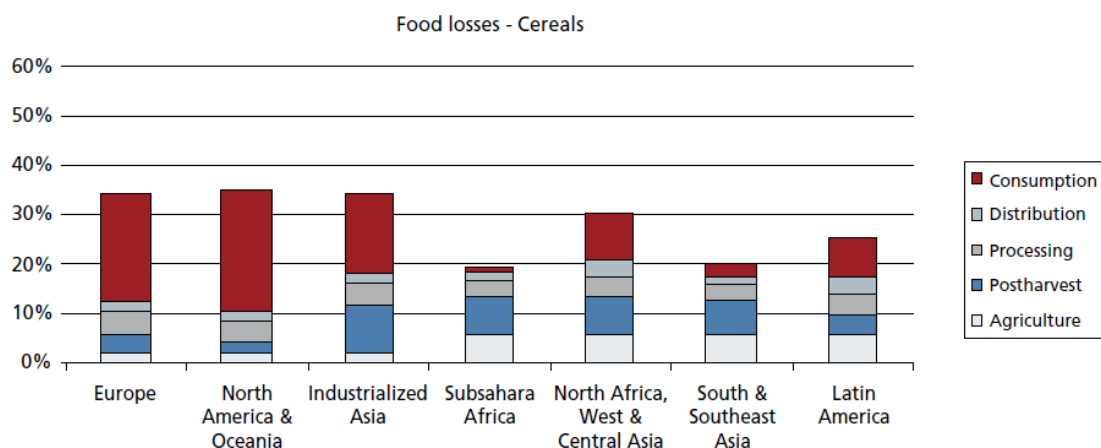


Global Food Losses. From Gustavsson et al. 2011

15. Global differences between regions (Gustavsson et al. 2011) seems to reveal relations between the patterns of losses and waste, i.e. the repartition of the losses along the food chain for different products, and the degree of economic development. There could be a tendency to increase of waste linked to the increase of income.

16. Losses and waste of cereals are double in Europe than in sub-Saharan Africa (see figure below). For instance, in Africa cereals are lost in the first stages. In Europe, they are lost mostly at the consumer stage: 25% against 1% in Africa. In turn, losses of milk are the double in Sub Saharan Africa than in Europe. For fruits and vegetables, the differences between regions are also striking. In Africa processing and distribution are the weak links, which highlights the need of investments in these stages. In Europe it is at the production and consumption stages that most of the losses occur. These wide differences show possibilities of improvements to reduced losses for certain products, but also a risk of increased food waste.

Part of the initial production lost or wasted, at different food supply chain stages, for cereals in different regions



Imbalances

17. In spite of these global trends to increased per capita consumption and change in diets there are still vast numbers of undernourished and malnourished people. At the same time there are also a growing number of overweight and obese people.

18. According to the State of Food Insecurity in the World 2010 (FAO/WFP 2010), a joint report from the Food and Agriculture Organization of the United Nations (FAO) and the World Food Programme (WFP), the total number of undernourished people in the world was estimated at 925 million in 2010. While this figure was down nearly 10 percent from the number of undernourished people in 2009, due to the partial recovery of the global economy, it was still significantly higher than the level that existed in 1996 – 828 million – when in 1996 the World Food Summit set a target to reduce the number of the world’s hungry by half by the year 2015. Developing countries account for 98 percent of the world’s undernourished people and, as of 2010, had a 16 percent prevalence of undernourishment.

19. Today, micronutrient malnutrition – often referred to as “hidden hunger” – affects around 2 billion people worldwide, more than one-third of the global population. These vitamin and mineral deficiencies, including iron, iodine, zinc and vitamin A, lead to poor physical growth and development, lowered mental capacities, reduced productivity, impaired immune systems and other health problems. Today, around 2 billion people are anaemic, mainly due to iron deficiency,¹¹ 250 million children around the world are at risk of vitamin A deficiency, a condition that can lead to blindness and early death, 800 000 childhood deaths can be attributed to zinc deficiency each year, 200 million people have goiter, and another 20 million are mentally retarded as a result of iodine deficiency. Close to 10 million children die before their fifth birthday every year as a consequence of malnutrition.¹²

20. The massive growth in obesity rates in recent years has been in large part due to high levels of dietary energy intakes and reduced physical activity due to poor diet and lifestyle choices. Obesity has emerged as the most serious health concern of the twenty-first century and is the leading cause of preventable death. Once considered only a problem of high-income countries, obesity rates are rising globally and affect both developing and developed countries. A recent analysis by the International Association for the Study of Obesity¹³ estimated that approximately 1 billion adults are currently overweight and a further 475 million are obese. The same study found that 200 million school-aged children are either overweight, of which 40–50 million are classified as obese. WHO give similar global figures with one billion overweight of which at least 300 million are obese.¹⁴ For children under five

¹¹ <http://www.who.int/nutrition/topics/ida/en/index.html>

¹² <http://www.who.int/nutgrowthdb/estimates/en/index.html>

¹³ <http://www.iaso.org/publications/trackingobesity/>

¹⁴ https://apps.who.int/hpr/NPH/docs/gs_obesity.pdf

years of age 43 million (6.7%) were overweight and obese in 2010. Eighty percent of deaths from diabetes occur in low-and middle-income countries (WHO, 2011).

21. Undernourishment and malnutrition strongly depends on poverty and inequality between countries and within countries.

Projections

22. Given the interactions among various factors, projections of food consumption are inherently uncertain and can be used only to identify broad tendencies (Foresight, 2011). The FAO baseline projection (Bruinsma, 2009) of an increase of 70% in global food demand in 2050 has been widely cited and commented (Grethe et al., 2011). It is important to underline that these projections are of demand, not of needs. Even though demand will rise, there will still be undernourishment and malnutrition as these depend not only of food availability but also on the distribution of income.

23. Demand is set to increase significantly towards 2050 because of population growth and continuing change of dietary patterns. Income growth in low-income countries and emerging economies will drive demand even higher (Foresight, 2011). There will be a shift to high-status and non-seasonal foods, including more meat consumption, particularly in countries with rising income. FAO projects that by 2050, average meat consumption per person will be 40% higher than in 2010 (+ 70% in developing countries) (FAO, 2009a). According to FAO's estimations (FAO, 2009a), increase in consumption of livestock products will cause a 553 million tons increase in the demand for feed, which represents half of the total demand increase for coarse grain between 2000 and 2050.

24. Other authors have attempted to describe alternate scenarios. For instance Agrimonde (2009) describes a baseline scenario, Agrimonde 0, with an increase of global demand of dietary energy of 83 percent, and an abated scenario Agrimonde 1, where the increase is 28 percent. This last scenario supposes radical changes in consumption patterns and behaviors and in worldwide distribution of food, including a decrease of 25 percent of the per capita consumption in OECD countries between 2000–2050, without any income reduction, and a slowdown in the increase of per capita consumption in emerging countries. Such a scenario would require radical changes in consumers' behaviors, reduction in waste, and implementation of efficient public policies to promote more balanced and healthy diets.

25. Another study (Erb et al., 2009) elaborates scenarios based on diets – “western high meat”, “current trend”, “less meat”, and “fair less meat”, concluding that under the fair less meat scenario it would probably be possible to feed the world with organic crops and an organic livestock system with a very equitable distribution and an average daily intake of 2 800 kcal per capita of which 20 percent of protein from animal origin. The “western high meat” diet, with 44 percent of protein intake of animal origin would also probably be feasible, but only with a cropland expansion of 20 percent, intensive crop production and intensive livestock production.

Changes in food systems and consumers' demands

26. Developed countries place growing importance on information and logistics technologies, and food safety and quality standards. Food systems are increasingly linked from producer to consumer with an increasingly dominant role played by highly concentrated agro-industrial firms and retailers. These trends are expected to expand to developing countries, along with the expansion of supermarkets and hypermarkets (OECD, 2011).

27. Increasing urbanization, the growth of the middle class, rising per capita income, the growing distances between home and the workplace, and an upsurge in the number of working women are all factors that lead to a growing demand for processed food products that meet stringent quality and safety requirements and broader voluntary quality standards (including sustainability standards, organic, fair trade, geographical indications, local trade...). This offers new opportunities provided that adequate means are available to establish the processing technologies and industrial operations needed to deliver compliant products.

28. To feed the cities requires the gathering of supply in sufficient quantities that meet more stringent quality standards set by retailers and consumers, which would usually exclude smallholder producers. Companies tend to delist suppliers who do not meet expectations in terms of volume, quality and

delivery. Farmers wishing to supply supermarkets must accept to deliver fresh products, often every day, and they must accept the fact that buyers will consider part of their produce as of unacceptable quality (FAO, 2005).

Development of voluntary standards

29. A plethora of voluntary standards (VS), codes of conduct etc are emerging to cater for increasing consumer concerns on specific quality in relation with the food product (organoleptic, nutritional, etc.) and with the wider ecological, social and ethical aspects of its production processes; among them, some are public-driven, some are being driven exclusively by the private sector or NGOs/CSOs and in these cases, often considered by governments as non-tariff-trade barriers. In between these extremes are benchmarking schemes of standards and guidelines that are partly developed in consultation with governments (Code of Conduct for Responsible Fisheries, International Guidelines for Certification of Aquaculture and various national GAP programmes, etc.).

30. For instance the market for organic products is still relatively small (2 percent of global retails), but growing significantly worldwide. The global organic market size was USD 55 billion in 2009, a threefold increase from USD18 billion in 2000, with double-digit growth rates each year, except in 2009, when it still grew by five percent in spite of the financial crisis. Growth is expected to pick up again, due in part to increasing organic conversions in developing countries including in India and China (FIB and IFOAM, 2011).

31. Many countries are concerned that food standards do not present unnecessary barriers to market access by small scale producers and processors. Voluntary food standard schemes risk to make market access more difficult for small scale operators and, furthermore, major voluntary schemes can impact public policy objectives. On the other hand compliance with standards and improved market access for small farmers and processors and increasing stakeholder involvement in the development of standards, can greatly enhance sustainable consumption and production.

Consequences

32. Food demand growth and changing patterns of food consumption and demand has a very strong influence on agriculture, natural resources and food security, especially in rural areas. The first consequence is the necessary increase in crop production (see trends 5 and 10), notably to meet the increased demand for feed. However, the shift towards more high value products will change the context for livelihoods of farmers, rural development, and food security.

33. The livestock sector is one of the fastest growing parts of the agricultural economy, driven by consumer income growth and supported by technological and structural change. The growth and transformation of the sector has both positive and negative impacts. It leads to agricultural development, poverty reduction and food security gains, since beyond their direct role in generating food and income, livestock are a valuable asset, serving as a store of wealth, collateral for credit and an essential safety net during times of crisis. It leads to more efficient farming systems: in mixed and integrated farming systems, where waste products from crop and food production are used to feed livestock and where manure is used as fertilizer, and animals provide power for ploughing and transport. The growth of the sector can however lead to potential risks to the environment and human health.

34. Powerful forces of economic change are transforming the livestock sector in many rapidly growing developing countries. Production of livestock, especially pigs and poultry, is becoming more intensive, geographically concentrated, vertically integrated and linked with global supply chains. Higher animal-health and food-safety standards are improving public health, but are also widening the gap between small livestock keepers and large commercial producers, at the expense of smallholders. The “livestock ladder” – by which smallholders climb up the scale of production and out of poverty – is missing several rungs (Sones and Dijkman, 2008).

35. The growth of the demand in fish leads to positive impacts on economic development, in particular in coastal and rural areas, on the employment, especially for women in processing and on regional trade and exports. As the industry has become part of a global supply chain, much value is created in processing, trade and distribution. Net export revenues earned by developing countries from their fish exports exceed USD 25 billion a year and is larger than the combined total of all their other food

commodity net exports. The future of the sector is however intimately linked to sustainable harvesting and management of the world's wild fisheries resources, and of the sustainable development of the aquaculture sector.

36. The global increase of demand for food and feed can also exacerbate the impact of price increase on the poorest. Food price has an increasingly different effect on demand depending on countries. In high income countries, food prices have steadily declined, relative to income, thanks to competition on price, to subsidies for agricultural production, and to a low level of integration of negative externalities in costs. In poor countries, food is still a very important part of most household budgets. For example, the budget share of food expenditure is about 70 percent in Tanzania and 45 percent in Pakistan against an average of 10 percent in the USA (HLPE, 2011). Increased demand for agricultural products for food, feed, and non feed uses such as biofuels is a driver of price increase. As incomes increase, food demand becomes less sensitive to price changes and, as income is increasing in most of the world, global food demand is becoming less and less sensitive to price changes. Price increase will not reduce global demand but it will have disproportionate effects on poor (HLPE, 2011).

37. The increase of demand and the shift towards more livestock products will also have a strong impact on the management of natural resources and will require natural resource efficiency gains in order to decouple production growth from environmental impact

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TREND 2: GROWING COMPETITION AND DIMINISHING QUALITY AND QUANTITY OF NATURAL RESOURCES AND LOSS OF ECOSYSTEM SERVICES

1. Trends for 2050 suggest growing scarcities of agricultural land, water, forest, marine capture fisheries and biodiversity resources (GEA1). Competition over natural resources for food and non-food is not new but the nature and the intensity of the competition has changed significantly in several ways during the past decade and the tendency is expected to continue. This competition is driven by accelerated intensification of human activities, with increasing pressures on land, water, biodiversity, energy and nutrients in coming decades for urban expansion, infrastructure, industry, mining, food production, bio-energy and non-food raw materials, and wood and tertiary products. Consumption of cereals and oilseeds for the production of biofuels has increased, as well as the use of biomass as a substitute for petrochemicals. Competition over natural resources is exacerbating pressures on and hence degradation of resources and ecosystems. At the same time, degradation and abandonment of natural resources can lead to increased competition over other natural resources. Reasons for diminishing resources for food and agriculture include depletion and degradation of soil and water resources, loss of biodiversity and loss of productive land for other uses. A number of ecosystems at risk have been identified (SOLAW, 2011). Scarcities of agricultural land, water, energy and nutrients vary widely geographically, with in some cases scarcity in one region due to biophysical or political and socioeconomic constraints, and excessive or inappropriate use and environmental harm in other regions.

2. Growing competition for natural resources can lead to a zero sum game if not managed in the public interest. It will exacerbate scarcities and threatens to alter the earth's ecological functioning in a way harmful to many regions in the world (Rockstrom et al 2009). Such competition also threatens to reduce resource availability for food production and thereby put pressure on food prices and reduce access. At the same time, the use of natural resources for non-food production will provide additional income opportunities for the rural sector, thereby increasing the contributions of agriculture to economic activity. Governing institutions have not sufficiently adapted to deal with the growing competition and the interconnections in natural resource use. Strong governance mechanisms are needed at national and international levels to strike the appropriate balance between conflicting needs and opportunities, and to provide an enabling environment for sustainable land and ecosystem management and in particular to implement appropriate frameworks for secure tenure rights over natural resources.

Growing intensity of competition over natural resources: drivers and forms

3. Increased demand for natural resources is likely to be sustained over future decades because of some key driving factors such as:

- Population growth. Land area per capita is decreasing in many parts of the world driven by population growth, poor governance and lack of alternative employment to allow people to move off the land. Globally about 0.25 ha of land is cultivated per head of the world population but high income countries cultivate more than twice the area per capita (0.37ha) than low income countries (0.17 ha).
- Increasing urbanization rates - that re-allocate rural land and water for urban purposes and increase the share of the world's population that depends on food purchases.
- Changing consumption patterns (such as growth in meat consumption) that require more land-intensive production.
- Bio-energy production
- Increasing food demands for export as a result of globalization and food security concerns in investor countries.
- Growth of commercialized production of natural resources.)

- Input and production subsidies to the agricultural sector, such as for energy, fertilizer, water and government purchase of production (which aim to promote production and food security but may promote the expansion of agricultural lands).

4. At the same time, this competition is over a shrinking base of natural resources because of:

- Degradation, depletion, over-exploitation and pollution of natural resources.
- Climate variability and change and natural disasters (e.g. flooding of coastal areas, erratic rainfall and prolonged droughts).
- Land being taken out of production through land abandonment due to civil strife, displacement and land mines, expansion of human settlements, and infrastructure and mineral extraction.
- The protection of ecosystems from human pressures by limiting access to their natural resources through environmental legislation and designation of parks and reserves.

5. When users of land and other natural resources are affected or displaced for these various reasons they often intensify competition over natural resources in the areas they exploit and resettlement areas. Reduced access to land and water resources is becoming a limiting constraint on further expansion of production in the crop, livestock and aquaculture sectors.

6. Three main forms of increasing competition can be identified:

a) Increasing competition arising from non-food demands for biomass (e.g. energy and other purposes)

7. The use of natural resources for non-food products has a long history (e.g. plantations for palm oil, tobacco, pulp and paper) but substantial new demands for natural resources have emerged. In particular, the rate of use of cereals and oilseeds has been significant. Between 2000 and 2011, without biofuel, the growth rate of world cereal consumption was 1.3 percent compared with 1.8 percent for biofuels; while growth of oil seed consumption was even more important, its share of biofuels jumped from 11 to 24 percent (HLPE, 2011). More broadly, in the face of future shortages of petrochemicals there is considerable potential and interest in using increasing amounts of biomass in the context of bio-based economies, with varying potentials across regions. An impact of this trend is increased competition between food and non-food uses of biomass is an increased tension on the markets, and increasing interdependence of food, feed and energy markets. It also impacts local food security and access to land resources.

b) Increasing competition arising from demands for biomass (including food and feed)

8. The increasing competition between food and non-food uses of biomass exacerbates competition for land and natural resources. For example, the recent wave of large-scale acquisitions of land and water for biofuel production attracted attention of the global media, civil society, policy-makers and researchers. In other instances food production can prevail over feed or energy uses: infrastructural improvements and the rising value of fish are, in general, leading to a growing share of the world's wild catches going to direct human consumption, rather than being used for other purposes (such as fish meal and fish oil production).

9. The same form of competition can play out differently in different parts of the world because local conditions shape the dynamics of the competition. In the case of investment deals for biofuels, where people have secure tenure rights to natural resources, they tend to be significant providers of natural resources for investors. Elsewhere, governments dominate where natural resources are formally owned by the state, even if those resources are accessed through customary institutions. The effects on local resource users can vary from them benefiting from an income stream by renting their land to being dispossessed and displaced.

10. Complexity further arises because the use of natural resources is interconnected. The livelihoods of the rural poor are often diversified and dependent on access to several different natural resources, e.g. households may combine crop production and livestock grazing with fishing and gathering of forest products. Where land and water resources are scarce or crop and livestock production is risky due to

problem soils, prolonged drought or serious pest or disease outbreaks, significant populations rely on extensive pastoral systems and/or on hunting and gathering and the sustainable use of biodiversity and natural ecosystems to provide forage, fodder, firewood, bush meat, edible and medicinal plants, mushrooms, honey etc, and ensure food security.

11. Interconnectivity is increasing as virtually all coastal and land-based resources are already used and claimed in some way, even if only for periodic uses due to resource constraints, such as shifting cultivation, nomadic pastoralism, seasonal fishing and gathering of forest products. The expansion of one type of use often comes at the expense of other uses and users, as illustrated in the table below.

	Effect on arable land	Effect on pastures	Effect on forest land	Effect on fisheries and aquaculture
Increased crop demand	Crop production more competitive, including between smallholders and large-scale industrial operations	Land and water diverted from grazing in favour of cultivation	Forests cleared for cultivation	Fish habitats degraded by wetland drainage, flood protection and irrigation systems, and fertilizers and pesticides
Increased livestock demand	Increased use of arable land for feed	Undetermined, as industrial livestock might prevail over pastoralism.	Forests cleared for grazing	Fish habitats degraded by livestock access to water bodies
Increased industrial forest product demand	Land and water diverted from cultivation in favour of plantations	Pastoralists prohibited from grazing livestock within forest boundaries	Competition between indigenous/local forest users and commercial plantations	Fish habitats degraded by timber harvesting practices
Increased aquaculture production and fishing capacity expansion in capture fisheries	Land and water diverted or degraded in favour of fish ponds	Land and water diverted from grazing in favour of fish ponds	Mangroves cleared for aquaculture	Growing competition and conflicts between small and large-scale fisheries, and across international boundaries

12. The belief that large tracts of idle and underused natural resources exist and are available for use is largely a myth. In the Near East, North Africa and South Asia, all land suitable for cultivation is already farmed (Bruinsma, 2009) and/or at various degrees of degradation and constraining productive agriculture. There is potential land for rainfed crop production in sub-Saharan Africa and Latin America but this would involve conversion from less productive land currently used for grassland or forest/woodland and would aggravate climate effects and biodiversity loss.

c) Increasing competition over the purposes of management of natural resources and ecosystems (biomass, carbon storage, biodiversity, urbanization, etc.)

13. The availability of natural resources for agriculture, fisheries and forestry is further affected by other demands. On the one hand, there are growing pressures for environmental initiatives, such as enhancing land carbon sequestration, protecting natural resources and reducing negative impacts of their exploitation, such as through the Desertification, Biodiversity, Climate Change and Ramsar (Wetlands) Conventions and the establishment of marine protected areas. On the other hand, the availability of, or access to natural resources for agriculture, fisheries and forestry is threatened by other uses, notably, the exploitation of minerals, oil and gas, the creation of new energy sources such as dams and hydropower schemes and offshore windmills, and the promotion of tourism, particularly in coastal areas. The

expansion of urban areas is taking place worldwide and in some regions, especially in the Near East, is occurring on limited agricultural lands fuelled by high land prices and profitability of construction, and lack of or inadequate land use planning, agro-ecological and economical zoning, as well as appropriate policies to protect agricultural lands. Increasing competition for the use of water bodies in general, in coastal areas, in lakes or rivers and increasingly in world oceans is displacing more and more fishermen from traditional fishing areas. Other non-food demands for natural resources are less publicized but still significant: recreational fishing, for example, has become a large and important economic sector and its economic value in some regions may be larger than the value of landed commercial catch.

Diminishing quality and quantity of natural resources and loss of ecosystem services

a) Breakdown and loss of ecosystem services

14. FAO's State of Land and Water Report identified a set of productive ecosystems that are at risk of progressive breakdown through a combination of demographic pressure and unsustainable natural resources management practices. In such systems climate change is exacerbating physical limits to land and water availability through rainfall variability (unreliable) and more extreme events. The drivers of unsustainable resource use include poor governance, inadequate and conflicting policies and legislation, weak institutions and inadequate incentive mechanisms for farmers and other users of land resources to adopt sustainable natural resources and landscape management. Insecurity of tenure and land fragmentation are major barriers to sustainable land and fisheries uses. Climate change will exacerbate the situation and threaten future production capacity requiring major adaptation efforts in many areas to reduce vulnerability of populations and enhance resilience to stresses. As a result of increasing competition for natural resources, traditional management systems are progressively being eroded with inadequate recognition of their multiple values, and too often not being replaced with resource and cost efficient systems.

15. The number of regions that are reaching the limits of their production capacity is fast increasing. The intensive systems that have been damaging the environment will need to adopt more resource efficient (water, energy) and sustainable technologies. Food production is keeping up with rising demand through intensification and irrigation development however with increasing environmental and social costs in terms of loss of ecosystem services, reduced resilience and increased vulnerability of small scale farmers and the poor. Besides on-site impacts of unsustainable use of land resources across commercial and subsistence farming systems worldwide, extensive off-site impacts include changes in hydrological regimes and ground and surface water recharge rates that in some regions are seriously impacting on water availability, and pollution and siltation that are affecting water quality and the productivity of aquatic systems. Particular imbalances also exist in nutrient and carbon cycles with implications in terms of productivity and climate change. Accelerating loss of biodiversity at habitat, species and especially genetic levels is reducing options and the potential of humankind to adapt to demographic pressure and climate variability and change.

16. The impacts are increasingly felt in terms of the reduced capacity of communities and countries to ensure food security of their populations, reduced resilience of the human-managed production systems to change and vulnerability of farming populations in particular to climate change, variability and extreme events. The trends in scarcity of resources and degradation will require greater efforts to ensure more resource efficient, sustainable and productive crop, livestock, forest and aquatic systems.

17. There are many examples worldwide of successful intensification through resource efficient irrigation and rainfed technologies but they tend to be relatively limited in scale due to a range of policy and institutional constraints that impede effective uptake and scaling out. Relatively less attention and investment has been placed on the sustainable use of fragile lands and extensive livestock and rangeland systems although they support important populations and will be more vulnerable to climate change. Many ecosystems are reaching the limits of their production capacity with implications in terms of resilience to change, food and livelihood security, migration and trade.

b) Depletion and degradation of land resources

18. The global land area is 13.2 billion hectares; of this 12 percent is currently used for agricultural crops, 28 percent forest and 35 percent comprises grasslands and woodlands ecosystems. The net increase

in cultivated area over the last 50 years (159M ha) is attributable to an increase in irrigated cropping, which has doubled. Land under rainfed systems has shown a slight decline; some land has been taken out of production due to degradation or for construction and some forest land has been lost to cropping and pasture development (est. 135M ha decline over last 30 years). The loss of grazing land is hard to assess; however, in semiarid areas, large scale conversion of fragile grasslands to cropland and inappropriate management are leading to serious degradation and displacement of pastoral people's in some parts of the world driven by either population pressures or biofuels, but also by inadequate valuation of the multiple ecosystem services that rangelands provide (FAO, 2011a). Fragmentation and resource-degrading practices especially by resource-poor smallholder farmers are resulting in a spiral of increased degradation, reduced productivity, increased poverty and food insecurity in many countries (e.g. India and many countries in sub-Saharan Africa, as demonstrated by the UNCCD process).

19. While food production since 1960 has increased by 2.5 to 3 times on only 12 percent more cultivated land area the cost has been high. Intensification has in many cases been unsustainable resulting in depletion and degradation of soil, water and biological resources and loss of ecosystem goods and services (biomass, carbon storage, soil health, water storage and supply, biodiversity and social and cultural services) while also leading to social inequities (displacement of poor; gender imbalance –labour, income and support services).

20. One quarter of the world's food-producing lands/soils are highly degraded or are rapidly being degraded; add to that other soils which are degrading "moderately", and the area under threat amounts to one-third of the Earth's endowment of cropland. Worldwide, 1.5bn people are affected. Degradation processes include accelerated soil erosion on sloping lands, depletion of nutrients and organic matter, damage to soil structure and health and loss of water holding capacity in rainfed systems, overuse of mineral fertilizers in intensive systems, depletion of aquifers and soil and water salinization associated with increased groundwater withdrawals and inadequate drainage in irrigation systems, as well as salt water intrusion in coastal areas.

21. Globally only half of the nutrients removed from the soils by harvesting agricultural products are replaced by fertilizers (SOLAW) but in large regions of the developing world nitrogen (N) is a limiting factor for cropping (access; availability) while in developing countries excess N applications cause serious damage through leaching into aquatic systems. Phosphate (P) is a non renewable resource that is used widely in Asia (54 percent of globally available P fertilizer) and very little in Africa (only 3 percent) but it may become a limiting factor with increasing demand on limited supplies of high grade rock phosphate ores. Loss of soil organic matter and effects on the carbon cycle are serious worldwide but especially through degradation of fragile tropical soils, degradation of dryland soils and effects on water retention, and drying of wetlands and peat soils.

22. There are also positive trends. In some areas, this degradation trend has been reversed through investment in irrigated systems, and in others by agro-ecological and farming principles, that rely on diversified systems and sustainable technologies that restore the ecological services provided by the land (carbon, nutrients, water retention, biocontrol of pests, pollination). Such successful technologies include: conservation agriculture, agroforestry, integrated crop livestock systems, terracing and contour farming, water harvesting, sustainable livestock and grazing management, catchment and river basin management, and so forth (WOCAT, ICRAF, Critchley et al). However such trends tend to be localized and dependent on investment in land and water resources development in irrigated systems (land levelling, pumping, transmission, etc.) and investment largely in human capital for the sustainable management of soil, water and biological resources in rainfed systems (knowledge, technology transfer etc.).

c) Depletion and degradation of terrestrial water resources

23. A relatively small share of the global renewable water resources (replenished through the hydrological cycle) are withdrawn from watercourses, lakes and aquifers – only 9 percent of the total volume generated by rainfall. But of this volume, withdrawals for irrigation dominate (70 percent) followed by industries (19 percent) and for municipal use (11 percent). However availability and use varies widely. In many of the low rainfall areas of the Middle East, N. Africa and C Asia (e.g. India, NE china) the situation is critical as most of the exploitable water is already withdrawn, with 80-90 percent for agriculture and with serious depletion of rivers and aquifers. In intensive agricultural economies of

Asia some 20 percent of internal renewable water resources are withdrawn (systems already under pressure).

24. Water availability to agriculture will become a growing constraint in areas that use a high proportion of their water resources, exposing systems to high environmental and social stresses. Climate change is expected to exacerbate these stresses and will require adaptive management to build resilience but also exploit new climatic niches. Because of the dependence of key food producers on groundwater, declining aquifer levels may create a risk to regional food production, with possible implications on food prices at global level.

25. The rate of expansion of land under irrigation is already slowing substantially. FAO has projected that the global area equipped for irrigation may increase at a relatively modest rate to reach 318 million ha. in 2050, compared to around 301 million ha. in 2009. Most of this expansion is projected to take place in developing countries. This would represent an increase of around 11 percent, or 0.24 percent per year, much slower than in recent years – between 1961 and 2009 irrigated area worldwide grew at 1.6 percent a year and at more than 2 percent in the least developed countries.

26. The trend in water use by agriculture is also slowing as the performance of irrigation systems and agronomy improve, raising both the productivity of irrigated land and water productivity. But rapid transitions from rural to urban settings are further concentrating patterns of demand. Since agriculture will continue to be the main water user, improved agricultural water use in irrigated agriculture will have a direct impact on local and regional water demands. Allocations of raw water away from agriculture to other higher utility uses – municipal supplies, environmental requirements and hydropower generation – are already taking place, but there is still scope for optimizing these allocations in economic and environmental terms. Agriculture will also need to benefit further from the progressive increase of treated wastewater use from the urban sector which is already significant in the Near East region.

d) Loss of biodiversity at ecosystem, species and genetic levels

27. Thousands of species of crops, farm animals, aquatic organisms, forest trees, micro-organisms, invertebrates, and their genetic variability make up the web of biodiversity in the diverse ecosystems on which the world's food and agriculture production depends. For thousands of years, humankind has used, developed and relied on biodiversity for food and agriculture. However, worldwide, biodiversity including genetic diversity, is being lost at an alarming rate. With the erosion of these resources, humankind loses the potential to adapt to changing socio-economic and environmental conditions, such as population growth and climate change.

28. Unsustainable management practices are the key drivers behind the rapid loss of biodiversity and the reduced capacity of healthy ecosystems to deliver their wide range of goods and services (i.e. food, water, timber, air purification, soil formation and pollination). In food production the importance of the multiple goods and services provided by ecosystems has frequently been overlooked and under-valued, but awareness on their value to human well-being and to future economic and social development is increasing.

29. The specialization of cropping systems and planted forests, largely driven by the seed/germplasm industry and global markets, has tended to reduce the diversity of crops and trees available to farmers and hence grown. In addition, as a “side-effect”, it has also reduced the diversity of associated beneficial plant, animal, microbial and invertebrate species above and below ground in the farming systems. However, to cope with change, farmers will need a genetically diverse portfolio of crop and forest varieties, suited to a range of agro-ecosystems and farming practices, and resilient to climate change (extreme events, rainfall variability and temperature). In this respect, in addition to ex situ conservation, in situ conservation and sustainable use, including the conservation of crop wild relatives are key. Also, intensification of livestock production and more recently aquaculture systems both favour the use of a small number of breeds selected for their high productivity and the specificity of their products, rather than diversity of products or resilience.

30. Loss of biodiversity has also been driven by land fragmentation and loss of habitat and poor governance over land resources and the subsequent insecurity of tenure as well as inadequate recognition of the current and future value of genetic resources for food and agriculture. For example, poor livestock

management of common property grasslands and rangelands can lead to overgrazing, allowing for an increase of less palatable species and leading over-time to reduced grazing and decreased livestock productivity as well as reduced diversity of other grass and rangeland products, such as fuelwood and medicinal plants. An increased focus on staple foods for subsistence (monocropping) or on specific commodities (i.e. energy crops like rapeseed and soybeans used for the production of biodiesel) can have negative effects on food diversity and food security.

31. These trends are leading to a certain degree of homogenization between different ecosystems (Lockwood et al., 2001) based on more uniform high yielding crop and livestock species, varieties and breeds, with serious implications in terms of sustainability due to reduced capacity to adapt to change and reduced resilience to shocks due to pest and disease outbreaks and climate variability and extreme events. Most people today depend on just 14 mammal and bird species for 90 percent of their food supply from animals, whereas over 500 aquatic species are cultured and used as food; 30 major crops provide 95 percent of our calories, and in industrialized and increasingly urban societies half of the crop energy is provided by just four plant species (wheat, maize, rice and potato).

32. The aquaculture sector must also look to intensification of production as the main way forward. This is also the case in the few regions where spatial expansion is still possible as commercial aquaculture is increasingly relying on economies of scale, reached through intensification of production, in order to remain competitive in the market. Improved breeding technology, better yields and feed conversion factors, more disease resistant brood stock and faster growing fish are all elements in this process. More intensification also presents challenges to policy makers to ensure sustainable development of the aquaculture sector.

33. Legally established protected areas cover an estimated 13 percent of the world's forests. The primary function of these forests may be the conservation of biological diversity, the protection of soil and water resources, or the conservation of cultural heritage. While the rate of deforestation is still alarmingly high, it shows signs of decreasing, with around 13 million hectares of forest were converted to other uses or lost through natural causes each year in the last decade, compared to 16 million hectares per year in the 1990s.

34. Agriculture, fisheries, forestry and the natural resources on which they depend will be challenged to ensure the food security of an increasing number of people during this century – an additional 3 billion people requiring an estimated 70 percent increase in global food production. This will have to be carried out under changing climatic conditions, especially in the most vulnerable parts of the developing world. In these areas in particular, adaptation of agriculture, fishery and forestry sectors, where management of biodiversity and genetic resources is key, will not be an option but an imperative for survival. Yet, within the present international policy arena on climate change, the role of the terrestrial and aquatic food production systems is not prominent although greater efforts are being made by some countries and organizations to position agriculture firmly in the global negotiation process (CGRFA, 2011).

Implications for the governance of natural resource management

35. Recent investment deals for the large-scale acquisition of natural resources have promised benefits of jobs, technology, infrastructure and tax revenues. The extent to which these benefits arise depends in large part of the quality of governance, and particularly of the framework of property rights over natural resources. Where governance of the allocation and regulation of use of natural resources is weak, the rules governing the changing competition over natural resources may not exist, or they may favour the powerful over the poor, or they may be ignored. Weak governance marginalizes the poor who lack the political force to influence decisions and the financial resources to bribe corrupt officials. Growing competition over natural resources in situations of weak governance can lead to the rural poor being dispossessed of the natural resources upon which they base their livelihoods. Women are particularly vulnerable where they are already socially and economically marginalized, for example, through unbalanced division of labour, inadequate rights over natural resources and inequitable decision making power.

36. Governing institutions have not sufficiently adapted to the interconnections in natural resource use. While sectoral approaches are usually still required, they are often not coordinated and integrated

across the various resource sectors. The lack of coordination may result in their effectiveness being greatly reduced if not negated.

Consequences for food and agriculture and FAO

37. This trend of diminishing and degrading natural resources is in direct contradiction to the increasing global and national demands for food and, indeed, to the respective sustainable management goals enunciated in Goal 3 of FAO's Strategic Framework 2010-2019. Moreover, the effects on production of food and other products seriously undermine national and global capacities to achieve Goals 1 and 2 of FAO that address enhanced food security and reduced poverty.

38. With a decreasing availability of natural resources, increasing competition can lead to a zero sum game if resource allocation is not subject to clear regulation in the public interest. Investments in commercial agriculture or fisheries may focus on prime agriculture land or fisheries, but where property rights are weak, people using that land or fishery may be dispossessed and forced to seek access to less productive resources, which in turn may be used by others. The allocation of state-owned natural resources to investors may not be priced at the market value, and is often not costed at its social value when those resources are used by local communities through customary tenure, i.e. when their property rights do not have legal recognition and protection. Social safeguards are necessary to manage trade-offs by optimizing economic production while protecting vulnerable groups.

39. There are trade-offs between various development pathways that affect different stakeholders differently and need to be examined and weighed up in regard to the various goals of optimizing production, minimizing the environmental footprint, ensuring the conservation and sustainable use of biodiversity, promoting fair and equitable development processes, supporting subsistence and commercial farming, and so forth. Scarcity of natural resources should also lead the food and agriculture sectors to focus more on reduction of post harvest losses in general, and on increasing the overall value derived from the resource. This should include incentives for attaining balanced provisioning, ecological and socio-cultural values such as payments for environmental services. Public awareness and understanding of the potential and actual flows of economic benefits can help leaders move toward socially responsible and sustainable natural resource use underpinned by sound scientific advice.

40. The anticipated impacts of climate change (extreme events, rainfall variability and temperature) and the pressures on land and water resources are such that local adaptation capacity will need to be built to cope with the changes and political, technical and investment support and incentive measures will be needed to help develop diverse and resilient land use systems to feed the expanding urban and rural populations.

41. The temporal and spatial scales of development will need to transition from short term project cycles to long term vision and development strategies that address demographics, resources availability and demand, and national food security. This will apply to small-scale interventions up to community territory, watershed, river basin and wider landscape dimensions that address the interactions between terrestrial and aquatic ecosystems (freshwater, coastal and marine) and with human society.

42. No State has ever established or maintained a prosperous food system based on genetic resources of purely domestic origin, or without a system of well governed natural resource management. Many river basins and ground and surface water resources are transboundary and some countries have very limited land and water resources. Sound national policies and strategies, as well as international policies and intergovernmental bodies, are essential to protect the global public goods - the land, water and biodiversity resources - and allow continued exchange of genetic resources and fair and equitable sharing of benefits derived from their use with a view to food security for all in future generations. As Amartya Sen put it, famines do not occur in functioning democracies because governments are more responsive to the needs of citizens. The cause of many famines can be attributed to institutional failure resulting from the lack of broad-based accountable governance, rather than to market or production failures (Agbor and Moyo, 2011). Managing competition over natural resources and addressing their diminishing quality and quantity require a system of well governed natural resource management, including for property and other tenure rights. Institutional capacity to oversee, monitor and enforce regulations, promote and ensure implementation of good management practices, and effective policies for bio-security within the larger context of food production are necessary in the crop, livestock, forestry and fisheries sectors.

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Appendix 1 Major categories of ecosystems at risk (SOLAW)

1. *Densely populated highlands used mainly for rainfed cropping in poor areas* of Asia, Africa and Central America that face erosion, degradation, reduced soil and water productivity, increased intensity of flood events, as well as high out-migration, poverty and food insecurity
2. *Smallholder rainfed cropping and agropastoral systems in semi-arid tropics* of the Sahel zone and savannahs in W, E, and southern Africa and Southern & W India that face desertification, reduced production potential, increased crop failure due to climate change and variability, increased conflicts as well high out-migration, poverty and food insecurity
3. *Densely populated, intensively cultivated rainfed cropping systems* around the Mediterranean basin facing the same problems as the system above as well as further land fragmentation
4. *Highly intensive agriculture in temperate regions* those in Western Europe facing pollution of soils and aquifers with associated costs, loss of biodiversity and degradation of freshwater ecosystems and those in US, Eastern China, Turkey, New Zealand, parts of India, Southern Africa and Brazil that also face increased climate variability and crop failure.
5. *Irrigated rice based systems* both those in SE and Eastern Asia that face abandonment, loss of buffer role of paddy land, high costs of and conservation, pollution and health hazards and loss of cultural values of land and those in SSA, W & E Africa facing high rehabilitation costs, poor return on investment, stagnating productivity, large scale land acquisitions and land degradation.
6. *River basins with large contiguous irrigation systems from rivers in dry areas* including Colorado, Murray Darling, Krishna, Indo-Gangetic plains, Northern China, Central Asia, Northern Africa and the Middle East that face increasing water scarcity, loss of biodiversity and ecosystem services, desertification, expected reduction in water availability and in some places shift in seasonal flows due to climate change
7. *Groundwater dependent irrigation systems in interior arid plains*: India, China, Central USA, Australia, North Africa, Middle East and others that face loss of buffer role of aquifers, loss of agricultural land, desertification, and in places reduced recharge due to climate change.
8. *Rangelands including Pastoral and grazing lands* on fragile soils in the Sahel, western Africa, North Africa and parts of Asia that face desertification, out-migration, land abandonment, food insecurity, extreme poverty and intensification of conflicts.
9. *Tropical forest-cropland interface* in Southeast Asia, Amazon basin, Central Africa and Himalayas that face cropland encroachment, slash and burn, leading to loss of ES and land degradation.
10. *Deltas and coastal areas*: Nile and Red River deltas, Ganges, Brahmaputra, Mekong and coastal alluvial plains that face loss of agricultural land and groundwater, health related problems, sea level rise, higher cyclone frequency and incidence of floods and low flows.
11. *Small islands*: including the Caribbean and Pacific islands that face total loss of freshwater aquifers, cost of freshwater production, increased climate related damage (hurricane, sea level rise and flood).

TREND 3: ENERGY SECURITY AND SCARCITY – THE LANDSCAPE AND TRENDS

1. The IEA suggests that global primary energy demand will increase by a third during the period 2008-2035 and that today's developing countries will account for a large proportion of this demand increase. Fossil fuel is expected to contribute with around 81 percent of these requirements under present public policies. The gap between energy demand and access is large and about one fifth of world population lacks access to electricity. The cost of oil and gas production is expected to increase contributing to upward pressure on its price to consumers. High energy prices will have a negative effect on agricultural production costs and food security around the world. This provides opportunities for cleaner and more affordable energy production in rural areas, which is a major contributor to food security.

Global energy trends

2. Coal, oil and gas, ranked by importance, are the fossil fuel sources used to supply the primary energy mix. Renewable energy, including biomass, is on the rise and will continue to do so in the future. It supplied an estimated 16 percent of the global final energy consumption. In 2010, it accounted for approximately half of the new electric capacity added globally, delivering close to 20 percent of global electricity supply; by early 2011 renewable energy comprised one quarter of global power capacity from all sources (REN21, 2011). Renewable energy will contribute to about 15 percent of the total energy mix under current policy scenarios (this share could increase up to 27 percent under more ambitious environmental policy implementation). Today, bioenergy represents about 50 EJ or 10 percent of global annual primary energy consumption, and accounts for more than 70 percent of global renewable energy use. More than 80% of bioenergy use concerns the traditional and most often unsustainable use of biomass (mainly woody) for cooking and heating. Potential deployment levels of biomass for energy by 2050 could be in the range of 100 to 300 EJ- hence at least double the current one (Chum et al, 2011). However, there are large uncertainties in this potential such as market and policy conditions, and it strongly depends on the rate of improvement in the production of food and fodder as well as wood and pulp products Bioenergy has recently witnessed a sharp increase in demand and attention in two areas:

- In the wood energy sector, because of the increased demand for woody biomass for
 - heating and electricity in OECD countries – with national demand far outstripping national supply in the future. This already causing an increase in the use of woody residues and new plantations in developing countries, and this trend is likely to become more pronounced, and
 - in developing countries, due to the persistent and growing traditional use of wood and charcoal in south Asia and Africa, with again prospects that this trend is continue for a foreseeable future.

3. In the transport sector, because liquid biofuels (often simply called biofuels) are the only renewable resource that can currently provide high energy density liquid fuels. Global ethanol production increased fivefold and global biodiesel production sevenfold between 2000 and 2010. According to IEA (2011b), by 2050 biofuels could provide 27 percent of total transport fuel, i.e. more than tenfold its current proportion. Estimates concerning land use for biofuels vary widely. But a recent review considers that land used for biofuels in 2020 would amount to between 3 and 10 percent, from about 1.5 percent in 2008. Therefore, on balance, there should be enough land to fulfil global food, feed and fuels by that time (Gallagher, 2008). More strikingly perhaps is the fact that biofuels is considered usually the main cause for increased land use for crop production in the future. But this proportion could be significantly reduced (10 to 25 percent) with massive use of residues (Gallagher, 2008). By 2020, about 13 percent of coarse grain production and 31 percent of sugar cane are expected to go to ethanol production, and 16 percent of vegetable oil to biodiesel production (OECD-FAO, 2011). Scenario analyses indicate that strong short-term research and development (R&D) and market support could allow for commercialization around 2020 depending on oil and carbon pricing.

4. Crude oil prices increased from USD 28 per barrel in 2000 to USD 120 in early 2011. The costs of oil and gas production, both to operate current capacity and develop new supply, have been increasing

strongly in recent years and are assumed to continue increasing up until 2035, contributing to upward pressure on prices. Conversely, the costs of renewable energy have been recently declining at a steady pace. This trend will continue in the coming decades, making renewable energy more and more competitive with conventional energy.

5. The energy sector is the largest contributor to climate change, as it produces nearly 60 percent of GHG emissions. Under increasing demand for fossil fuel energy patterns and little implementation of alternatives, it is obvious that the world is struggling to meet the global CO₂ emission targets. In many ways, the pattern of global energy related CO₂ emissions mirrored global economic performance whereby the economic slowdown resulted in a slowdown in CO₂ emissions between 2008 and 2009. Worldwide, the use of biomass for heat and power could save more than 1 gigatonne of carbon (GtC) annually by 2030. The co-firing of biomass with coal could save nearly 0.5 GtC per year at fairly modest costs. Savings in the traditional biomass and charcoal sectors could amount to another 0.5 GtC, although considerable effort would be required in this sector to overcome the higher investment cost, the complex socio-economic and cultural issues around traditional biomass use and the transaction costs associated with providing the equipment and reliable biomass supply (FAO, 2010).

6. The gap between energy demand and access is large and demand will certainly increase as countries develop. Average per capita energy use in low-income countries is a third that of middle-income countries, which is in turn almost a fifth of per capita energy demand in high-income countries¹⁵. From a household perspective, access to modern energy services is still extremely problematic in many developing countries. Improved energy access is essential if the poverty reduction targets set out in the MDGs are to be met. Energy services¹⁶, the services that energy and energy appliances provide, are essential to both social and economic development and a much wider and greater access to energy services is critical in achieving the poverty reduction goals set out in the MDGs. Today, 20 percent of the world's population live without access to electricity and the opportunities it provides for working, learning, or operating a business. Twice as many – nearly 3 billion people – use wood, coal, charcoal, or animal waste to cook their meals and heat their homes, exposing themselves and their families to smoke and fumes that damage their health and kill nearly 2 million people a year. Without access to energy, it is not possible to achieve the Millennium Development Goals (UN, 2011). A goal to achieve sustainable energy for all has been set for 2030 by the UN Secretary General Sustainable Energy for All Initiative, which was launched in 2012. The goal of achieving sustainable energy for all by 2030 is underpinned by three objectives, i.e. ensuring universal access to modern energy services, doubling the rate of improvement in energy efficiency and doubling the share of renewable energy in the global energy mix. Investment of \$48 billion per year will be needed to provide universal energy access by 2030. This is more than five times the level of investment in 2009 to expand energy access (\$9.1 billion) but represents only 3 percent of total global energy investment. Only \$4-5 billion per year of that total is needed for clean cooking facilities (UN, 2011).

Energy and the agrifood chain

7. Agriculture and energy have always been closely interlinked but the nature and strength of the linkages has varied over time. Agriculture has always been a source of energy, whilst energy has become a major input in modern agricultural production. In the past centuries animals, fed from agricultural produce, powered farm equipment and were used for transport. This is still the case in many parts of the world. In the twentieth century the linkages between agriculture and energy output markets weakened as fossil fuels mostly supplied the transport sector. At the same time, linkages on the input side strengthened as agriculture became increasingly reliant on chemical fertilizers derived from fossil fuels and machinery powered by diesel. Food storage, processing and distribution, too, are often energy intensive activities. Higher energy costs, therefore, have a direct and strong impact on agricultural production costs and food prices. Bioenergy, and more specifically biofuels, have received much attention over the last few years due to the increased links between agriculture and energy markets resulting from their production. The increased link between large energy markets and the agriculture markets has also resulted in increased

¹⁵ Average per capita energy use in low income countries is 423 ktoe/capita, 1242 ktoe/capita in middle income countries and 5321 ktoe/capita in high income countries (World Development Indicators 2010).

¹⁶ Energy services include lighting, heating for cooking and space heating, power for transport, water pumping, grinding, and numerous other services that fuels, electricity, and mechanical power make possible.

price volatility. The recent emergence of liquid biofuels based on agricultural crops as transport fuels has reasserted the linkages between energy and agricultural output markets.

8. The use of fossil fuels by agriculture has significantly contributed to feeding the world over the last few decades. Energy from fossil fuels has increased farm mechanization, boosted fertilizer production and improved food processing and transportation. As a result, there is a strong link between energy prices and food prices, and the recent increase in biofuel use has compounded this link. Recent increases in fuel energy prices may well signal the end of the era of cheap oil. Prices for nitrogen fertilizers and other farm chemicals are closely related to the crude oil price, so rising oil prices translate into increasing production costs.

9. Based on FAOs current work on Energy-Smart Food for People and Climate (ESF) (FAO, 2011 a and b), the whole agrifood chain currently accounts for around 30 percent of the world's total energy consumption,¹⁷ and more than 70 percent of this use occurs beyond the farm gate. Food losses occur at all stages of the supply chain and about one-third of the food produced is lost or wasted (Gustavsson et al, 2011). This food contains embedded energy. The energy embedded in global annual food losses is thought to be around 38 percent of the total final energy consumed by the whole food chain.

10. Energy use and energy loss along the agrifood chain vary between developing and developed countries.¹⁸ Fossil fuel consumption for agriculture is higher in high-GDP countries (around 20.4 GJ/ha) than it is in low-GDP countries (around 11.1 GJ/ha.) (Giampietro, 2002). In low-GDP countries, cooking consumes the highest share due to use of low energy value sources such as dung, biomass residues and inefficient stoves. Food arriving at the table is rarely wasted, but considerable food losses occur earlier in the supply chain due to inadequate harvesting techniques, poor storage facilities, limited transportation infrastructure and ineffective packaging and market systems. Food losses in low-GDP countries are due to certain extent to a lack of access to energy. High-GDP countries use a greater portion of energy for processing and transport. Energy used for processing, transport and food preparation is usually around three to four times the amount used for primary production (Smil, 2008). Food wastage in high-GDP countries mainly relates to consumer behaviour.

11. Greenhouse gas emissions from the entire food chain, including landfill gas produced from food wastes, account for approximately 20 percent of total emissions (FAO, 2011 a). Energy-related CO₂ emissions are produced from the combustion of fossil fuels to run machinery, generate heat and electricity for food storage and processing, and from the use of petroleum fuels for food transport and distribution. Energy-related CO₂ emissions have a lower impact than methane from rice paddies and ruminant livestock, combined with nitrous oxides from nitrogenous fertilizers, soil and animal wastes.

12. According to FAO most of the additional 70 percent food production needed to feed the world will have to come from agricultural intensification. Combined with the increasing consumption of energy-demanding food (meat and horticultural products), this also means a significant increase in energy needs in the agrifood chain. Moreover, the conventional intensification pathway - improved varieties, increased external inputs, mechanization- results in a development pathway that is highly dependent on fossil fuels. Given that fossil fuel resources are decreasing and the cost of fossil fuel is increasing, this pathway will most probably be unaffordable to the majority of farmers in developing countries thus constraining agricultural production and ultimately threatening food security.

¹⁷ Energy includes direct energy used at the operational level primarily on farms and processing plants, for example for irrigation, land preparation and harvesting as well as indirect energy, on the other hand, is not directly consumed to operate farms, in fishing or processing plants but rather the energy required to manufacture inputs such as machinery, fertilizers and pesticides.

¹⁸ The spectrum of agri-food systems is complex and diverse. All of these systems are dependent on energy. Both developed and developing countries may have both energy-intensive and less energy intensive systems. Therefore, it is no longer practical to classify countries using standard comparisons such as OECD or non-OECD, developed or developing, traditional or conventional, and subsistence or industrialized to explore the linkages between energy and food. The terms used are '*high-GDP*' and '*low-GDP*'. The term high-GDP describes the top 50 or so countries measured in terms of their GDP on a purchasing power parity basis divided by their population. The term low-GDP applies to the remaining 176 or so nations.

Bioenergy as part of the energy-smart food strategy

13. Bioenergy¹⁹ can be one output of the agrifood chain. It has the potential to contribute to a new energy portfolio strategy and be part of the solution within the energy smart systems approach but there can be risks associated with biofuel production and bioenergy production more broadly, depending on how their development is implemented. While the exact prospects regarding bioenergy, in particular biofuels and wood energy, is the object of debate, the increasing trends mentioned in the first section of this note show that these are here to stay. Several drivers have recently emerged regarding the sustainable deployment of bioenergy. These include changing policy contexts, market-based activities, the increasing support for advanced biorefineries and R&D regarding advanced biofuel options (including algae and lignocellulosic biofuels, and the development of sustainability criteria and frameworks.

14. As regards more specifically biofuels, their current production is mostly stimulated through government subsidies, tax incentives and mandates (particularly in the G20 countries). Nonetheless, the four-fold increase in price of crude oil has significantly increased interest and investment in alternative sources of energy supply, especially liquid biofuels²⁰ such as ethanol and biodiesel which are made from agricultural feedstocks. While higher oil prices have increased returns to biofuel production, leading some countries like the US to recently consider dropping drop their biofuel subsidies. On the other hand, the “threshold” at which biofuel production becomes profitable has also risen along with the price of agricultural feedstocks. This means that government policy support measures, particularly mandates in OECD countries, remain an important driver for most types of biofuels. By and large, developing countries have been slow to take up biofuel production, with the key exceptions being Brazil, Malaysia, and Indonesia. Other developing countries such as Argentina, Colombia, China, Thailand and India have increased production, but are still at low levels. In many developing countries there is considerable room to increase agricultural productivity, and increased demand for biofuels could be a driver for this. The new investment that biofuels could bring to agriculture should be used to increase productivity throughout the sector, thus allowing increased food production and increased energy production.

15. The precise contribution of biofuels to the recent rise in commodity and food prices has been the subject of considerable debate, but its effect is difficult to disentangle from that of other contributing factors, including rising food demand in emerging economies, declining stocks, exchange rate movements and trade restrictions. Estimates of the impact of biofuels vary, given differences in methods, commodities, and time periods covered, but most studies have found that biofuels have accounted for about a third of the increase in the prices of maize and vegetable oils in recent years, with smaller effects for other commodities.

16. The impacts of biofuels vary widely by type, feedstock and method and location of production. Impacts also vary between consumers and producers—and between different types of producers. This makes it difficult to draw general conclusions about the net impacts of biofuel for countries, particular groups and households.

17. As regards drivers of woody biomass use, one has to distinguish between two distinct uses, i.e.

- traditional use for cooking and heating in developing countries; where the drivers are primarily population growth, urbanisation and affordability of traditional woodfuel and charcoal;
- the recent increase in demand for modern heat and electricity production in OECD countries; which is caused by the search for renewable energy sources, to diversify economies away from fossil fuel and mitigate climate change.

Implications of the trends

18. The combination of increased energy needs and significant dependence on fossil fuel of the agrifood is therefore cause for concern in terms of sustainability and in particular achieving food security. As a result, due consideration to future agriculture development is crucial; in particular, the agrifood

¹⁹ Bioenergy is energy from biofuels. Biofuel is fuel produced directly or indirectly from biomass. Biomass is material of biological origin excluding material embedded in geological formations and transformed to fossil. FAO 2004, United Bioenergy Terminology, Food and Agriculture Organization, Rome

²⁰ Liquid biofuels are often simply called biofuels and this will also be the case in this note

chain will have to become gradually decoupled from fossil fuel dependence so that it can deliver more food with less and better energy. In a strive to find climate change solutions and within the scope for green economies, new development paths are sought that put agriculture and economic equity at the centre. The agrifood chain, the supply chain from field to the plate, can be part of a strategy to tackle the need for increased energy access, climate change mitigation and adaptation, and poverty while ensuring food security is safeguarded or improved.

19. A new paradigm of agriculture and food systems is needed to respond to the rising energy costs and the subsequent price increases for inputs produced from fossil fuels and the anticipated impacts of climate change. In short, the agrifood sector will need to become energy-smart. More efficiency, energy diversification through gradual increased use of renewable energy and improved energy access through integrated food- energy production along the whole agrifood chain are the three areas of intervention that can make the agrifood chain energy smart. This is possible because the agrifood chain is both a consumer of energy and a producer of energy and covers the whole food system and commodity supply chain including primary production from crop farming, fisheries, livestock, post-harvesting, transport and distribution, processing, retail, preparation and cooking. Many measures aimed at achieving energy efficiency behind the farm gate are actually a co-benefit of agro-ecological agriculture, which FAO has recently captured in the proposed new “save and grow” paradigm for agriculture. Indeed, many farming techniques promoted under this new paradigm, including no-till, precision farming, integrated crop-livestock systems, allow for less use of external inputs, and therefore save energy inputs at the input manufacturing and production stages of the agrifood chain. More analysis is required on how a shift to a less fossil fuel dependent food sector would affect food security, food prices, energy access, climate change resilience, technology uptake and capacity building. Lack of data is currently a limiting factor.

20. The sustainability of sharp future global increases in biofuel deployment depends significantly on the availability of commercially viable advanced biofuels, increase in agricultural yields, and the use of residues. The jury is still out regarding availability of advanced biofuels on a large commercial scale and there is strong support regarding the development of such types of biofuels.

21. The significant increase in demands for wood energy, be it for traditional or modern use, has to be addressed in different ways:

- The increase in traditional use of woody biomass for energy purposes may exacerbate the already significant impacts on:
 - The environment: Although there are data gaps concerning the dynamics between traditional biomass use and forest pressures, it is recognized that present unsustainable practices contribute to local deforestation and unsustainable forest resource exploitation. This is particularly the case in areas under population pressure (peri urban zones and/or refugee camps). Additionally, both the act of deforestation and combustion of biomass results in an increase of carbon in the atmosphere. The severity of global emissions from utilizing inefficient cookstoves alone is immense. For instance, research shows that global emissions from outdated cookstoves represent a quarter of all black carbon emissions, (UNEP, 2012). Nevertheless, ways to make wood energy for domestic use sustainable are known. From a supply side they include village wood lots (e.g. woodfuel plantations in the Green Belt Movement in Kenya) and community-based forest management (e.g. rural fuelwood markets in West Africa),
 - Social aspects: Globally, respiratory diseases from these practices can cause 1.6 million deaths a year, making it the second cause of mortality after AIDS (UNEP, 2012). This challenge is being addressed through a major new effort in the shape of the Global Alliance for Clean Cookstoves; with a goal of spurring the adoption of clean cookstoves and fuels in 100 million households by 2020.
 - Addressing both the above-mentioned environmental and social challenges requires that the traditional wood energy chain be formalized and more collaboration between concerned Ministries (including energy, forest, environment and agriculture)

22. The increase in the use of woody biomass for modern energy has to consider the fact that a significant of the demand for such energy in OECD countries will have to be imported from developing

countries. If biomass is sourced from food-insecure countries where local land rights are weak, there is a real risk that people could lose the land they depend on for their livelihoods. On the other hand, if wood residues become a valuable export commodity, there is a risk of favoring export markets versus domestic ones, with missed opportunities to address local energy deficits.

23. More broadly, the rapid development of bioenergy has generated considerable debate regarding their sustainability; making bioenergy development sustainable becomes even more challenging when one tries to capture its potential rural development, climate and energy security benefits. A sound and integrated approach is required in order to address these links and in particular promote both “food and fuel”, and ensure that bioenergy contributes to sustainable development. This approach requires:

- An in-depth understanding of the situation and of the related opportunities and risks, as well as synergies and trade-offs;
- An enabling policy and institutional environment, with sound and flexible policies and effective means to implement these;
- Implementation of good practices by investors/producers in order to reduce risks and increase opportunities; and appropriate policy instruments to promote these good practices; and
- Proper impact monitoring and evaluation and policy response mechanisms.

24. In order to promote this sound and integrated approach, over recent years FAO, partly in collaboration with partners, has developed the FAO Support Package for Decision-Making for Sustainable Bioenergy: Making Bioenergy Work for Climate, Energy and Food Security²¹. In addition, an interdisciplinary approach, often coined a nexus approach between energy, food, water and climate change requirement, is needed to ensure that all issues are covered and that the best solution is found while considering all demands.

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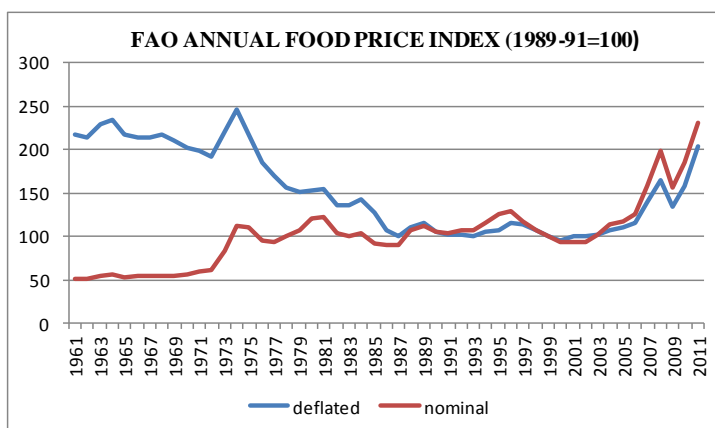
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TREND 4: FOOD PRICE INCREASES AND HIGH PRICE VOLATILITY

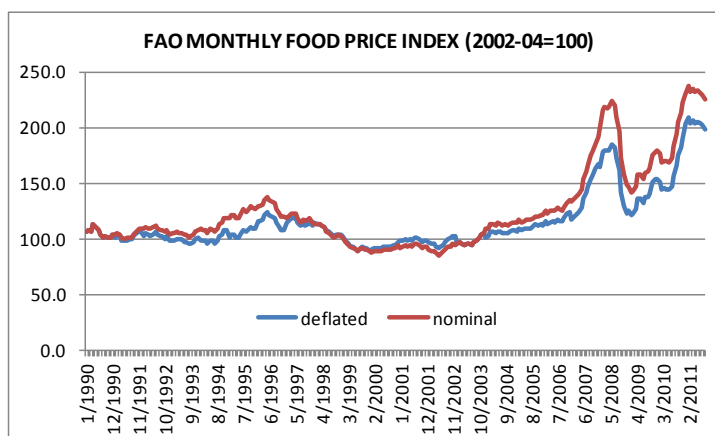
1. In recent years increased food prices and their wide variability have triggered worldwide concern about threats to food security and have shaken the complacency caused by many years of falling commodity prices. A certain degree of variability is normally expected in agricultural prices, ultimately due to the impact of climate and biological variables on production. Where markets function correctly, the variability of prices provides information that facilitates arbitrage across locations. However, large and sudden price swings exceeding expectations can have negative consequences. Recent price increases and their high volatility may be explained by several causes including supply shocks, low stocks, rising energy prices and increased global demand. Estimates indicate that these conditions will not change in the future and that consequently prices are likely to remain on a high plateau compared to previous decades and that the high volatility observed will also continue. Higher commodity prices could benefit producers around the world and net food exporting countries but will negatively affect world consumers, increase food insecurity of poor consumers and the position of net importing countries.

Evolution of prices

2. Up until 2006 the cost of the global food basket had fallen by almost a half over the previous thirty years or so when adjusted for inflation. Declining real prices in agriculture over the long term result from technological advances that reduce production costs combined with the slow-down of demand growth generated by saturation.



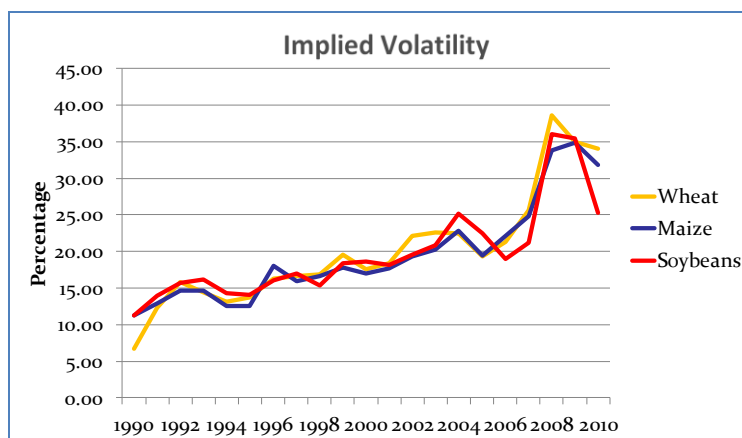
Source: FAO



Source: FAO

3. There have been, however, periods of high and turbulent commodity prices, including food prices. The spike which took place in the first half of the 1970s is clearly visible in the above chart. That episode was triggered mostly by a supply shock coupled with rising energy prices and monetary expansion. In subsequent years, however, prices went back to their previous declining trend, following a strong supply reaction.

4. Between 2008 and 2011, international food prices rose to levels not seen in decades. Escalating world prices for cereals, vegetable oils and sugar have fuelled much of the recent and highest increases. The FAO global food-consumption weighted price index rose to a record level in 2011, climbing 26 percent from the previous year. Volatility observed in 2010 was about twice the one observed in the early 1990s. The FAO Fish Price Index also shows that prices have risen over the last decade, and become more volatile.



Source: OECD-FAO Agricultural outlook 2011-2020

5. At country level, case-studies and data from local markets – such as those available through the FAO Global Information and Early Warning System - have documented higher price volatility in several developing countries, more persistent volatility in some cases, or lower volatility in others. Price transmission and the functioning of markets is one key element in this respect. Some consumers and producers around the world have been somewhat insulated from the volatility on world markets. Depending on the functioning of local markets, this may have exacerbated the impact of supply shortfalls; or it may have resulted in more stability at the local level; but it has also have added to the volatility of international markets, given that insulated agents do not react to the price increases by modifying demand and supply. Developing countries that depend on food imports to a large extent – for instance some in the North Africa and Near East region – suffered from the volatility of international markets both in terms of prices and in terms of reduced availability of international supplies. Taxation of foods in developing countries is another area which needs to be considered when assessing the impact of high and volatile prices at the country level.

6. One key question is whether the recent behaviour of food and agricultural prices will continue in the future, or whether prices will revert to their long term declining trend. There is no definite answer to this question. The outlook for the coming decades can only be derived by looking at the reasons behind the recent increase in price levels and volatility.

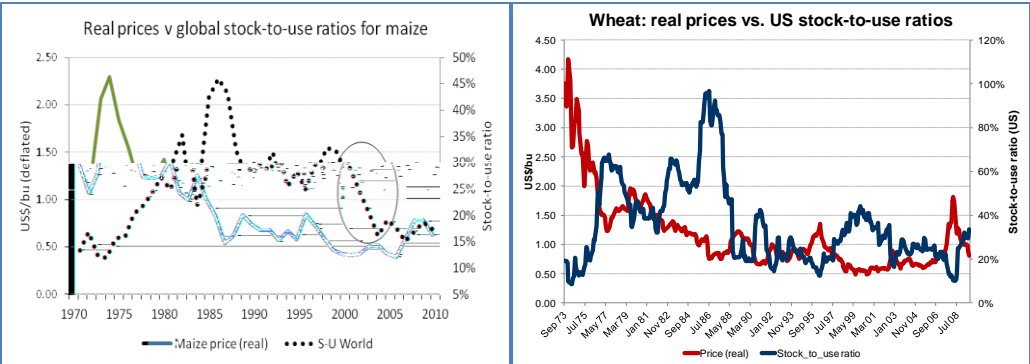
Why prices were higher and more volatile?

7. There are numerous reasons concurring to explain the recent increased level and volatility of food prices. Consensus seems to be emerging around four main elements, which are described below.

Supply shocks with low stock level and rising demand

8. Production of cereals in major exporting countries declined in 2005 and 2006 as well as in 2009 and 2010 due to unfavourable weather. Such supply shortfalls have taken place in a period in which demand has been expanding, driven by economic growth in developing economies, and after a long period of under-investment in agriculture, driven by low prices. At the same time, stocks have reached a critically low level: following the conclusion of the Uruguay Round several large countries decided to

reduce strategic reserves and rely more on world markets. The level of stocks relative to utilization declined in several key markets, and this has made prices more sensitive to supply shortfalls.



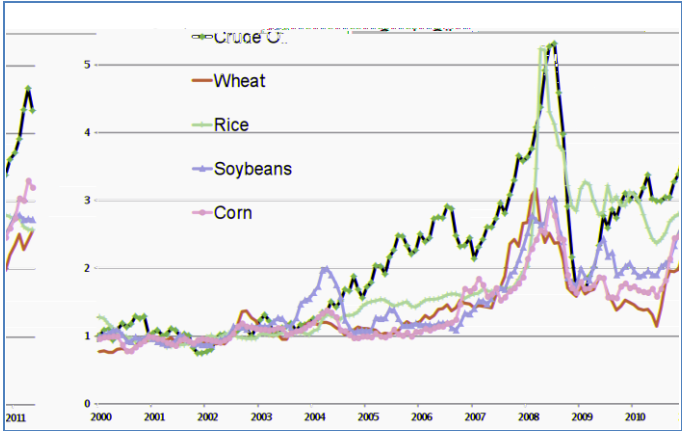
Source: data from FAO and Usda

9. Volatility in fisheries prices is also more linked to the supply side than the demand side: drastic changes in catching quotas of capture fisheries and disease outbreaks in aquaculture led to abrupt supply shortfalls, which had an immediate impact on prices.

Energy prices

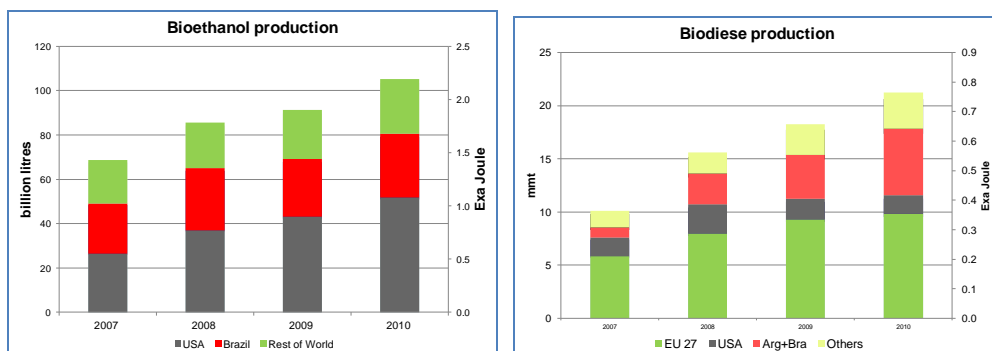
10. The recent food price increase occurred in period of rising energy prices, arising from underinvestment in the past decades, which limited the ability of supply to match fast demand increases from emerging economies. Agricultural and energy prices exhibit considerable co-movement. On the supply side, energy prices impact production costs through inputs such as fuel for machinery, fertilizers and pesticides.

Monthly world prices of selected commodities



Source: FAO

11. Over the last years the agriculture and energy markets have become more integrated, following the fast growth of demand for crops by the energy sector. Increased shares of sugar, maize and oil crops have been used in the bioenergy *filière*, following competitive conversion conditions and policies such as mandatory blending targets.



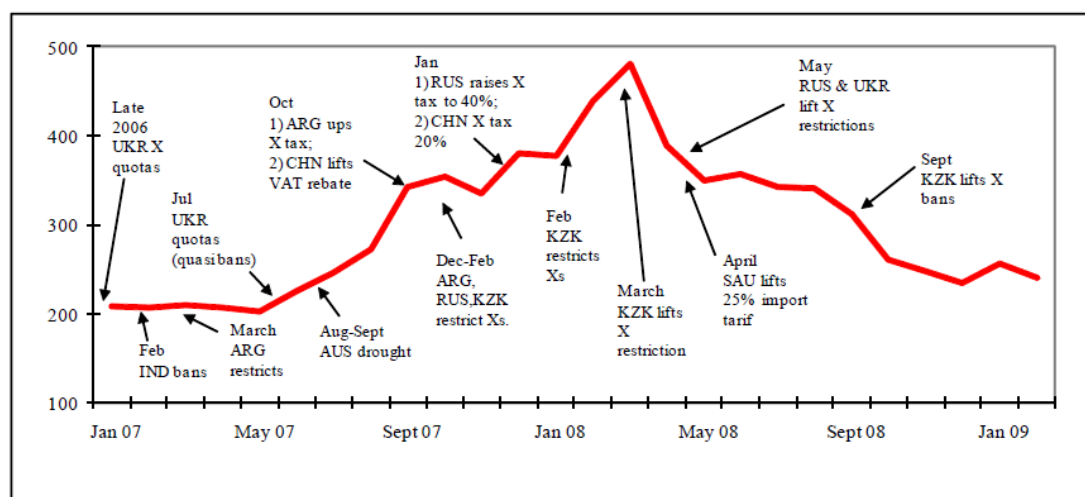
Source: FAO

12. This link between agricultural and energy prices has contributed to higher and more volatile agricultural prices, both through production costs and through the additional demand created by biofuels. As energy is generally more price-elastic than food, where market incentives or policies so dictate, the energy market can absorb large amounts of production, and make food and feed markets more tight.

Trade restrictions

13. As prices began to rally in 2008, many governments attempted to contain domestic food price inflation through a variety of measures, including export restrictions. The reaction was similar in 2010. Both export and import restrictions amplify price volatility in international markets.

Trade policies and price spikes, example for wheat (price in USD/ton)



Source: Sharma, 2011

Exchange rates

14. Most commodity prices are denominated in US dollars. The depreciation of the US dollar reduces the cost of commodities for countries whose currencies are stronger than the US dollar, resulting in a cushioning of food price increases. For countries whose local currencies are pegged to or are weaker than the US dollar, depreciation in the US dollar increases the cost of procuring food.

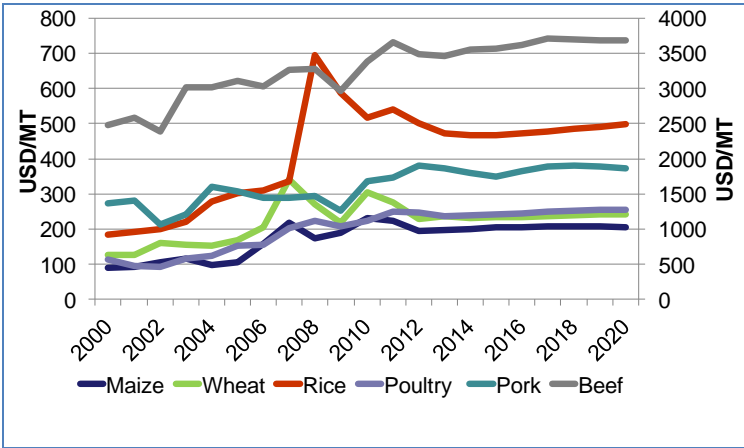
15. In many discussions on high food prices and volatility the increased integration of agricultural and **financial** markets is quoted as one possible reason for instability. In fact since the early 2000s global trading activity in futures and options based on agricultural products has more than doubled; “non-commercial traders” have been increasingly buying into agricultural commodities on futures markets to diversify their portfolios, as returns on other assets become less attractive. Some analysts agree that high levels of speculative activity in futures markets may amplify price movements in the short term; but there is no conclusive evidence that this has been the case, nor systematic effects on price volatility. In fact, there is no evidence that traders are determining significant deviations of prices from what is consistent

with the fundamentals of agricultural markets. Rather, investors in financial markets seem to operate on the basis of the available outlook information on agricultural market.

The outlook for the coming decades

16. The reasons behind the recent price behaviour explain the expectations for the coming years. As mentioned, the latest issue of the Outlook jointly produced by OECD and FAO - referred to the period 2011-2020 - indicates that prices are likely to remain on a higher plateau in real terms compared to the previous decade. And that the volatility observed in recent years may also continue to characterize agricultural markets. Restoring market balances and re-building stocks, in fact, require some time. And some of the other reasons that determined the turbulence observed in the most recent period, such as the increased linkage with energy markets, will likely continue to operate.

Price projections to 2020



Source: OECD-FAO Agricultural outlook 2011-2020

17. Also for fisheries, the OECD-FAO projections to 2020 indicate somewhat higher prices. Over the next decade, aquaculture is expected to account for an increasing share of supply, hence price swings in this activity will have a higher impact on the sector overall. As higher costs are foreseen for fishmeal, which is a crucial ingredient in aquaculture, and given that for many species production cycles last several years, prices are expected to remain at a relatively high level, and more volatile.

18. In the longer run, given growth prospects, it is expected that more consumers around the world will reduce their sensitivity to food prices; food demand may thus become even less price-elastic. This implies that the buffer capacity of the market may be further reduced, and prices may remain volatile. At the same time, the development of complex food supply chains may in part absorb price shocks, given that the share of agriculture in final food products would become smaller.

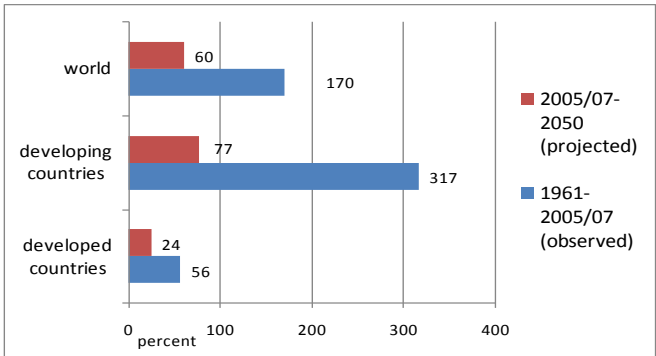
19. While short run imbalances between demand and supply contributed to increasing prices, mainly through the low level of stocks, in the long run the relationship between supply and demand remains uncertain and will depend, to a great extent, on two broad processes. On the one hand the evolution of global demand which will be affected by population growth, income per capita increases in the developing world and the potential increase in the production of alternative non food products. On the other, how food supplies increase in response to that demand.

20. FAO’s baseline projections indicate that, under plausible assumptions on yield improvements and rates of expansion of land and water use it should be possible to meet the food and feed demand of the projected world population of year 2050. However, this path is surrounded with considerable uncertainties. Significant efforts in terms of investment, technological innovation and policies to support these are needed in order to achieve these production projections.

21. In addition to the uncertainty about the ability to raise production to meet 2050 food demands there are other emerging concerns, such as a) how to reduce the environmental impact of the necessary agricultural intensification to reasonable and sustainable levels and b) how climate change may impact on global agricultural production potential.

22. Given the expected evolution of consumption,²² production in 2050 should increase considerably: compared to 2005/07, the world would need to produce every year one more billion tons of cereals; 196 more million tons of meats; 660 more million tons of roots and tubers; 172 more million tons of soybeans; 429 more million tons of fruits; 365 more million tons of vegetables. Overall, world agricultural production would need to increase by about 60 percent between 2005/07 and 2050. Although these figures, compared with past performances, imply a slow down given that world agricultural production has grown by about 170 percent between 1961-63 and 2005-07 it is now necessary to evaluate them in the context of the new constraints that will be present in the future.²³

Past and projected increases in global production



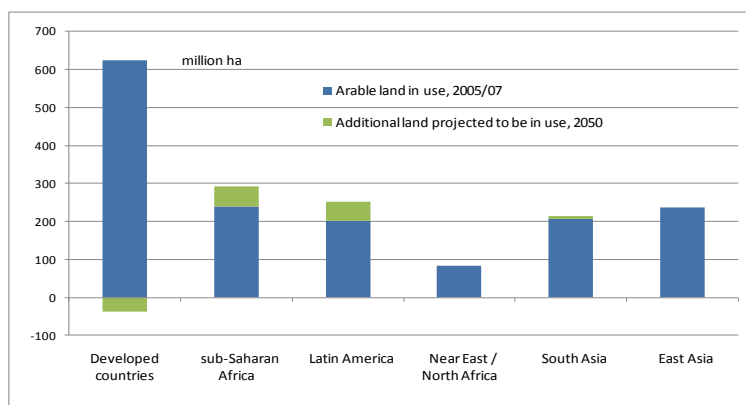
Source: Bruinsma, 2011

23. Is there enough land to support the projected increase in production? FAO projections indicate that the most *likely* – not necessarily *desirable!* – outcome will be an intensification of production. At world level, about 91 percent of the growth in production is expected to derive from increases in yields, while 4.3 percent would originate from area expansion and another 4.5 percent from an increase in crop intensity. In developing countries, 85 percent may originate from increased yields. The main issue is that with current technologies such intensification will carry increased environmental pressure, which needs to be counteracted through improved and more eco-friendly and climate-smart cultivation techniques. Arable land expansion is expected to be limited, and concentrated mainly in sub-Saharan Africa and Latin America. Combating further land degradation is thus another significant challenge.

²² Under the assumption that household food demand behavior will not change sharply from existing patterns and that levels of waste, that most evidence suggests is high, will continue.

²³ Several recent FAO publications describing the FAO baseline projection to year 2050 report an overall figure of 70% value-based aggregate increase in global production and consumption between 2005-07 and 2050. That figure was computed using FAOSTAT data for 2005-07 available in 2009. The same projection was computed again in 2011, based on more updated FAOSTAT information on 2005-07. Under the same assumptions, the new projections indicated a lower (60%) expected value-based aggregated increase in global production and utilization between 2005-07 and 2050. This large change is due to the fact that levels of production and utilization in 2005-07 were estimated to be higher than previously thought. This new result has to be regarded as provisional - as it was not yet fully validated - and is due to be published in the coming months (Bruinsma, 2011).

Projected changes in arable land



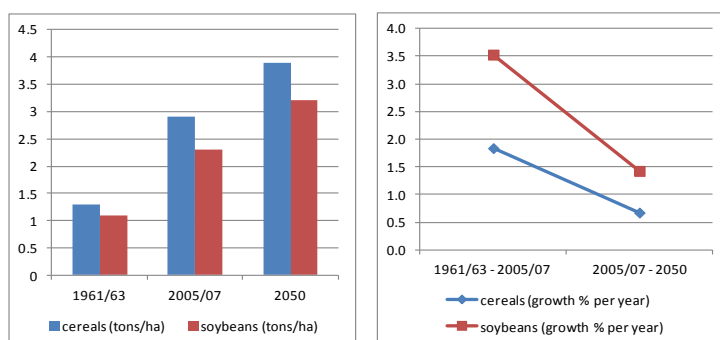
Source: Bruinsma, 2011

24. Is there enough water to support the projected increase in production? Historically irrigation has been a major determinant of increased production and productivity. Agriculture uses about 70 percent of the water resources of the planet. Pressure on water resources is beyond critical levels in certain regions, notably Southern Asia and the Near East/North Africa. Here further expansion of irrigation is unlikely. However, the situation is different in other regions, including Latin America and Sub-Saharan Africa. The world total area equipped for irrigation is expected to expand by about 20 million ha or 6 percent between 2005/07 and 2050.

25. Significant increases in the efficiency of irrigation may occur in land-scarce regions, where pressure to increase crop production per hectare may be higher. Competition with non-agricultural uses of water also needs to be addressed through a more integrated management of this key resource.

26. In absolute terms yields need to increase considerably. Is this feasible? At the global level yield growth projected by FAO is half the rate of growth observed over the last decades: 0.8 percent per year is the expected growth between 2005/07 and 2050, while 1.7 percent per year was observed between 1961 and 2007. This slowdown, which is mainly due to diminishing returns and a slow-down in demand, is expected to continue in the future, also in relation to the emerging urgent natural resources and environmental constraints. In some regions these may directly limit agricultural production.

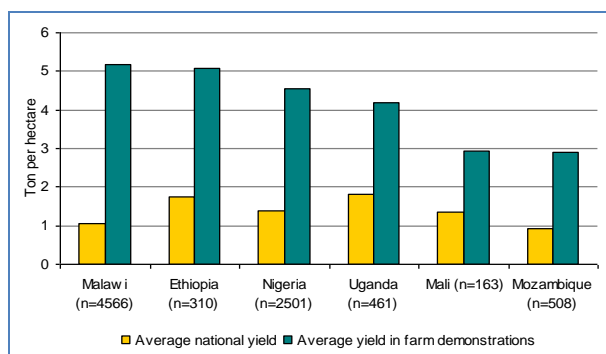
Past and projected yield increases



Source: Bruinsma, 2011

27. Today a large gap exists in some regions between average farm yields and the yields obtained in experimental fields. This is particularly the case in Sub-Saharan Africa for key products such as maize. Closing such gaps is not a matter of transferring technologies: farmers are likely to adopt technologies only if these are economically viable, and yield gaps can likely be closed only if there is an economic incentive to do so. In many areas this means that farmers and other stakeholders must be allowed to operate within well-functioning input and output markets; that they must have access to efficient infrastructures, as well as to better finance and risks management tools. Appropriate policies and institution to address these needs will be necessary.

Actual and potential yields: maize in Africa



Source: World Bank (2008)

What are the consequences of higher and more volatile food prices?

28. In general, while increased volatility has mostly negative consequences, higher food prices imply both costs and benefits.

29. High price volatility is mostly negative, as market participants have difficulty planning ahead and adjusting to fluctuating market signals. On the supply side, production levels would likely be reduced by increased volatility, due to increased risks that producers would face along supply chains. For farmers, this implies a lower application of inputs such as fertilizers, given lower expected revenues. Where they have limited or no access to savings and insurances to hedge against risk, volatility can result in higher poverty and food insecurity. The delay between production decisions and actual production creates additional risks, as farmers base their investment and planning on expected future prices. As unpredictable changes surpass a certain critical size, traditional coping mechanisms are likely to fail. Public and private sectors have limited incentives to invest in agricultural production and infrastructure if prices are volatile. These factors rendered production in many developing countries unprofitable.

30. On demand side, volatile prices affect negatively consumers, whose expected real income will need to account for variability. The impact is regressive across the income scale: relatively poorer households will be affected proportionally more, given that their share of food expenditure in total expenditure is higher. Food insecurity may therefore increase. Instability has negative repercussions on all economic activities, as food is usually an important wage good.

31. A high level of agricultural prices, within a relatively predictable environment, instead, implies a more nuanced scenario. Households that are net food buyers, both in urban and rural areas, are negatively affected by high food prices. Farmer's income, however, should increase, provided that markets allow transmitting prices. And incentives to invest and expand supply and agricultural infrastructure should also increase. In turn, this may facilitate also well the possibility to gradually re-build stocks. Income opportunities would also spread across production chains.

32. Policies to address volatility are multifaceted, and this largely depends on the specific context. However, they are likely to be in two main areas. In the short run, safety nets and risk management strategies will need to be reinforced, to protect incomes of the most vulnerable, both on the supply and the demand side of the market. In the longer run, focus should be on investment to increase productivity, both in agriculture and in the rest of the economy; this will likely raise real incomes and make agents less vulnerable to price fluctuations. An effective transmission of information and price signals is a necessary pre-condition to allow investment opportunities and increased productivity to materialize, as well as to allow farmers and other stakeholders to benefit from high food prices.

33. Finally, it is worth observing that international and national policies seem to have evolved over the last few years, partly as a consequence of the turbulence observed in agricultural and food markets. The recent period may thus be seen as a change in the previous trend in agricultural policies. In developing countries, agricultural policies seem to have evolved from a condition in which the sector was directly and indirectly taxed, to one in which it is less taxed, and protected in some countries (Anderson et al., 2009). Over the last few years, authoritative sources – starting from the World Bank (2008) - have

shown that investment in agriculture had been stagnating, and need to be revived. A number of international and regional initiatives have taken the same approach; examples are the *Aquila Food Security Initiative* (AFSI) of the G8, or the Comprehensive Africa Agriculture Development Programme (CAADP). Policies in key countries, such as Russia, China and India have placed increased emphasis on domestic productivity. Agricultural trade policies and their reform should be seen as a natural complement to these initiatives.

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TREND 5: CHANGING AGRARIAN STRUCTURES, AGRO-INDUSTRIALIZATION AND THE GLOBALIZATION OF FOOD PRODUCTION

1. The evolution of food production systems over the last decades has been characterized by an increased integration between agriculture, fishery and forestry and other economic activities. The emergence of complex and diverse agro-industrial production chains has implied qualitative and quantitative changes in the demand for primary products as well as income distribution across sectors and population groups. As a consequence, the distribution of productive resources has been changing starting with an increasing presence of large scale primary producers along with the persistence of small scale operations. Large agribusiness firms, including wood based industries, concentrate a growing proportion of manufacturing, distribution and retail of food products. This vertical integration occurs at the national level and at the global level in the development of large and complex global value chains. These processes modify market functioning and the distribution of rents between the different participants in the value chain at national level and in the international market. It also illustrates the importance of market access and market transparency for the development and wellbeing of small farmers and the new opportunities for product differentiation and value added activities including compliance with food safety regulations.

Concentration in land ownership and use

2. Land use for agriculture around the world is undergoing significant changes and shifts in access among different types of agents, especially in developing countries and emerging economies. An increase in the number and size of large farms has been documented especially in land abundant regions, particularly in Latin America, in Eastern Europe and Central Asia, in Southeast Asia, and more recently also in Sub-Saharan Africa. This trend stems in most cases from economies of scale, which affect the ability to comply with standards and to increase capital intensity. Horizontal integration in primary production, however, can also be a response to the need to counteract market failures - such as those of credit and insurance markets – as well as to counteract market power along production chains (Deininger and Byerlee, 2011) and to control water sources.

3. In more than one region, the change in land access and ownership has corresponded to increases in total arable land areas, and in a shift from small-size family farming to large size enterprises based on hired labour and higher capital intensity. However, the overall picture is quite nuanced: several regions witness a co-existence of different farm sizes, and conditions can even differ widely among countries in the same region.

4. These changes are consistent with those taking place in the organization of agri-food, fishery and forestry production chains. Their ultimate reasons are to be found in 1. technical change, which makes primary production processes more standardized, hence reducing the importance of local knowledge and advantages deriving from lower supervision costs in small scale operations; 2. the development of complex supply chains, pushing primary producers to integrate horizontally where possible, in order to increase their market power; and 3. lower availability of workforce in remote areas, creating an incentive for increasing capital intensity (Deininger and Byerlee, 2011).

5. Given these reasons, the tendency towards increasing farm size is likely to continue in the future. It is worth noticing that the increasing scale of operation is not necessarily inconsistent with a family-based organization of production, where production and distribution decisions are taken by assuming resources available in a household as a starting point. Nor is it necessarily leading toward uniform physical sizes of holding, as this depends on the specific product mix.

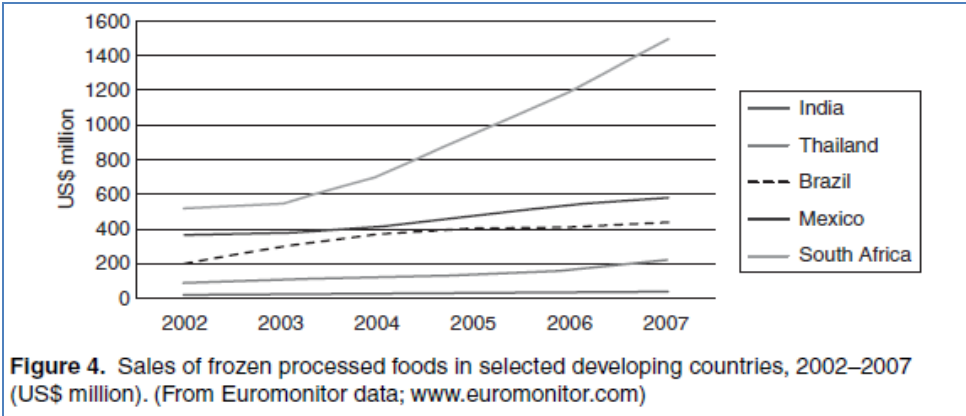
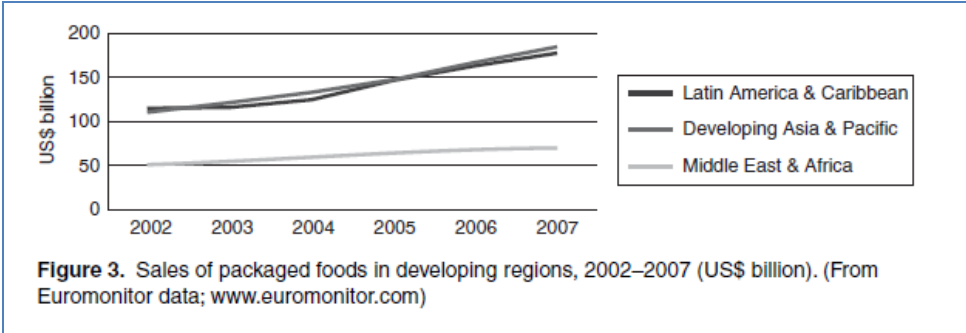
Agro-industrialization and the globalization of food production

6. While there is a popular image that agro-industrialization is relatively new to developing regions, agro-industrial capacity has existed in all countries for decades. The way agro-industrialization capacity was established in developing regions resulted in limited contributions to national economic development and was not conducive to the garnering of popular or political support.

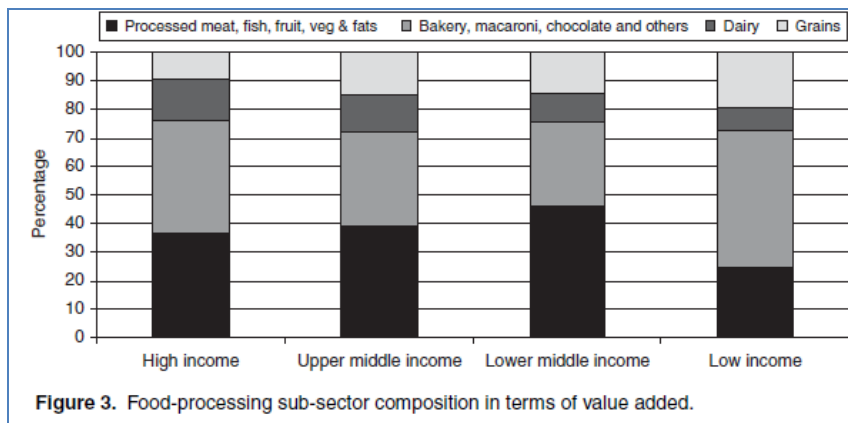
7. By the early to mid-1990s, therefore, some new and quite positive trends started to take hold in many developing countries. Two of the significant trends included:

- a) Agro-industrialization spread deeper into more agricultural sectors as global and national companies started to develop efficient and productive supply chains for niche tropical and local products increasingly in demand by high income consumers and diaspora populations. Since these were niche products, these new industries more often involved and benefited smaller scale producers and local communities. The specific quality traits of products meant that this newer phase of industrialization was associated with greater services provision and capacity development by agricultural companies.
- b) The relatively rapid growth of income and urban populations during the 1990s greatly increased effective demand in developing regions for high quality and yet affordable products. This stimulated foreign direct investment, nearly always accompanied with transfer of agro-industrial management expertise, technologies and processes. This in turn stimulated local companies and entrepreneurs to make investments and set up facilities to capture market share. The result was a relatively rapid broadening to new sectors and within sectors dominated by the traditional larger scale firms.

8. Food and beverage processing in developing countries are today the most important activities within agro-industry, accounting for more than 50 percent of value added in low and middle income economies. Among African countries, in Ethiopia, Eritrea and Senegal, food and beverages represent more than 70 percent of the value added of agro-industry, and roughly 30 to 50 percent of the whole manufacturing.



Source: da Silva et al. 2009, Chapter 1



Source: da Silva et al. 2009, Chapter 3

9. As income grows, the composition of the agrifood industry seems to shift away from cereal- and grain based products, such as bakery products or pasta, and to increase the share of dairy products and meats. However, much of this change in composition may reflect differences in regional food preferences. According to an FAO report of 2007, the value added share in total manufacture generated of food, beverages, tobacco and textiles in developing countries have almost doubled since the 1980s (da Silva et al. 2009, Chapter 3).

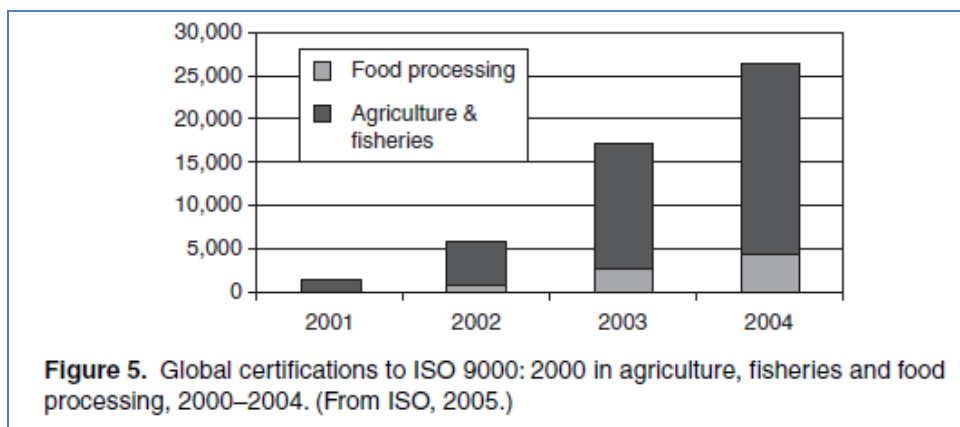
10. The development of agro-industry in developing countries involves the transformation of what is a largely informal food production system into a formal industry. Raw materials and final products employed in this industry are perishable, and this makes production, transformation and marketing sensitive to specific quality parameters.

11. With increasing economic integration, production chains tend to become longer, more complex and trans-national. The massive reduction in transaction and information costs that took place in the recent decades thanks to innovative and more efficient transportation and communication technologies has led to increasingly complex logistical processes that allow exploiting cost advantages. This was the case of many East Asian countries, where cheap and abundant labour is available, as well as resource-abundant countries in Latin America, albeit the situation is different in sub-Saharan Africa.

12. In this environment, firms tend to increase the scale of operation and become more vertically integrated. This requires interaction among different several kinds of stakeholders, including farmers, processors, traders and retailers, often located in different countries, each making use of large amounts of inputs and services.

13. Significant changes are taking place in terms of employment, such as rising numbers of wage workers and also more opportunities in the rural non-farm economy. The labour force is required to develop more and more complex skills, and to adjust across economic activities. Labour regulations, associations of rural workers and producers' organisations may also undergo significant changes.

14. The growing presence of supermarkets in developing countries has moved competition in the output market towards quality, along with prices. Standards setting and compliance thus become a key variable in the production chain, as well as in the institutional framework in which firms operate.

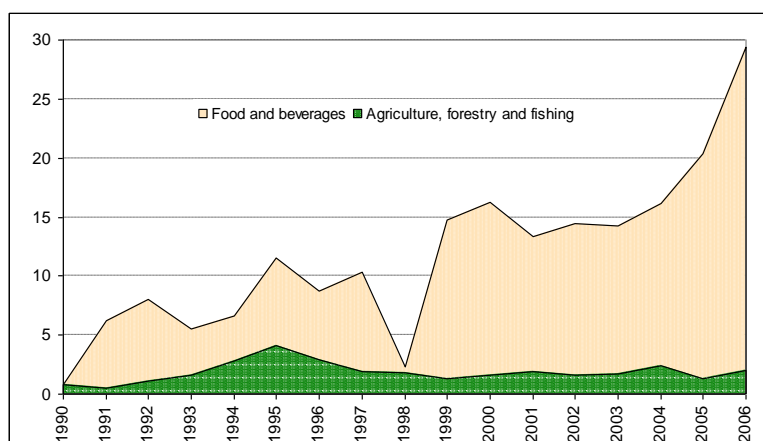


Source: da Silva et al. 2009, Chapter 1

15. Primary production is adapting to the development of agro-industry. More standardized products need to be made available; timeliness often becomes a key requirement for processors and retailers to remain competitive; and the availability of adequately skilled workforce becomes increasingly important. Primary products for which potential economies of scale exist, such as plantation crops or forestry plants, are witnessing increased scale and vertical integration, along with increased technology adoption. Where potential economies of scale in primary production are limited - as it is the case of some high unit value horticultural products -- contract farming is increasing its presence, as a way to link farmers to large food chains.

16. Foreign Direct Investment, as mentioned, is playing a major part in the development of agro-industry in developing countries. Foreign capital can speed-up concentration and technical change, on the one hand; while at the same time exerting strong competitive pressure and even displacing more traditional production systems. Demand characteristics can change considerably with the introduction of new products, requiring deep adaptation of the food economy.

FDI inflows in agriculture, forestry and fishing and food and beverages

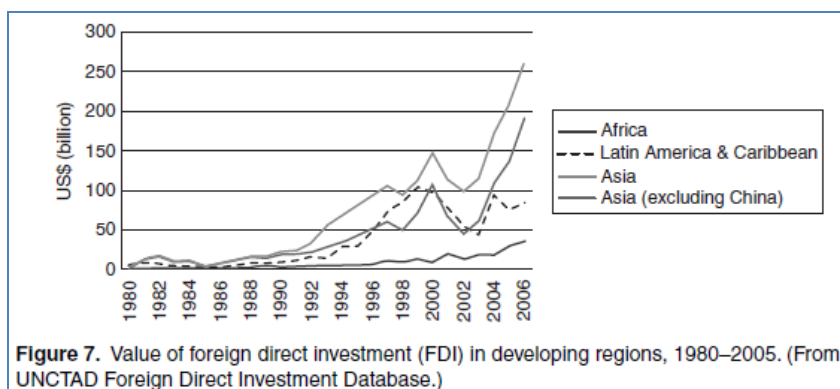


Source: UNCTAD, FDI/TNC database

17. At the same time, the spread of supermarkets and agro-industrial FDI has co-exists in several countries with a host of different enterprises, located along a *continuum* of scale and characteristics. Informal labour-intensive production chains, based on low capital use, have survived mainly by responding to the demand of middle and low-income consumers. A number of local and regional modern retail stores have also emerged for the same reason: they tend to be more responsive to local market circumstances with respect to product categories, store locations (beyond expatriate enclaves), willingness to procure and sell lower cost local products if appropriate products are available, etc.

18. The co-existence of different types of firms can bear positive effects in terms of impact on the behaviour of large scale stakeholders: the latter may become less capable of exerting market power, and

there is decreasing risk that global retail firms will be able to engage in uncompetitive behaviour when it comes to consumer pricing.



Source: da Silva et al. 2009, Chapter 1

Potential consequences of agro-industrial development

19. Potential consequences of the agro-industrial development and increased foreign presence in developing countries are manifold. The emergence of large firms, the increasing role of trans-national corporations and openness to trade and foreign direct investment is often associated with increasing income opportunities. It also generates, under certain conditions, the displacement of established local firms and difficulties for small primary producers that need to meet stringent quality standards. Whether these benefits materialized as a consequence of more foreign trade and investment, as some scholars argue, will depend to a great extent on the normative frameworks, regulatory public policy and the supply of public goods offered by the public sector.

20. Farmers and other stakeholders along production chains in poor countries may benefit from more specialization higher labour productivity, along with increased access to markets and improved means to manage income risks. However, adjustment costs and barriers to entry into modern production chains may likely be prohibitive for many, whose operation may be just affected by competition. This can generate significant social costs.

21. The term “smallholder²⁴” can be referred to households operating under limitations in terms of production scale, availability of resources, access to markets, information, technology and infrastructures, relying heavily on family labour, with consumption related to own production. Given this definition, smallholders may be constrained in their ability to access opportunities arising from the emergence of modern agrifood production chains and the rural non-farm economy.

22. Increased income opportunities may materialize where smallholders manage to translate some features of their production system into a competitive advantage within modern production chains, and for diversifying out of agriculture and exploiting opportunities in the rural non-farm sector. Examples may be found among labour-intensive activities implying high supervision costs, such as horticultural or livestock production; the availability of family labour can be an advantage in these conditions.

23. At the opposite extreme, smallholders’ adaptation is more difficult where agro-climatic conditions are less favourable, and considerable capital and variable input use is required to produce. Managing risks under these circumstances may be too difficult for smallholders, despite potentially higher returns. Location also matters: farms located in remote areas may be more easily marginalized, due to higher transaction costs. Other small farms may instead be sufficiently close to markets for commercial agriculture to be the main income source.

²⁴ The definition of “smallholder” is problematic. Smallholders are mostly defined in terms of the physical size of holdings, that is, through number of hectares or livestock heads below the median size. These indicators, however, can be misleading, as the median farm size can vary significantly. While smallholders do not necessarily coincide with poor farmers, they are certainly more vulnerable to risks in their activity.

24. Small-scale fishing communities face similar conditions: insecure access rights to fishery resources vulnerability to natural disasters and climate change, weak organizational structures and inadequate representation and participation in decision-making.

25. The diversification of incomes, gender dynamics and migrations also play a significant role in determining the impact of agrifood development. Income diversification, both across agricultural and non agricultural activities, is mostly a risk-management strategy that improves resilience and eases adaptation to changing market circumstances. However, the ability of poor rural women and men to participate in potentially more lucrative rural non-farm employment can be limited, due to low education, difficulties in accessing land, credit and productive resources.

26. Migration from rural to urban areas – which accounts by far for the largest share of total population movements – can also be associated with the evolution of activities in rural areas, and agro-industrialization. Migration can be driven by rural-urban income differentials, when workers find a higher wage in towns. However, if productivity in rural areas is stagnant, migration can become just a last resort, moving poverty into towns. While in the first case, migration offers opportunities for promoting development in both urban and rural areas, in the second case, it does not. For the latter conditions to prevail, *inter alia*, it is important that smallholder farmers – as defined above – can be involved in the evolving agrifood production chains, and participate of the increased income opportunities. The more frequent situation seems to be in between these two extremes: urbanization generates income opportunities, but at the same time, urban and periurban areas that welcome rural exodus are also generating a rising demand for protection of the livelihoods of recently ‘displaced’ urban poor.

27. Policies and their sequencing also matters in determining the outcomes of agrifood industrialization and globalization in developing countries. Some of today’s most successful agrifood producers and exporters, such as China and Viet Nam established their international competitiveness under protection and import substitution regimes and only subsequently embarked in more openness to trade, foreign investment and the presence of large transnational firms. Success in these cases was built through careful institutional building, and policies that gradually stimulated entrepreneurship and the willingness and ability to assume risks. At the same time, in many developing countries agriculture has been negatively affected by inward-oriented industrial development strategies and the anti-agriculture policy bias. These have held back investment in agriculture and the agri-food production chains, and slowed the ability to export and compete with imports, jeopardizing the development of domestic markets. The development of domestic market and a functional economic integration between urban and rural areas can not only contribute to enhance food availability, but also provide more and more diversified income opportunities.

28. One of positive change as a result of the food prices crises has been a refocusing on food industries globally, and particularly on staple food industries. During 1990s and early 2000s, there was complacency about global food supply sufficiency, even if not about food and nutritional insecurity at the individual and household level. As a consequence, there was less investment and innovation in the staple food industries compared to other sectors. This has changed dramatically, with significant interest and investment now going into developing food industries in developing countries by bilateral agencies, financial institutions, foundations, equity funds and companies.

29. Another important recent trend in agro-industries and globalization has been a notable change in the policies and business models of some of the most influential global companies. Many global companies are increasingly dependent on global sourcing and growing market share in developing country markets. In order to mitigate their risks, they are having to mainstream responsible procurement practices and to create capacity to respond to consumer interests in developing regions, not only the interests of consumers in high income countries. Many of these companies have become innovation leaders in establishing responsible business models and there are clear signs of a growing convergence in interests with respect to the longer term sustainability and inclusiveness goals of FAO and other multilateral agencies.

The outlook for the coming decades

30. As seen, modern supermarkets, global and regional food and input supply companies, and local small and medium enterprises co-exist in several countries. At the same time, some farmers have already

transitioned to being suppliers of agro-industrial enterprises while others continue to depend primarily on self-production and retail sale in local markets for their livelihoods.

31. What are expectations as to how current trends in agro-industry development in developing countries will shape up in the coming decades?

32. Being ultimately driven by income growth and urbanization and their impact on food demand, the current trend towards producing more processed and differentiated food products may likely continue and deepen over the coming decades.

33. Given the increased integration of agricultural markets with others - notably that of energy and other non food uses –supply chains could even become more complex, multifaceted and integrated among each other. More industrial use of primary products, including fishery and forestry products, seems likely. More specialization and inter-industry competition may lead to the emergence of comparative advantage for areas with the resources needed to increase primary production, which may favour agro-industries in the tropical and semitropical zones. This may result in further increased South-South trade and economic integration, leading to a more diverse international economic environment.

34. Standards will likely continue to gain importance in shaping international trade of food and agricultural products, given consumers' increased willingness to pay for products' characteristics, and especially those that depend on the specific features of the production process. Potential rejection by consumers will likely become increasingly important in shaping the organization of food chains. This may further drive up private standards, thus placing additional burdens on producers and poorer consumers.

35. Should recent trends continue and spread to larger market shares, agro-industries in high, middle and even lower income countries will become increasingly integrated and share more and more characteristics in common.

36. Two main conclusions might be drawn from this cursory review of agro-industrialization and globalization. The first is that recent trends in agro-industrialization and globalization have been quite positive, on balance, compared to the first decades of agro-industrialization in developing regions. This is interlinked with the second main conclusion: the nature and pace of future agro-industrialization will have important positive and negative consequences depending on the policies and programmes put in place to guide and shape, encourage or discourage the on-going development of agro-industries in developing regions.

37. Some of the key opportunities and risks policies likely will need to address include:

- a) With agro-industrialization, there generally are reductions in transaction and information costs through application of innovative and more efficient transportation and communication technologies, and logistical processes that allow exploiting cost advantages. Policies to support innovation and logistics will influence which countries can maintain competitiveness.
- b) Competition in output markets is increasingly based on quality and specific product traits, along with prices. Raw materials and final products employed often are perishable, and this makes production, transformation and marketing sensitive to specific quality parameters. Standards setting, certification, traceability and compliance thus become key issues to address.
- c) Farmers and other stakeholders along production chains in poor countries may see increased income opportunities, as well as benefits from more specialization higher labour productivity, along with increased market and income risks to be managed. However, adjustment costs and barriers to entry into modern production chains may be prohibitive for many, whose operation may be just affected by competition. This again calls for strengthening of institutions and services to help producers adapt.
- d) Even for small-scale stakeholders and farmers who can get involved in modern production chain, the consequences may largely depend on the distribution of market power. Rents and risks sharing along supply chains is likely to be favourable to processors and retailers, given their usual larger economic scale and their closer interaction with consumption. This means that organizational strengthening, empowerment and steps to overcome the transactions costs of

working with smaller-scale stakeholders are needed to help ensure that they benefit from increased opportunities.

- e) The need to improve alignment along supply chains requires interaction among different several kinds of stakeholders, including farmers, processors, traders and retailers, often located in different countries, each making use of large amounts of inputs and services. Actions are needed to establish fair and governance of supply chains, and to improve transparency through improved communication and information flows.
- f) The emergence of national agro-processing firms, as well as the increasing role of trans-national corporations and openness to trade and foreign direct investment, is often associated with increasing income opportunities. However, these seem unlikely to materialize just as a consequence of these changes; local communities must be equipped with enough physical and human capital to benefit.
- g) Foreign investment is playing an important role in the development of agro-industry in developing countries. Foreign know-how, technologies and capital are speeding up technical change and business innovation, on the one hand; while at the same time global firms can exert strong competitive pressure, contribute to concentrate and by-pass smaller scale producers. There might well be a need for action at a global governance level in order to secure the benefits of global know how and technologies without undue risk to local communities and enterprises.
- h) Agro-industrialization and globalization of food production can also imply significant environmental impacts. Changes in primary production usually affect resource use, starting from land. Land use may become more intensive and involve marginal areas, thus increasing the pace of deforestation, desertification and loss of biodiversity. Beyond the expansion of cultivated land, which is often a costly process, a higher intensity of cultivation usually brings about also increased use of agro-chemicals and water. More processing and a wider product distribution often involves an increased production of waste, owing to increased packaging as well as a larger energy use per unit of food produced. On the other hand, there are clear indications that many global companies are now giving priority to environmental sustainability. With proper policy enablers and incentives, agro-industrial development could well become part of the solution in shifting to environmentally sustainable supply chains.

38. In summary, steps to put in place sound policies, fair governance, and effective institutional support and services will have a major role in determining the outcomes of agro-industrialization and globalization in developing countries. Positive outcomes are more likely if there is attention to careful institutional building and policies that gradually stimulate entrepreneurship, investment in agriculture and agrifood chains, increased alignment among the farms and firms along agro-industrial supply chains, and increased ability to export and compete with imports – while at that same time ensure that the pace and pattern of agro-industrialization in developing countries does not pose undue risks and costs on the large numbers of smallholders – producers, processors, traders and others – who depend on agriculture for their livelihoods.

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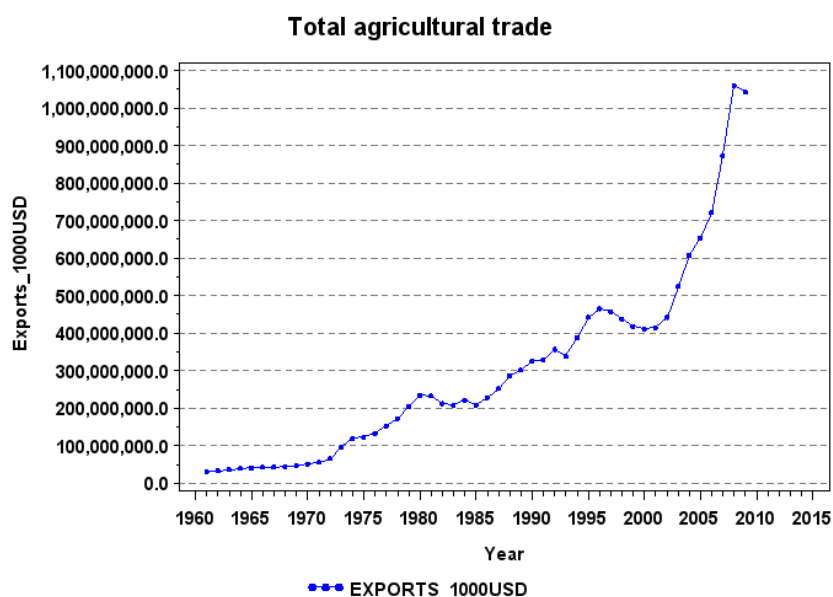
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TREND 6: CHANGING PATTERNS IN AGRICULTURAL TRADE AND THE EVOLUTION OF TRADE POLICIES

1. Three major trends characterized agricultural and fisheries trade over the past decade: a) the increase in volumes exchanged which has been considerable but less than it would have been in the absence of a high protectionism, b) fundamental changes in the relation to the origin and destination of trade flows. Poorer developing countries, notably the Least Developed Country group, have become large net importers while emerging economies in Latin America, Eastern Europe and Asia have emerged as large net exporters reducing the role of OECD countries, and c) policies evolving towards more openness while at the same time promoting a host of regional and preferential agreements which in the last few years have become more prominent than multilateral co-ordination. These trends are likely to extend in the future and will bring forward and/or strengthen a number of trade issues such as a larger participation of government agencies in trade agreements, larger intra-firm trade and the utilization of private standards.

Trends in world agricultural trade

2. The volume of international trade in agricultural products has been increasing considerably over the last four decades, following reduced physical and economic barriers to trade and reduced transport costs. At constant prices, total exports have increased from about 3.5 billion US\$ in 1961-63 to about 110 billion US\$ in 2009.

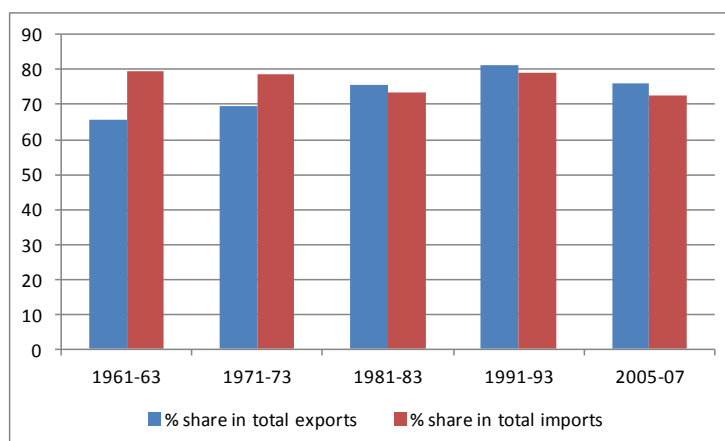


3. This increase reflects expansion in regional trade, both in industrialized and developing regions, as well as among far-away regions. More in general, the increased volume of agricultural trade reflects economic growth and an increased economic integration which involves agri-food system across the world as the rest of the economy.

4. In the early 1960s agricultural products accounted for 23 percent of total merchandise trade, while they were counting for about 6.2 percent in 2005-07. The fact that agricultural trade grew at a slower pace compared to other goods stems from the higher protectionism that characterizes the sector and the lower degree of intra-industry trade, which follows from the higher influence of agro-ecological conditions on production.

5. The concentration of agricultural exports has been slowly increasing from the early 1960s to the 1990s, but has decreased slightly in the subsequent period, following the emergence of new exporters especially in Eastern Europe and Central Asia. This is particularly the case of cereals.

Percentage share of the 20 most important exporters and importers

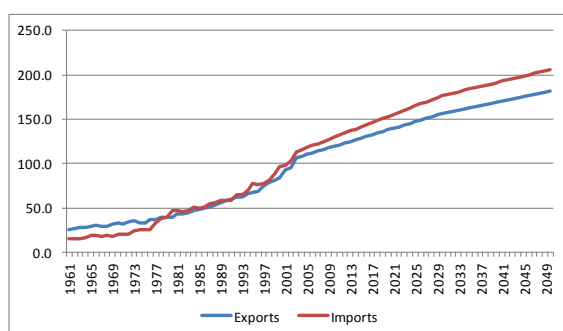


Source: FAOSTAT

6. On the import side the concentration fluctuated between 70 and 80 percent.

7. From a geographic standpoint, the distribution of trade flows has changed dramatically from the early 1960s. Agricultural exports from developing countries were then focused mostly on tropical products such as coffee, cocoa, tea or rubber, whose demand has been stagnant in developed countries over the subsequent decades. Increasing supplies in developing countries contributed to exert downward pressure on prices, resulting in a declining share of agricultural exports.

Past and projected evolution of net agricultural trade in developing countries (billion constant US\$)

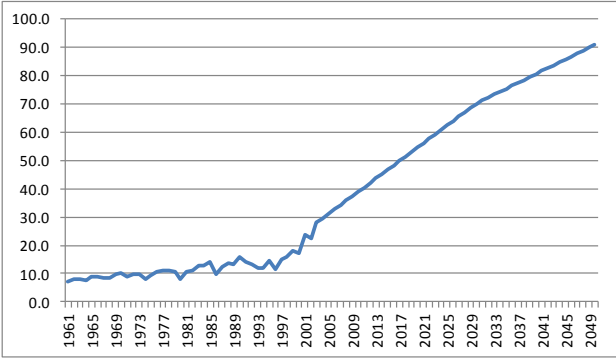


Source: data from FAO- ESA Global Perspectives Studies

8. At the same time large technological application in OECD countries boosted agricultural productivity, facilitated by protectionist policies and domestic subsidies. This trend – that started before the Second World War in the US and in the 1960s with the EU Common Agricultural Policy - accelerated in the aftermath of the food price spike of the early 1970s. Fast population growth in developing countries and the large availability of cheap staple food in thin world markets encouraged increasing reliance on imports of food staples. Coupled with the decline in exports, developing countries have turned into net importers of agricultural products. This trend is particularly prominent for Least Developed Countries, and is expected to continue in projections to year 2050.

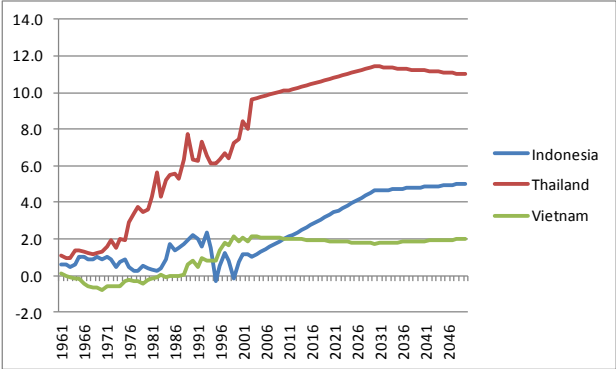
9. Large emerging economies such as Brazil, Thailand, Indonesia, as well as export oriented economies in Asia are reverting this trend, and playing a major role as exporters of agricultural products. This tendency is expected to deepen further in the coming decades, following favourable competitive conditions in these countries and improved technology.

Past and projected evolution of net agricultural exports from Latin America (billion constant US\$)



Source: Source: data from FAO- ESA Global Perspectives Studies

Past and projected evolution of net agricultural exports from selected Asian countries (billion constant USD)

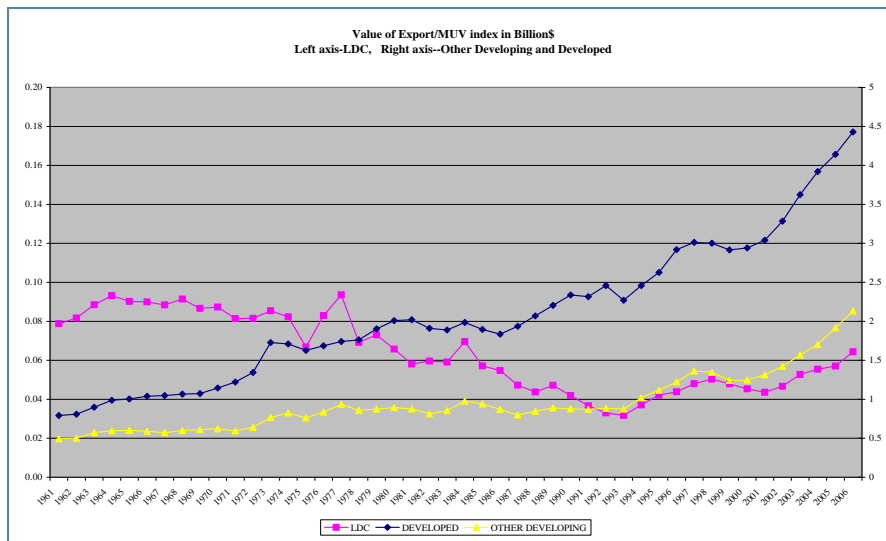


Source: Source: data from FAO- ESA Global Perspectives Studies

10. The international grain trading system has been characterized by the emergence of new exporters from Eastern Europe and Central Asia. Exports of wheat from the Commonwealth of Independent States (CIS), for instance, moved from virtually zero in early 1990s to about 20 percent of world markets in 2011, and they are expected to continue grow significantly more the next 10 years.

The outlined evolution of trade among major country groups is taking place against changing terms of trade. A distinction has to be made, also in this case, among Least Developed countries (LDCs) and other developing countries. As shown in the chart above, the deflated value of agricultural exports, which measures the purchasing power of agricultural exports, seems to have evolved totally differently for developed countries, LDCs and other developing countries.

Income terms of trade of agricultural exports

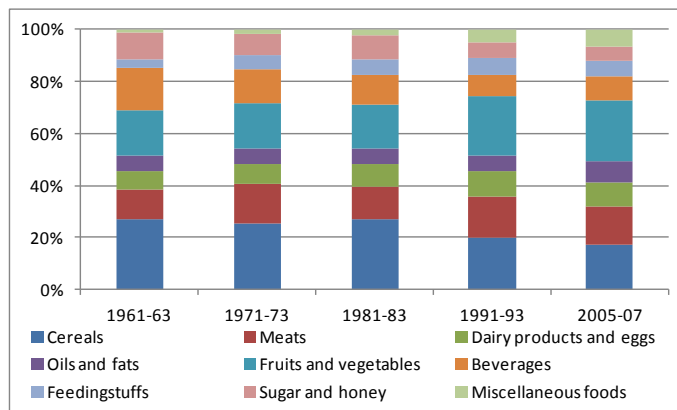


Source: FAO Trade and markets Division; Sarris (2009)

11. The index for the LDC is mostly declining, while that of the developed and other developing countries increases. The main reason for this development, since the three groups of countries face the same international prices, is to be found in the different rates of productivity growth, which is lower in LDCs.

12. Among agricultural commodity groups, cereals are the most important products in international agricultural trade. Their relative importance has been diminishing, from about 27 percent in the early 1960s to about 17 percent in 2005-07. Their volume, however, has kept increasing, and is today more than four times what it used to be in the early 1960s. Among other products, meat, oils and fats and feedstuff have been gaining importance. Oilseed trade, particularly, has increased by a factor of 10 between the early 1960s and today.

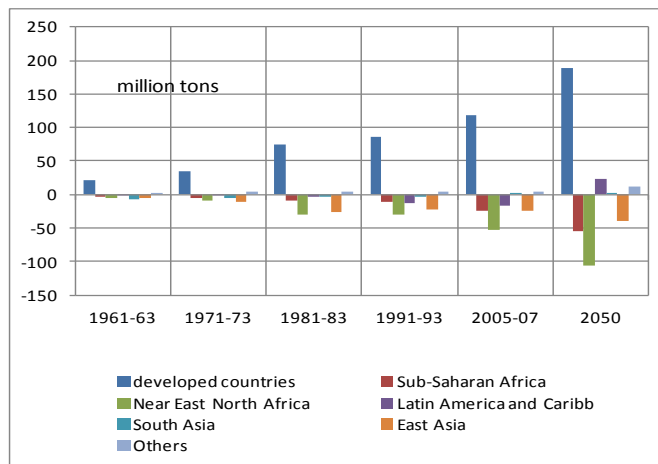
Shares of product groups in world agricultural trade



Source: FAOSTAT

13. Cereals trade – the relatively most important product group – is traditionally dominated by exports from developed countries, which correspond to growing imports into most other regions, primarily the Near East and North Africa, Sub-Saharan Africa and East Asia. Latin America is expected to play a wider role as an exporter in this market in 2050.

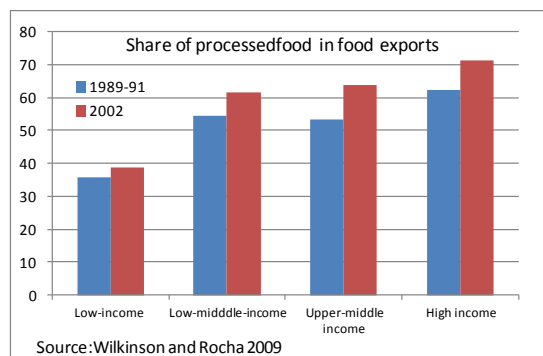
Past and projected evolution of cereals net trade



Source: data from FAO- ESA Global Perspectives Studies

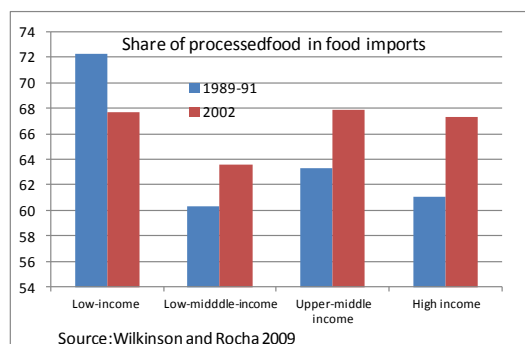
14. Trade in fisheries products has also increased considerably. Nowadays, almost 40 percent of all fish, whether caught or farmed, is internationally traded. Fast-growing economies such as China, Thailand and Viet Nam have become large exporters.

15. Trade in processed agricultural and food products is also increasing, but at a diverse pace among country groups. The share of processed products in total food export is higher and growing relatively faster in high income and upper-middle income countries, and notably in countries like Argentina, Brazil, Chile, Indonesia, Malaysia, Thailand and Turkey.



16. Trade in processed fishery products is also increasing, following growing production in Asian emerging economies. Some of these countries are also involved in processing raw fishery materials imported from developed countries.

17. On the import side the situation is more diverse. Low income countries show a high, albeit declining, share of processed food in total food imports. Local processing seems to substitute for imports at a slow pace; this process is often driven by foreign capital. The contrary is happening in middle and high income countries, where more intra-industry trade is taking place.



Trade policies

18. Rules governing international trade of agricultural products have evolved considerably over the last four decades. The current set up can be described as a mix of multilateral and bilateral/regional trade regimes.

19. The multilateral process emerged in the aftermath of the Second World War with the GATT as a trans-Atlantic initiative. Agricultural products were virtually excluded from negotiations, based on exceptions that allowed the use of quantitative import restrictions, export subsidies and the use of non-tariff barriers under special circumstances which would include primary products.

20. In fact, several OECD countries had maintained a relatively high level of protection in agriculture since the end of the II World War, along with other forms of support to domestic production. The opposite, was happening in several developing countries, where agriculture was shown to be taxed compared to other activities, both through explicit and implicit policies. It was only in the mid-1980s, with the launch of the Uruguay Round of GATT negotiations, which the discussion focused on trade rules applied to agricultural products. An agreement on agriculture was reached in 1993 and applied from 1995, when the GATT was turned into the World Trade Organization. The agreement brought about more discipline in trade policy and in the use of domestic policies that impact agricultural trade. Developing countries were granted a special treatment, involving reduced commitments in terms of policy changes, and Least Developed countries were granted a total exemption.

21. One more round of multilateral negotiations – known as Doha Development Agenda -- was launched at the end of 2001. The new round attempted to respond to an emerging demand by developing countries that multilateral trade rules would encourage a reduction in the asymmetry of the trade system. Despite considerable progress the round was suspended in 2008, due to the impossibility to close remaining gaps. One major difference between the Doha round and the previous one has been an active participation of a wider number of countries. Since 2008, negotiations under the Doha round are in a stalemate, despite significant progress made since the inception on many chapters, including agriculture. Among the reasons for such condition there are the concerns of a number of poor developing countries that the multilateral framework may not offer enough opportunities for their exports, as well as enough means to counteract potential threats to infant industries.

22. The evolution of the negotiations over multilateral trade rules is consistent with the changing balances within the world economy. Until the 1980s major parties involved in the negotiations were part of the Oecd countries; an agreement in the Uruguay Round was found when the US and the EU agreed on key points. In the Doha round, instead, developing countries and a number of large emerging economies – many of which are part of the G20 group – are playing a prominent role, which corresponds to their increasing economic and political power.

23. Today the relative position of countries in terms of protectionism in agriculture has changed. In many OECD countries tariffs and non-tariff barriers to agricultural trade were reduced substantively, also as a result of the conclusion of the Uruguay Round. In developing countries, agriculture is today less taxed than it was in few decades before; and some of the larger economies in Asia, Africa and Latin America have been moving more decisively towards supporting the sector (Anderson et al., 2009).

24. Along with the multilateral framework, agricultural trade developed along a set of bilateral and regional agreement. These are discriminatory in nature, as they imply the application of different conditions to different trading parties, and are legally based on exceptions allowed by WTO rules. The European common market, which adopted the Common Agricultural Policy and eventually become the European Union, is one example. Others are the set of subsequent Conventions governing trade that were established between the European Union and the African Caribbean and Pacific country group since the 1960s. Several regional frameworks were adopted in the Americas, eventually from the NAFTA in North America, to the MERCOSUR in South America and the several others covering virtually all countries. The ASEAN process in South East Asia is another example, as well as the many schemes adopted in Africa, involving different degrees of economic integration. Along with these, several inter-regional agreements have been negotiated between specific countries or specific country groups. The EU-MERCOSUR scheme is one example; the “Everything But Arms” initiative of the EU and the AGOA scheme of the US towards Least Developed Countries are others.

25. An increase in such initiatives has taken place in the decade after the Uruguay Round, and this is today the area in which trade policies seem to be more active. The system has become so intricate to be often described as a “spaghetti bowl”. Results of such initiatives appear to be variable; in some regions, such as the Near East, they seem not to have been much effective.

26. Among specific trade rules, one area which has gained considerable importance for agricultural trade is that of product standards. Standards imposed at the national level can in fact prevent import of non-compliant products. From a policy perspective, transparency in the standards adopted form the basis of their legitimacy: the line between consumers’ protection and information and disguised protection is often difficult to draw. In the WTO process, the area is regulated by the Agreement on Sanitary and Phyto-Sanitary measures, as well as the Agreement on Technical Barriers to Trade.

27. However, private standards adopted by companies involved in international trade are becoming more relevant and stringent than public provisions. Given the sensitivity of food and agricultural products and their direct linkage with health, consumers have become increasingly willing to pay for safety characteristics, especially in developed countries. Private companies, consequently, have had increasing incentive to raise the level of standards.

28. How may the policy setting change over the coming decades?

29. On the one hand, sustained growth prospect in emerging economies may bring about increased pressure toward trade liberalization and the opening-up of markets. On the other, however, prospects of slow growth in the world economy may revamp pressures toward increasing protectionism.

30. An FAO survey based on information for 77 countries found that in 2008, after the first price spike, about half of the countries surveyed took measures to reduce food import taxes and about 25 percent imposed some form of export restrictions. Beyond these short-term reactions – most export restrictions have been lifted by now - the increased volatility of the recent period has to some extent undermined the confidence in the global market as a reliable source of agricultural supplies. Several developing countries and many of the large emerging economies in Asia and Africa have placed emphasis on increasing productivity domestically. In some cases, this correspond to a large size of the domestic markets compared to current imports: rising domestic supplies, where possible is seen as a more feasible strategy than replying more decisively on foreign market. In some countries, this attitude has translated into setting explicit self-sufficiency targets.

31. One possibility is for the regional approach to be increasingly adopted in counteracting market instability. So far this approach has not been used extensively; one example is that of the ASEAN countries, along with the long-standing one of the EU. But there seem to be increasing interest of developing countries in Africa Asian and Eastern European countries for regional initiatives.

32. More in general, emerging issues for trade policies seem to be in the following areas.

- *Standards, and particularly private standards.* Given the increasing product differentiation and the increasing concerns for safety this matter is likely to continue attracting increasing attention. The relative role of Governments and private sector are also bound to change, with the latter gaining space. Civil society will also probably play a larger role here, as a mean to counteract the power of increasingly large corporations.
- *Environmental issues.* International trade regulations are likely to increasingly intersect with environmental ones. The wide impact of agriculture on the environment and of the transport system will probably lead to an increased emphasis on the characteristics of the production process lying behind the goods that are exchanged. Themes like the carbon footprint of products will possibly become more relevant also in the discussion on trade rules.
- *Impact of trade on food security.* This matter will likely re-gain prominence in the future, given the revamped attention of policies to food security. Recent efforts to analyze and capture in policies proposals the linkage between trade and food security were conducted on different and related occasions. One was the discussion on safeguard mechanisms for developing countries to shield disruptive increases in imports, negotiated in the Doha Development Agenda. Another was the definition of so-called “special products” – discussed in that same context, and in the

negotiations on the EU Economic Partnership Agreements - for which a food security related justification for protection would hold.

- *Preferential trade and its impact on developing countries.* Given the intricate network of preferential trade agreements, it is likely that the current demand for technical information on the impact of such schemes on the economies of the involved parties will persist in the future. Developing capacities to analyze trade policies in developing countries will remain an important challenge in the future, given their direct impact on poverty and food security.
- *International competition policy.* Given the growing size of firms operating in the agri-food sector, the increasing complexity of production chains, decision by one particular stakeholder are increasingly likely to affect others located in different countries. This will likely call for regulation allowing market power to be controlled along such production chains. Also in this area the private sector and civil society are likely to become increasingly present.
- *Government role in trading firms.* Large emerging agricultural traders, both on the import and the export side of the market, show a public presence among trading firms. Examples can be found in countries like Mexico, China, Russia, Argentina and to certain extent Brasil. This is likely to be one more issue to which policies and international policy co-ordination mechanisms will need to direct their attention.

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TREND 7: CLIMATE CHANGE WILL HAVE A GROWING IMPACT IN AGRICULTURE

1. Climate change is now evident and is expected to increase in the decades to come, in spite of the measures that may be taken to mitigate it. It already impacts on agriculture, forests and ocean fisheries and these impacts are expected to increase in the future with variations between subsectors and regions. Adverse effect of climate change will also impact food security especially as some of the most vulnerable countries are already food insecure. Adaptation to climate change is a growing concern especially for activities that require medium and long term investments for irrigation, livestock and plant breeding, forestry etc. Climate change is increasing the degradation in dry lands and in general the frequency of natural disasters

Climate change (from the 2007 IPCC 4th assessment report)

2. Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level. Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases.

3. For the next two decades a warming of about 0.2°C per decade is projected for a range of emissions scenarios. Even if the concentrations of all GHGs and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected. Afterwards, temperature projections increasingly depend on specific emissions scenarios.

Main changes:

- warming greatest over land and at most high northern latitudes and least over Southern Ocean and parts of the North Atlantic Ocean, continuing recent observed trends
- contraction of snow cover area, increases in thaw depth over most permafrost regions and decrease in sea ice extent; in some projections using SRES scenarios, Arctic late-summer sea ice disappears almost entirely by the latter part of the 21st century
- *very likely* increase in frequency of hot extremes, heat waves and heavy precipitation
- *likely* increase in tropical cyclone intensity; less confidence in global decrease of tropical cyclone numbers
- poleward shift of extra-tropical storm tracks with consequent changes in wind, precipitation and temperature patterns
- *very likely* precipitation increases in high latitudes and *likely* decreases in most subtropical land regions, continuing observed recent trends.

“Extreme events”

4. The link between an increase in climate induced disasters and climate change is much discussed. The very definition of “extreme events” is problematic as the notion of “extreme” can be perceived by their infrequency or intensity. Moreover intensity can be perceived and assessed as the intensity of the event itself or by the importance of its effects, which are very much caused by the vulnerability of the affected area. Agriculture is very specific in that sense, and particularly vulnerable as some slight changes in temperature or rain patterns can have devastating effects on crops, grasslands or forests.

5. According to the IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, released in December 2011, there is evidence that some extremes have changed as a result of anthropogenic influences, including increases in atmospheric concentrations of greenhouse gases.

6. Economic losses from weather- and climate-related disasters have increased, but with large spatial and interannual variability. Economic, including insured, disaster losses associated with weather, climate, and geophysical events are higher in developed countries. Fatality rates and economic losses

expressed as a proportion of GDP are higher in developing countries. Increasing exposure of people and economic assets has been the major cause of the long term increases in economic losses from weather- and climate-related disasters. Long-term trends in economic disaster losses adjusted for wealth and population increases have not been attributed to climate change, but a role for climate change has not been excluded.

7. The severity of the impacts of climate extremes depends strongly on the level of the exposure and vulnerability to these extremes. Extreme events will have greater impacts on sectors with closer links to climate, such as water, agriculture and food security, forestry, health, and tourism.

Regional impacts of climate change

8. Global climate change translates into a diversity of regional and local trends and impacts.

Africa	<p>By 2020, between 75 and 250 million of people are projected to be exposed to increased water stress due to climate change.</p> <p>By 2020, in some countries, yields from rain-fed agriculture could be reduced by up to 50%. Agricultural production, including access to food, in many African countries is projected to be severely compromised. This would further adversely affect food security and exacerbate malnutrition.</p> <p>Towards the end of the 21st century, projected sea level rise will affect low-lying coastal areas with large populations. The cost of adaptation could amount to at least 5 to 10% of Gross Domestic Product (GDP).scenarios (TS).</p> <p>By 2080, an increase of 5 to 8% of arid and semi-arid land in Africa is projected under a range of climate.</p>
Asia	<p>By the 2050s, freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease.</p> <p>Coastal areas, especially heavily populated megadelta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some megadeltas, flooding from the rivers.</p> <p>Climate change is projected to compound the pressures on natural resources and the environment associated with rapid urbanisation, industrialisation and economic development.</p> <p>Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in the hydrological cycle.</p>
Australia and New Zealand	<p>By 2020, significant loss of biodiversity is projected to occur in some ecologically rich sites, including the Great Barrier Reef and Queensland Wet Tropics.</p> <p>By 2030, water security problems are projected to intensify in southern and eastern Australia and, in New Zealand, in Northland and some eastern regions.</p> <p>By 2030, production from agriculture and forestry is projected to decline over much of southern and eastern Australia, and over parts of eastern New Zealand, due to increased drought and fire. However, in New Zealand, initial benefits are projected in some other regions.</p> <p>By 2050, ongoing coastal development and population growth in some areas of Australia and New Zealand are projected to exacerbate risks from sea level rise and increases in the severity and frequency of storms and coastal flooding.</p>

Europe	<p>Climate change is expected to magnify regional differences in Europe’s natural resources and assets. Negative impacts will include increased risk of inland flash floods and more frequent coastal flooding and increased erosion (due to storminess and sea level rise).</p> <p>Mountainous areas will face glacier retreat, reduced snow cover and winter tourism, and extensive species losses (in some areas up to 60% under high emissions scenarios by 2080).</p> <p>In southern Europe, climate change is projected to worsen conditions (high temperatures and drought) in a region already vulnerable to climate variability, and to reduce water availability, hydropower potential, summer tourism and, in general, crop productivity.</p> <p>Climate change is also projected to increase the health risks due to heat waves and the frequency of wildfires.</p>
Latin America	<p>By mid-century, increases in temperature and associated decreases in soil water are projected to lead to gradual replacement of tropical forest by savanna in eastern Amazonia. Semi-arid vegetation will tend to be replaced by arid-land vegetation.</p> <p>There is a risk of significant biodiversity loss through species extinction in many areas of tropical Latin America.</p> <p>Productivity of some important crops is projected to decrease and livestock productivity to decline, with adverse consequences for food security. In temperate zones, soybean yields are projected to increase. Overall, the number of people at risk of hunger is projected to increase (TS; medium confidence).</p> <p>Changes in precipitation patterns and the disappearance of glaciers are projected to significantly affect water availability for human consumption, agriculture and energy generation.</p>
North America	<p>Warming in western mountains is projected to cause decreased snowpack, more winter flooding and reduced summer flows, exacerbating competition for over-allocated water resources.</p> <p>In the early decades of the century, moderate climate change is projected to increase aggregate yields of rain-fed agriculture by 5 to 20%, but with important variability among regions. Major challenges are projected for crops that are near the warm end of their suitable range or which depend on highly utilised water resources.</p> <p>Cities that currently experience heat waves are expected to be further challenged by an increased number, intensity and duration of heat waves during the course of the century, with potential for adverse health impacts.</p> <p>Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution.</p>
Polar Regions	<p>The main projected biophysical effects are reductions in thickness and extent of glaciers, ice sheets and sea ice, and changes in natural ecosystems with detrimental effects on many organisms including migratory birds, mammals and higher predators.</p> <p>For human communities in the Arctic, impacts, particularly those resulting from changing snow and ice conditions, are projected to be mixed.</p> <p>Detrimental impacts would include those on infrastructure and traditional indigenous ways of life.</p> <p>In both polar regions, specific ecosystems and habitats are projected to be vulnerable, as climatic barriers to species invasions are lowered.</p>
Small Islands	<p>Sea level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards, thus threatening vital infrastructure, settlements and facilities that support the livelihood of island communities.</p> <p>Deterioration in coastal conditions, for example through erosion of beaches and coral bleaching, is expected to affect local resources.</p> <p>By mid-century, climate change is expected to reduce water resources in many small islands, e.g. in the Caribbean and Pacific, to the point where they become insufficient to meet demand during low-rainfall periods.</p> <p>With higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands.</p>

(source IPCC 4th report).

Uncertainties

9. Climate data coverage remains limited in some regions and there is a notable lack of geographic balance in data and literature on observed changes in natural and managed systems, with marked scarcity in developing countries.
10. Analysing and monitoring changes in extreme events, including drought, tropical cyclones, extreme temperatures and the frequency and intensity of precipitation, is more difficult than for climatic averages since longer data time-series of higher spatial and temporal resolutions are required.
11. Difficulties remain in reliably simulating and attributing observed temperature changes to natural or human causes at smaller than continental scales. At these smaller scales, factors such as land-use change also complicate the detection of anthropogenic warming influence on physical and biological systems.

Causes (from IPCC 4th report)

12. Global GHG emissions due to human activities have grown since pre-industrial times, with an increase of 70% between 1970 and 2004. Global atmospheric concentrations of CO₂, methane (CH₄) and nitrous oxide (N₂O) have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years. There is *very high confidence* that the net effect of human activities since 1750 has been one of warming.
13. There is *high agreement* and *much evidence* that with current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades.
14. Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would *very likely* be larger than those observed during the 20th century.
15. Agriculture is a major contributor to GHG emissions, both directly, 13.5% of emissions (IPCC 2007), and as a driver of deforestation which accounts for 17.5 % of emissions. Direct emissions are expected to increase, in line with the increase of production (IPCC 2007). The magnitude of CO₂ emissions from land-use change and CH₄ emissions from individual sources remain as key uncertainties.

Consequences

Impact of climate change on production

16. It is essential to underline that for agriculture, some small changes in the climate, which would not be qualified as “extreme events” can have tremendous consequences as even small changes in annual rainfall or in seasonal precipitation patterns can impact productivity. Changes in short-term temperature extremes can be critical, particularly at key stages of plant development (Gornall 2010).
17. Climate change affects all agricultural sectors in a multitude of ways that vary region by region. For example, it reduces the predictability of seasonal weather patterns and increases the frequency and intensity of severe weather events such as floods, cyclones and hurricanes. Some regions face prolonged drought and water shortages. Changing temperatures are leading to changes in the location and incidence of pest and disease outbreaks (FAO, 2009). Approximately 20–30 percent of plant and animal species will be at increased risk of extinction if the global average temperature increases more than 1.5–2.5°C (IPCC, 2007). The widespread melting of glaciers and snow cover from major mountain ranges will reduce availability of water for irrigation downstream.
18. Vulnerable communities and people living in fragile environments, such as drylands, mountain areas and coastal zones, will be particularly affected. Climate change will significantly increase production risks of farmers, livestock keepers, fishers and forest-dependent people, particularly in regions that already suffer from chronic soil and water scarcity, high exposure to climatic extremes including floods and droughts, and poverty and hunger (FAO, 2008).
19. The increase in temperature will also affect soil quality, a driving factor for agriculture. Higher soil temperature and changing soil moisture conditions will affect soil organic carbon rich soils through

accelerated soil organic carbon decomposition, resulting in higher vulnerability to land degradation. Soil organic carbon rich soils are worldwide present in the high northern and southern latitudes, but also in often densely populated mountainous regions across the world. In addition, the accelerated loss in sequestered carbon will cause further increase in greenhouse gas emissions.

20. Climate change increases soil and water salinity in agricultural landscapes in arid and semi-arid regions that include:

- 1) Evapotranspiration and water balance at the land surface altered that changes the groundwater recharge as a result of climate change. In shallow aquifers, the groundwater responds to these changes quickly and moves towards the surface bringing salt with it and accelerates soil salinization.
- 2) Current best estimates suggest that in arid and semi-arid catchments, a reduction in rainfall due to climate change will result in up to double the reduction in run-off from catchment and river flow. Under such conditions the river salinity will increase as a result of reduced river dilution. This will affect the agricultural use of water and increased economic cost associated with treatments for domestic use. For example, salinity levels in the headwaters of the Murray-Darling Basin in Australia are expected to increase by 13–19% by 2050. In general, decreased groundwater recharge, which reduces mobilisation of underground salt, may balance the effect of decreased dilution of salts in rivers and estuaries.
- 3) In coastal areas, the risk of soil and water salinization under climate change is even higher because the increased sea level and frequency of tidal waves brings salt water along the river to inland and lost to groundwater making it saline. In low lying areas the salty river water moves to the land surface and causing soil salinization.
- 4) Continuous drought in some arid and semi-arid regions accumulates irrigation driven salt in floodplains. At the end of drought cycle the accumulated salt mobilized and released to river and making the water saline. The process may continue for years and affect environmental assets downstream of irrigated landscapes.

21. Bangladesh, Indonesia, Egypt, countries in the Arabian Peninsula, Caribbean island countries and small island countries and atolls in the Pacific are particularly vulnerable to soil and water salinization as coastal areas of these countries are affected by increased tidal waves. Freshwater input to the ocean due to climate change is also changing the salinity of sea water. Observed changes in ocean salinity over recent decades are suggestive of changes in freshwater input.

22. While farmers in some regions may benefit temporarily from the effects of CO₂ fertilization, longer growing seasons and higher yields, the general consequences of climate change are expected to be adverse, particularly for the poor and marginalized. Climate change impact has been found to differ between men and women. It affects food insecure people who are vulnerable to climate change in differing ways according to, for example, their gender, age, health or education.

23. Crop and livestock production will be affected by increasing temperatures, changing precipitation patterns, and more frequent and intense extreme weather events. These will have direct effects on crop growth and their need for water, as well as soil fertility, water supply for irrigation, and prevalence of pests and diseases. In terms of livestock, climate change also will affect the quality and amount of feed supply and the carrying capacity of pastureland. At the same time, they will have indirect effects on market prices, due to the different regional effects of climate change (UNFCCC, 2010).

24. Fisheries and aquaculture production systems are likely to suffer from increased water temperatures, sea-level rise and decreased pH, changes in current sea productivity patterns, flooding, droughts and increases in frequency and intensity of storms and other extreme weather events.

25. Forests and rangelands will be sensitive to climate variations, weather extremes and long-term changes, such as changes in daytime, nighttime and seasonal temperatures, storm patterns, duration and intensity of heat waves, droughts and floods, incidence of pests and diseases, and frost, snow and ice cover.

26. Coastal areas will suffer, as the rising temperature will affect coral reefs. Damaged reefs will no longer provide coastal protection which, in combination with rising sea levels and increased extreme weather events, becomes a direct threat to agriculture, forestry, fisheries and other livelihoods in coastal areas.

27. In addition to climate change, other interlinked environmental challenges, such as loss of biodiversity, land degradation and water scarcity, will affect the capacity of agriculture, forestry and fisheries to produce sufficient food, feed, fibre and other products, and provide services to meet the increasing demand stemming from population growth, urbanization, changing consumption patterns and economic growth.

28. By altering the conditions of agriculture, forestry and fisheries production and rural livelihoods, climate variability and long-term changes will likely have serious impacts on the four dimensions of food security (FAO, 2008).

Impacts on food security

29. Food availability – will decrease in some regions due to a decline in food production from agriculture, forestry and fisheries caused by extreme events, changes in the suitability or availability of arable land and water, and the unavailability or lack of access to technologies and crops, crop varieties and animal breeds that can be productive in changing conditions.

30. Food access – will face further constraints in some regions because of climate change events that can damage infrastructure and lead to loss of livelihood assets as well as loss of income and employment opportunities.

31. Food supply stability – will be influenced by food price fluctuations and a higher dependency on imports and food aid in some regions.

32. Food utilization – will be affected indirectly by food safety hazards associated with pests and animal as well as human diseases.

Consequences for planning

33. As climate change is expected to have increasing effects on agriculture, forestry and fisheries it has to be taken into consideration at various space and time scales to get prepared and adapt.

34. To deal with the uncertainty in actual effects, due to the lack of precise and detailed projections, there is a need to assess any decision taking into consideration increased variability and uncertainty as well as long term changes. Such measures are often framed in risk management strategies which aim first to reduce exposure to risk, before palliating with the effects of risk through risk coping, i.e risk retention (risk is borne by the farmer, i.e. self-finance) and risk transfer (insurance) mechanisms.

35. There is a growing interest in increasing resilience of the production systems including by promoting best practices in an ecosystem approach, the early detection of emerging risks, the subsequent reduction or elimination of a specific risk. The objective is also to help systems to recover, including by restoring productive capacities. In doing so, such strategies should combine specific policies targeted to address specific agents and categories of risks. They include measures to reduce or eliminate specific risks, such as plant pests and animal diseases, including advanced observation networks for quick response. Diversification can both increase the efficiency of systems and their resilience to direct and indirect risks. It also can spread risk, increasing economic resilience at farm and local level. Diversified rotations, including crop varieties and species with different thermal/temperature requirements, better water use efficiency and resistance to pest/disease, and lower yield variability are effective ways to reduce risks and increase efficiency. Other measures either prevent the loss of productive assets, such as feed banks for livestock during droughts, or enable quick recovery, such as availability of seeds.

36. The elements needed to establish and implement risk management strategies include, at local level, impact assessment and monitoring, vulnerability assessment, identification of (ex-ante) damage reduction measures including by early action and by building resilience at farm and system level. It shall also consider measures to ensure their implementation, including the establishment of institutions at national and regional level, capacity building and compensation for incurred costs, including investments

and income foregone during the transition period towards a more resilient system. It will also require supporting the development and dissemination of technologies and practices, as well as international cooperation for promoting the conservation and sustainable management of biodiversity, including ecosystem services to maintain and/or enhance ecosystem resilience; breeding of crops, trees, livestock and fish adapted to less predictable climate conditions; and enhancing in-situ and ex-situ conservation and sustainable use of genetic resources.

37. Increased uncertainty and growing impacts of climate change also calls for the development of risk coping mechanisms, especially for the more vulnerable populations, including through the establishment and potential extension of safety nets.

38. Understanding of how development planners incorporate information about climate variability and change into their decisions is limited. This limits the integrated assessment of vulnerability. The evolution and utilization of adaptive and mitigation capacity depend on underlying socio-economic development pathways. Barriers, limits and costs of adaptation are not fully understood, partly because effective adaptation measures are highly dependent on specific geographical and climate risk factors as well as institutional, political and financial constraints.

39. Agriculture is also increasingly called upon to contribute to mitigate climate change. Considering the necessary increase of production, it can do so by reducing emissions per kg of output and by enhancing carbon sinks. Estimates of mitigation costs and potentials depend on assumptions about future socio-economic growth, technological change and consumption patterns. Uncertainty arises in particular from assumptions regarding the drivers of technology diffusion and the potential of long-term technology performance and cost improvements. Also little is known about the effects of changes in behaviour and lifestyles.

40. There is now a growing tendency to consider adaptation to climate change and mitigation at the same time and to aim for what FAO has named Climate Smart Agriculture which considers both food security, adaptation and mitigation. The success of this concept, including towards the international negotiations on climate change under UNFCCC has done much to raise awareness to the importance of climate change for the agricultural sectors. It also enables to progress towards integrated approaches where sustainable management of natural resources could enhance ecosystems’ resilience including agriculture, forestry and fisheries at landscape level.

41. Climate change will thus make more difficult the achievement of FAO goals (a) reduction of people suffering from hunger and (b) elimination of poverty. Goal (c) sustainable management of natural resources will be key to address it. Adaptation to climate change requires sustainable management of natural resources and at the same time is part of it. It will also have to include mitigation of climate change as an objective.

Appendix 1. Overview of selected possible regionalized impacts of climate change on agriculture, forestry and fisheries (compiled from IPCC, 2007)

	Agriculture	Forestry	Fisheries and aquaculture
Asia and Pacific	<ul style="list-style-type: none"> • Freshwater availability in Central, South, East and Southeast Asia is likely to decrease. • Temperature increases will lead to a substantial increase in demand for irrigation water for sustained productivity in arid, semi-arid Asia and South and East Asia. • Land suitable for crop cultivation is expected to increase in East and Central Asia, but decrease in other areas, especially in South 	<ul style="list-style-type: none"> • Forest expansion and migration are affected, and biodiversity is threatened by land use, land cover change and population pressure in most of Asia. • In North Asia, forest growth and northward shift in the extent of boreal forests is likely. • The frequency and extent of forest fires and the risk of invasive species, pests and diseases in Asian forests are likely to 	<ul style="list-style-type: none"> • Sea-water intrusion is likely to increase the habitat of brackish water fisheries, but coastal inundation is likely to have serious effects on the aquaculture industry and infrastructure, particularly in heavily populated mega deltas. • Increased frequency of El Niño would cause a general decline in fishery production in the coastal waters of East, South and Southeast Asia. • Warming may make the

	Agriculture	Forestry	Fisheries and aquaculture
	<p>Asia.</p> <ul style="list-style-type: none"> • Crop yields could increase in East and Southeast Asia, while they could decrease in Central and South Asia even considering the fertilization effects of CO₂. • There will likely be a northward shift of agricultural zones. • Heat stress and limited pasture availability would limit the expansion of livestock numbers. 	<p>increase.</p> <ul style="list-style-type: none"> • The Pacific faces: increased incidence, intensity and impact of extreme weather events such as inundation, storm surge, erosion and other coastal hazards; loss of mangrove forests, severe flooding and cyclones; and increased invasion by non-native species. 	<p>Arabian Sea more productive.</p> <ul style="list-style-type: none"> • Small island developing states (SIDS), highly reliant on fisheries and highly exposed to the changes, will probably suffer most.
Europe and Central Asia	<ul style="list-style-type: none"> • Countries in the more temperate and polar regions are likely to benefit. • Countries in mid-latitudes will benefit at first but will begin to be affected negatively if temperatures rise by more than 2.5°C. • The combination of temperature increase and increasing CO₂ concentration will result in slightly positive agricultural development in southeastern Europe, while the Mediterranean area and southwest Balkans will suffer. • Central Asia, dependent on irrigation and with high inter-annual variations in yields, can be affected by climate extremes and decrease in water availability. • Cattle and small livestock could suffer from increasing heat stress and spread of diseases. 	<ul style="list-style-type: none"> • In northern Europe, the area of tree species native occurrence will shift northwards and increase in growth. • In the Mediterranean area, forest ecosystems or individual species will start to contract. • The tree species structure will change, e.g. shrubs may increasingly dominate trees in the southern Europe. 	<ul style="list-style-type: none"> • Warm water species are likely to spread to the north, with local extinction occurring at the boundaries. • Increased winter temperature can increase growth, but also increase the risk of diseases. • Marine productivity is likely to increase in temperate areas.
Near East	<ul style="list-style-type: none"> • Maize yields in North Africa would suffer first with rising temperatures, followed by Western Asia and the Middle East. • Water availability would decrease in most of the region, although it may slightly increase in some areas, such as most of Sudan, Somalia and southern Egypt. • Temperature increase may 	<ul style="list-style-type: none"> • Depletion of soil moisture may cause the productivity of major forest species to decline, increase fire risk and change the patterns of the region's main pests and diseases. • Severe water shortages due to decreasing summer precipitation in Western Asia will affect forest growth. 	<ul style="list-style-type: none"> • Many basins in the region already suffer from lack of water (Mediterranean, Near East) and the usable net water resources are still likely to decline. • In the Mediterranean, there will be changes in fish populations, recruitment success, trophic interactions and migratory patterns of fish populations.

	Agriculture	Forestry	Fisheries and aquaculture
	<p>lead to increased pasture production in mid-latitudes, with increases in livestock production.</p> <ul style="list-style-type: none"> Warmer winters may benefit livestock, while greater summer heat stress can have negative effects. 	<ul style="list-style-type: none"> Some countries already have experience in afforestation using sewage water for irrigation, which will counteract negative effects of climate change. 	
Africa	<ul style="list-style-type: none"> The number of extremely dry and wet years is expected to increase in sub-Saharan Africa during this century. Drying is expected in the Mediterranean area and in much of southern Africa. Rainfall may increase in East and West Africa. Some areas, such as the Ethiopian highlands, could benefit from a longer growing season. Rangeland degradation and more frequent droughts may lead to reduced forage productivity and quality, particularly in the Sahel and southern Africa. 	<ul style="list-style-type: none"> Mangrove forests protect coastal zones from storms and floods and forests in general regulate water flows and reduce flooding. Through its impact on forests, climate change also will affect wildlife, bush meat and non-timber forest production, which are important for food security in several parts of Africa. Availability of water rather than increases in temperatures will affect forest growth in Africa. African forests will generally face deforestation, degradation, increased forest fires and major changes, e.g. in mountain ecosystems. 	<ul style="list-style-type: none"> Sea level rise poses a threat to coastlands, lagoons and mangrove ecosystems especially on eastern and western shores of Africa. Changes in coastal ecosystems and delta areas, such as destruction of coral reefs, will have direct effects on the productivity of fish stocks. Productivity of the East African lakes could decline. Temperature increases as such may not affect pond aquaculture in the tropical regions, but water availability may become an issue.
Latin America and Caribbean	<ul style="list-style-type: none"> In temperate zones, such as southeastern South America, yield of certain crops such as soy and wheat will increase. As a result of increased thermal stress and drier soils, productivity in tropical and subtropical regions is expected to decline. In arid zones, such as central and northern Chile and northeastern Brazil, the salinization and desertification of agricultural land will possibly increase. Rainfed agriculture in semi-arid zones will face increasing risks of losing crops. In temperate areas, pasture productivity may increase, 	<ul style="list-style-type: none"> Tropical forests are probably affected more by changes in the availability of water in the soil CO₂ fertilization than by temperature changes. There will be a tendency towards “savannization” of eastern Amazonia. A high risk of forest loss is suggested for Central America and Amazonia, more frequent wildfire in Amazonia, more runoff in northwestern South America, and less runoff in Central America. Mangrove areas will likely be under threat in several parts of the Caribbean and Central and South America. 	<ul style="list-style-type: none"> More frequent storms, hurricanes and cyclones will affect aquaculture and fishing in coastal communities, especially in the Caribbean area. Availability of water for some aquaculture production technologies may be affected by retreating glaciers in some areas of the Andes. Distribution of some fish species in the tropical and subtropical seas may change southwards. Primary production in the tropical Pacific may decline because of increased stratification and decreased nutrient supply.

	Agriculture	Forestry	Fisheries and aquaculture
	benefiting livestock production.		

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TREND 8: SCIENCE AND TECHNOLOGY AS A MAIN SOURCE OF AGRICULTURAL PRODUCTIVITY AND PRODUCTION INCREASES IS PROGRESSIVELY BECOMING A PRIVATE GOOD AND THE PROCESSES ARE DOMINATED BY THE PRIVATE SECTOR.

1. Most of the increases in global agricultural production and productivity have been based in increases of yields per hectare. Cereals and oilseeds have played a major role in this process. The emergence of biotechnology as a major source of innovation in agriculture displaced the “technological space” in the direction of the private sector. The opportunities given by propriety biotechnological products have led to large investments by the private sector which is concentrated in grains and market oriented production conditions. As intellectual protection instruments become more standard, the magnitude of the investments needed increases, and the complexity of science makes essential high managerial capacities these trends will most likely consolidate. The organization of science and the interface between policy and science become more important. In particular public policies, public investments and partnerships with the private sector will be needed for a more universal utilization of the potential of innovations for increasing food production and poverty reduction

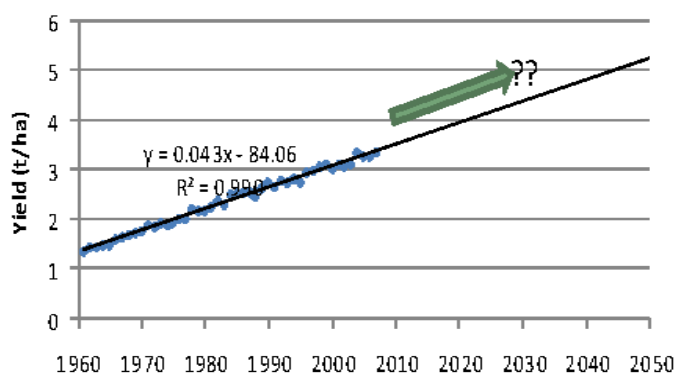
Current trends in Yields and Yield gaps

2. Most of the increase in global agricultural production over the past 50 years has been based on increasing yields.

3. Over the past five decades, global cereal yields have grown linearly at a constant rate of 43 kg/ha annually and with very low variability around the trend (Figure 1). Note that linear growth in Figure 1 implies declining exponential growth—from 3.2 percent per year in 1960 to 1.5 percent in 2000. Projecting the same linear trend to 2050 would deliver only 0.8 percent per year growth then.

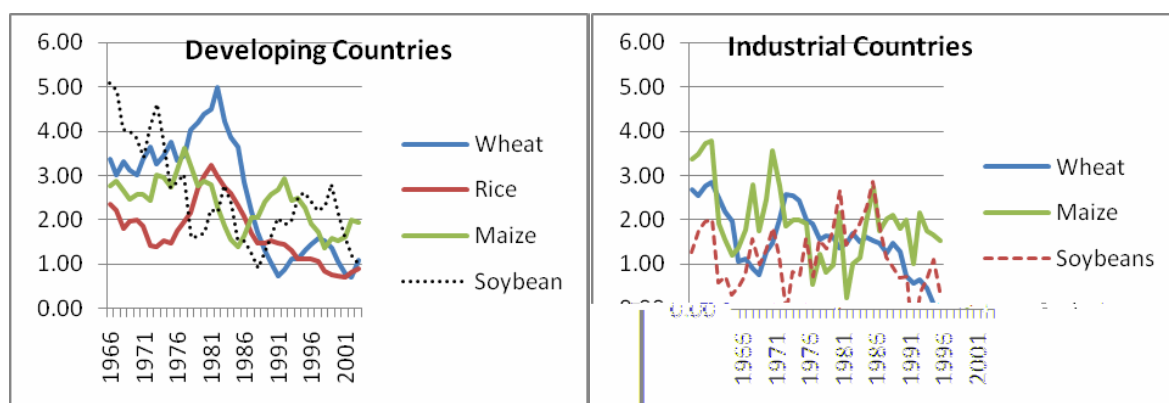
4. Trends in yields are very variable and heterogeneous both regionally and also for different cereals. Data show a slowdown in yield growth for rice and wheat, posterior to the introduction of modern varieties. Trends in Maize are different showing a linear trend at the global level and an accelerating trend in developing countries. (see figure 2).

Fig 1 Long-term trends in cereal yields globally



Source FAOstat and (1)

Fig 2. Ten-year moving average yield growth rates, wheat, rice, and maize in developing countries (left panel) and industrial countries (right panel)



5. Two categories of yields are to be taken into consideration here : actual farm yields which are average yield achieved by farmers in a defined region over several seasons and potential yields which are the maximum achievable yield with latest varieties, removing as much as possible all constraints, generally achieved in highly controlled station. The difference between these two is known as the yield gap.

6. What matters for present food security are the actual farm yields. What matters for future food security is the increase in farm yields, therefore the joint increase in potential yields and convergence of farm yields towards them. Indeed, potential yields can be seen as a yield frontier and progress in potential yields, through genetic and agronomic research is an important source of yield growth because raising the yield frontier lifts other yields as well .

Drivers and determinants of yield increase and the role of science and technology

7. Increases of yields are very linked to improved on farm technical itineraries, and to the application of technical progress in farming systems, due to (i) the adequate provision of inputs (N, water), (ii) better pest management, (iii) better varieties, (iv) better farm management.

8. Yield increases, such as those achieved during the Green Revolution are generally achieved through a combination of these factors. It needs science and technology to devise better technologies, innovative practices and systems and adequate means to transfer them in the field to be implemented.

9. Increased use of fertilizer has been a major factor explaining 1/3 to 1/2 of yield growth in developing countries since the Green Revolution .

10. However, growth through irrigation and fertilizer is no longer important in industrialized countries, and in major regions like Asia. Fertilizer use in SSA remains very low and explains a large part of the lagging productivity. Also, with growing competing uses, water availability is going to be increasingly constraining .

11. As a consequence, in the future, it is expected that yield increase will rely even more than today on the development of adapted and improved varieties, and on their appropriate diffusion and use.

12. Ever scarcer resources will require production to be more resource efficient. As natural resources are limited, increasing production in agriculture has to make a better use of them, making investment in it necessarily green. Technology will have to follow this pattern that allows for a “greening” of production, aiming to produce more output per unit of input, either land, water, energy or nutrient, and more per unit of greenhouse gas emitted (mitigation).

13. There is not one unique model of production that can achieve such an objective of sustainable intensification and their conception and development has to be driven by local specificities, with implications on the role and involvement of national and international public research and development systems (see below), including regarding the opportunities for biotechnologies.

Trends in science and technology (privatization of the technological space) and drivers

14. Global public plus private investment in agricultural R&D has constantly increased in the last three decades.

15. Global trend of investments in agricultural R&D is still of global increase but with patterns undergoing substantial changes. One important trend is the move towards a greater involvement of the private sector in developed countries and in some rapidly emerging countries, with an increasing spatial concentration of expenditures in the top 5 and top 10 countries.

16. Public sector investments in agricultural R&D has grown worldwide from about 16 billion USD in 1981 to 21 in 1991 and 23.5 in 2000 worldwide. But, at the world level, private sector investments are growing more rapidly, reaching 16 billion USD in 2000 (dollars from 2005), amounting to 40% of the 39.5 billion USD total investments in agricultural R&D worldwide that year (equal to 5.4% of all R&D spending worldwide).

17. Total agricultural R&D is increasingly concentrated in a few countries. This is a result (i) private R&D investments being spent at 93% in developed countries, and (ii) of public R&D currently the vastly dominating source of funding in developing countries, being spent at 49% in five countries only: USA, Japan, China, India, Brazil, in an increasing trend from the 41% in 1991.

18. In the OECD, the share of private investments in agricultural R&D expenditures has risen from 43.6 % in 1981 to 54.3% in 2000, showing a slowdown of publicly performed agricultural research in developed countries (3).

19. Investments by the private sector in the developing world accounted for only 2 percent of the total world agricultural R&D in 2000 (2, 3). In Sub-Saharan Africa, the majority of the tiny amount of private R&D is oriented to export crop improvement research such as cotton and sugarcane. (3)

Table 1: Total public agricultural R&D in 1981, 1991 and 2000 for different regions

Country category	Public agricultural R&D spending			Regional share of global total		
	1981	1991	2000	1981	1991	2000
	<i>(million 2005 PPP dollars)</i>			<i>(percent)</i>		
Country grouping by income class						
Low income (46)	1,410	2,009	2,564	9	10	11
Middle income (62)	4,639	6,301	7,555	29	30	32
High income (32)	9,774	12,577	13,313	62	60	57
Total (140)	15,823	20,887	23,432	100	100	100
Low- and middle-income countries by region						
Sub-Saharan Africa (45)	1,084	1,253	1,239	7	6	5
China	713	1,178	1,891	5	6	8
India	400	748	1,301	3	4	6
Asia-Pacific (26)	1,971	3,287	4,758	12	16	20
Brazil	1,005	1,433	1,209	6	7	5
Latin America and the Caribbean (25)	2,274	2,697	2,710	14	13	12
West Asia and North Africa (12)	720	1,074	1,412	5	5	6
Subtotal (108)	6,049	8,310	10,119	38	40	43

Table 2: Estimated global public and private R&D investment, circa 2000, for different regions

Region/country	Expenditures (million 2000 international dollars)			Share (percent)	
	Public	Private	Total	Public	Private
Asia-Pacific	7,523	663	8,186	91.9	8.1
Latin America and the Caribbean	2,454	124	2,578	95.2	4.8
Sub-Saharan Africa	1,461	26	1,486	98.3	1.7
Middle East and North Africa	1,382	50	1,432	96.5	3.5
Developing-country subtotal	12,819	862	13,682	93.7	6.3
High-income country subtotal	10,191	12,086	22,277	45.7	54.3
Total	23,010	12,948	35,958	64.0	36.0

20. The emergence of biotechnology as a major source of innovation in agriculture, and the existence of intellectual property protection options, has displaced the “technological space” (development and ownership of technologies, investments in R&D and orientation of research) in the direction of the private sector.

21. The emergence of biotechnologies is not the only explanation for the increased role of the private sector. The latter is also linked to the increasing importance of the food processing sector and, as income rises, of the demand that is addressed to it.

22. Nevertheless, intellectual protection possibilities and the ability they provide for capturing rents are a key driver of the interest of the private entities in agriculture, as for example in the seed industry.

23. Many methods and techniques can be used in agricultural plant, livestock and fish biotechnology, some of which are heavily patented, and therefore frame or restrict the deliverability of products. This is especially the case in the seed industry, with the private sector emphasizing on innovations that are amenable to various intellectual property protection options over breeding techniques and products, such as patents and plant breeder’s rights.

24. The current high food price environment and trend is expected to consolidate this movement and further stimulate involvement of the private sector in agricultural R&D and biotech.

25. Size of investments needed to develop new varieties using modern or GM techniques, and the economic model based on royalty revenues and licensing income from protected intellectual property (3) have led to a concentration of the seed sector in the hands of a few giant companies, setting in motion a complex global scale merger and acquisitions process that has led to the creation of what has become known as the “life sciences complex”, which integrates biotechnology with the agricultural chemical, seeds and food/feed sectors and controlling a large proportion of both the emerging products and enabling technologies

26. There is therefore a trend that private investors play a greater role in shaping research and development needs, towards a greater prioritization of research on a few crops and maize and soybeans (even to the detriment of other staples as wheat and rice). Monsanto has set itself the goal of doubling maize farm yields in the USA between 2000-2030 from 8.5 t/ha to 17t/ha. A conservative estimate is that the private sector spends about 1 billion USD/yr on maize research in the USA, compared to 181 million USD in 1990, dollars of 2008 .

27. At the same time there is also a trend towards more systemic and local based approaches to valorize local potentials. The employment of agronomists by private companies is a pattern that is bound to be followed in the developing world as industry grow in competitiveness.

28. Another important trend is the reduction of public extension services and the growing role of the private sector in the dissemination of technologies and practices.

29. The necessity to green the agriculture will however require a larger role of public actors both in research and development. This is even more the case that private-owned technologies are keen to focus on major markets, without a guarantee for isolated or non lucrative markets to benefit from them. This

will reinforce the need for the CGIAR to be strengthened as the main international public good producer in technology related fields.

Consequences

30. These trends are already modifying the way science and technology is conducted and transferred to the field. To assess their consequences on food security and agriculture, one must describe the various ways by which this increased role of the private sector in agricultural R&D drives the transformation of agricultural development. The above-mentioned trends present positive consequences or opportunities to increase productivity, but there is also a risk that, without appropriate public action, they lead to an increase of disparities between developed and emerging countries and those lagging behind, Africa being of special concern.

- 1) The increasing role of private sector research and development leads to increased funding, at the moment when the public spending effort on R&D and more specifically on agricultural R&D is getting more difficult to sustain given the current global economic context.
- 2) This trend leads to new technological progress, economic relevance, and to increase in the efficiency on the ground of research, by appropriate collaboration and task and cost-sharing of basic research with agricultural research institutes in developing countries.
- 3) There is an increasing tendency of public-private partnerships where public investments and public research systems, as well as extension system operate increasingly with the private sector, in much more diversified and complex universes, and where dissemination of techniques to and by the private sector is facilitated, including small local enterprises.
- 4) On the other hand, private sector investment is targeting mainly rich countries or a small number of developing countries where input markets are growing and becoming more cost effective to serve. As a consequence, and because of the parallel weakening of the public sector institutions except in a handset of countries (Brazil, Argentina, India, China), the divide between regional have and have-nots in agricultural R&D has a tendency to grow, in particular between rich and emerging countries (OECD, Brazil, China, India) with respect to less advanced countries. The rich/poor disparity in the intensity of agricultural research (dollar spend on agricultural R&D for 100\$ of agricultural GDP) is increasing.
- 5) The increasing importance of biotechnologies in agricultural research, and their associated high costs, is making even more difficult **the construction of agricultural research and development systems** in the less advanced part of the developing world. Private sector investments in developing countries are keen to focus on the provision of input technologies or services which are produced or owned in developed or powerful emerging countries, with no local benefit. This can hinder the emergence of national R&D systems and the structuration of the national agrifood sector, in regions where there is already a deficit of technology supply.
- 6) As private sector investments are coupled on food prices, and given the long gestation period for new crop varieties and livestock breeds, there is a risk to reinforce the problems of cyclicity of investments patterns in agriculture (4).
- 7) Private sector is likely to play an increasing role in the management of genetic resource worldwide, as tangible barriers will exist for accessing certain strategic technologies. This will reinforce the importance of sound regulation and of the strengthening of public good providers such as the GGIAR, regional and national systems.
- 8) Access to seeds is likely to rely more on economic and market conditions.
- 9) Without appropriate public action, there might be increased difficulties for applicable technologies providing yield increase, first, to be specifically developed for the poorest of the smallholders, to be adapted for them, and second, to reach them, and, if so, to be adopted by them. Reasons for this are the following:

- a. multinational and national private biotech and input supply firms mostly concentrate in the commercial agriculture sector where the market is mature and where institutional conditions are present to ensure suitable rates of return for their investments.
- b. adaptation of the technology to local conditions, and their commercialization often faces barriers, for example price barriers, regulations including in biosafety (6), access to credit or insurances, and intellectual property rights (3).
- c. R&D tends to be reoriented away from the type of technologies that are most easily adapted, hindering spillovers (5),

31. The impact, on the three FAO's current goals, of the increased role of the private sector in science and technology, everything else being equal, is difficult to assess, as it depends on the overall policy context.

32. This trend may trigger progress for goals 1 and 2, if it turns into substantially increased amounts of global funding and investments. There are also concerns that benefits might be limited to some areas or some productions, excluding from progress non profitable areas or productions, either because they are not targeted by private investments, or because smallholders have a lack of capacity to access the techniques.

33. The impact on goal 3 is also difficult to assess. One of the main question is how these trends will influence the way practices and technologies can be adapted to local conditions and resources, and contribute to global public goods.

34. The total effects of the trend are uncertain as yield gains, food security, and sustainable management are not achieved by technology alone but require changes in policies and institutions. For the gains in investments by the private sector to spread out towards the smallholders, it needs to be "potentialized" and regulated by appropriate public policies, supplemented by infrastructures and institutions to make technical progress accessible and reach the field.

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TREND 9: EVOLVING DEVELOPMENT ENVIRONMENT: INCREASED RECOGNITION OF THE CENTRALITY OF GOVERNANCE AND A COMMITMENT TO COUNTRY-LED DEVELOPMENT PROCESSES

1. During the last decade the development environment has changed in many ways. On the one hand new and more active stakeholders have emerged, both at the national and global levels, in particular civil society. This has resulted in the need for stronger and more complex governance mechanisms that allow for their participation in decision-making processes and implementation of development plans and programmes. On the other hand the international community has made new political commitments to promote and support regional and country-owned multi stakeholder's development processes, affirming the primacy of country-led development. This new environment has created new policy and institutional needs and at the same time has generated new opportunities for action at country, regional and global levels which have important implications for multilateral organizations in general and FAO in particular.

New and more active stakeholders: The need for stronger and more complex governance mechanisms

2. Development processes have become increasingly complex. At national and international levels a wider range of stakeholders, including the private sector, civil society, NGOs and foundations, is increasingly recognized as having a legitimate voice at the table. Effective governance at global, regional and national level is increasingly achieved when the voices of different stakeholders are incorporated into decision-making, policy formulation and regulatory framework, and their implementation and monitoring. This is particularly important for the most vulnerable, whose access to rights and opportunities, as well as platforms to share their voice, is often constrained by hunger and poverty. The participation of a wider diversity and growing number of stakeholders helps ensure accountability and fosters effectiveness in the implementation of policy and regulatory framework.

3. New mechanisms are being put in place to involve their representatives in decision-making processes, as well as in the implementation of jointly developed plans. It is further recognized that in order to achieve global and national development goals, not least to achieve food security, the participation of actors well beyond the agriculture sector is required, further broadening the range of stakeholders and competing views and interests. A heightened focus on cross-cutting issues, such as gender and the environment, adds further complexity.

4. Discussion between very diverse stakeholders and interests requires shared evidence to build decisions - involving scientific, transparent and open processes, including diverse forms of knowledge. This is why there has been a progressive development of science and policy interfaces at national and international levels, most notably on environmental issues such as climate change (IPCC), ecosystems (Millennium Ecosystem Assessment) and also in agriculture (IAASTD), and now in food security with the creation of the High Level Panel of Experts for food security and nutrition. A growing commitment to evidence based analysis to underpin decision-making processes is also reflected in regional and national development initiatives, such as the Comprehensive Africa Agriculture Development Programme (CAADP).

5. Increasing complexity calls for a greater focus on governance. Governance can be defined as the process of decision-making and the process by which decisions are implemented (or not implemented). The quality of these decisions depends on building effective, efficient and accountable institutions, and fostering participation, equity and transparency. The cross-cutting nature of emerging national and regional priorities have required commensurate support from the multilateral system, evidenced by the

growing need for governance mechanisms that address complexity and interdependence - on a global scale - through a trans-disciplinary lens.²⁵

6. Furthermore, global governance and the delivery of global public goods (GPGs) are essential underpinnings to the achievement of commitments made to country-led development processes.²⁶

7. As a response to these needs the UN system is increasingly redefining its role as one of identifying, defining and linking knowledge and expertise about policies that work, rather than providing traditional assistance and technical cooperation.²⁷

8. One example of how the FAO role in addressing complexity and emerging priorities through governance has evolved over time is its work on governance related to genetic resources and biodiversity for food and agriculture. FAO and its Members established the Commission on Plant Genetic Resources for Food and Agriculture in 1983, and developed a global system on plant genetic resources. By 1995, FAO Members broadened the mandate of the Commission in 1995 to cover all components of biodiversity of relevance to food and agriculture. The Commission was renamed as the Commission on Genetic Resources for Food and Agriculture, and is now an important intergovernmental forum where governments negotiate instruments related to biodiversity for food and agriculture through the lens of food and nutrition security. At present, the Commission, given the increasingly globalized nature of discussion on biodiversity and plant genetic resources, is even more relevant, important and necessary than when established in 1983. The Commission plays a global role in developing mechanisms and instruments, and negotiates, agrees and adopts standards necessary for the food and agriculture sectors to ensure food and nutrition security. For example, the Commission negotiated the International Treaty on Plant Genetic Resources for Food and Agriculture, harmonized with the Convention on Biological Diversity, and agreed on Global Plans of Action on Genetic Resources.

9. An additional example that illustrates how the governance role of FAO, and indeed, the UN system is evolving, is related to the lack of progress in overcoming world food insecurity which is attributed, among other factors, to weaknesses in governance of food security related to policies, institutions and organizations. Increasingly, FAO is being called upon to address critical issues that affect food security by developing more normative and standard-setting work and global public goods to improve governance and achieve impact aligned with national priorities. A common feature of virtually all of these governance structures is that they are increasingly defined by a growing number of stakeholders from a wider variety of sectors. Overall, an upward trend in the number and types of associations, networks and partnerships aimed at addressing increasingly complex and interdependent issues in food and agriculture systems is increasingly linked to calls for global governance mechanisms that use common platforms to address national priorities. Specific and recent examples of this over the past several years include requests to create global governance structures focused on FAO work related to

²⁵ In addition to local and national interests, governance of natural resources in some cases transcends administrative boundaries and reflects whole landscapes, regions or continents. Improved governance is needed to deliver global public goods such as climate change mitigation or biodiversity conservation. At the same time, governance structures must recognize the centrality of food and nutrition security to achieving sustainability. A key dimension in governance is the issue of equity. The human right to food, as recognised in many international agreements, as a human-rights-based approach, puts the individual at the centre of all development policies and ensures that individual rights are respected, protected and fulfilled. For example, this means safeguarding or improving vulnerable people's access to natural resources through fairer tenure systems, better knowledge and communication, and application of the principle of Free, Prior and Informed Consent (FPIC) in relation to resource management decisions.

²⁶ Kaul, Grunberg, Stern (1999): *Global Public Goods: International Cooperation in the 21st Century*, UNDP, New York. Global Public Goods (GPGs) are services or conditions that are essential for individuals and communities to be able to live without poverty and threats to life and well-being, and enjoy human rights. GPGs include natural commons (such as a sustainable environment, water or a stable climate), human-made commons (such as transport, communication, shelter or other infrastructure), and global policy outcomes (such as health, education, justice, freedom from discrimination, access to opportunity).

²⁷ See Strategy for the preparations for the 2012 Quadrennial Comprehensive Policy Review (QPCR) of Operational Activities for Development of the UN System, Development Cooperation Policy Branch, OESC, UN-DESA, 11 October 2011. The role of the UN system in bringing knowledge and expertise about policies that work is thus becoming more important in some countries than its ability to deliver traditional assistance and training. This points to the importance of enabling peer learning among Member States and different actors, giving priority to knowledge management and resources allocated to it, and tapping into the expertise of non-resident agencies. This, combined with the great focus on cross-sectoral interventions, has implications for the required UN staff capacity at country level.

global public goods, based on requests made through intergovernmental and multi-stakeholder processes, selected examples include:

- the request to the CFS to create an International Observatory on Land Tenure;
- the call by the G-20 to create a global agricultural marketing information system (AMIS);
- requests to focus on issues related to fisheries, aquaculture and oceans, through the GEF Areas Beyond National Jurisdiction (ABNJ) project, or review the governance of UN Oceans;
- the agreement to establish an Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES);
- the creation of a UN system-wide accountability framework on gender to focus on progress on calls for gender equality;
- development of Voluntary Guidelines on Responsible Governance of Tenure of Land and other Natural Resources;
- development of the Principles for Responsible Agricultural Investment;
- International Guidelines for the Governance of Tenure in Land, Fisheries and Forestry and the Voluntary Guidelines for Small-Scale Fisheries.

10. Most of FAO's longstanding work on governance and standard setting is conducted through statutory bodies or commissions, many operating under joint oversight with UN agencies. Generally only governments are members of these bodies and commissions, but allow participation of other stakeholders as observers, including NGOs, CSOs and the private sector. Examples include the *Codex Alimentarius* and FAO Committee on Commodity Problems, International Code of Conduct on the Distribution and Use of Pesticides, the Rotterdam Convention and Advisory Committee on Paper and Wood Products. There are also other types of existing international commitments, such as the Voluntary Guidelines to support the Progressive Realization of the Right to Adequate Food in the Context of National Food Security. For all of these, there has been a general trend towards more substantive involvement of non-governmental stakeholders, with some establishing formal advisory or consultative mechanisms, including private sector companies through their associations.²⁸

Regional and Country-owned Multi-stakeholder development processes

11. Since 2002, the international community has recognized that successful development must be driven and owned by countries themselves and that this requires coherent country strategies and programs. Major international fora, in particular the four High Level Fora (HLF) on aid effectiveness in Rome (2002), Paris (2005), Accra (2008) and Busan (2011) have explicitly articulated this commitment.²⁹ These commitments have reiterated the centrality of country-led strategies and programs for development. Many development partners have decentralized their decision-making processes, in line with these international commitments, allowing country offices much greater autonomy in determining the support they provide and the partnerships they engage in, and delegating significant budgetary authority to country offices.

12. Commitments in the HLFs have evolved from a focus on aid effectiveness to development effectiveness which places responsibilities to a much greater extent at the country level (See Figure 1): The 2002 Rome Declaration focused on commitments by development partners to align to country programs. The Paris Declaration in 2005 broadened commitment to alignment and harmonized support to country owned processes and put the emphasis on mutual accountability, between countries and development partners, thereby expanding responsibilities at the country level. The Accra Agenda for Action (AAA) in 2008 added the focus on partnerships at country level, including civil society, thereby broadening the national constituency that is explicitly considered as stakeholders in the country-led agenda. Civil society was also represented at the Accra Forum for the first time. The AAA further

²⁸ See FAO in the 21st Century, Part 1 – Major Challenges to Food Security in the 21st Century, FAO, Rome, 2011.

²⁹ See Appendix.

emphasized the need for capacity development to strengthen countries' ability to manage their own future. The Busan Outcome Document (2011), although less binding than its predecessors and requiring further follow-up to define measurable indicators and targets, advocates for a shift from aid to development effectiveness thereby further strengthening the role of national parties. Unlike in the previous High Level Fora, developing countries were at the centre of the deliberations in Busan, as they were in the process leading up to HLF4. They drove the negotiations on the outcome document and fuelled the momentum to uphold the unmet commitments of the Paris Declaration on Aid Effectiveness (OECD, 2011).

13. These development and commitments are significant. A number of critical challenges, however, remain to be addressed:

- crucial It must also be recognized, however, that in day to day practice, these good principles (ownership, coordination, alignment, inclusiveness) have not been fully translated into the modus operandi – in countries themselves and in development partner practices.
- the lack of capacities in both the public and private sphere limits countries' actual abilities to handle their own country processes - linked with this lack of capacity, there is often a lack of harmonization at country level linked with the multiplication of externally-driven initiatives and mechanisms ignoring country processes;
- the increasing complexity of the development process, involving multiple stakeholders with often contrasting interests, at multiple levels – local, national, global – and divergence in power between interest groups makes such inclusive processes a challenge to handle, especially at country level;
- development partner buy-in at headquarter/strategic level has not always been matched by buy-in at the country office level;
- countries have their own procedures and requirements, for example, legal framework, procurement rules, that differ from development partners, whose own processes often differ significantly. In addition, country owned processes take time and this often dramatically contrasts with the agenda and schedule as well as the complex requirements of development partners.

Needs for better policies and institutions for Regional and Country owned development processes

14. New implementation modalities and processes continue to emerge in the evolving development context, characterized by (1) the increasingly important role of Regional Economic Communities (RECs); (2) increasing needs for institutional capacities in planning/policy design and implementation; and (3) decentralization.

15. **Regional Economic Communities (RECs)** play an increasing role in supporting countries in their development efforts. They are empowered to coordinate and support countries and to undertake regional actions that cannot be undertaken at country level, for example actions related to trans-boundary plant pest and diseases, phytosanitary measures, management of shared ecosystems or transboundary waters or trade in food and agricultural products. This is, for instance the case of ECOWAS in West Africa, IGAD in the Horn of Africa, ECO in South Asia, and CARICOM in the Caribbean.

16. At country level, poverty reduction strategy papers, as well as agriculture and food security frameworks (policies, strategies, plans and programs) already exist. Countries therefore often require support not to start from scratch but to amend and strengthen existing frameworks to support effective agricultural development and progress in achieving food security. In many cases existing frameworks may not sufficiently include multi-sectoral approaches to food security, and a common vision of priority investments is also missing. Frameworks may vary substantially from one country to another, but working within and strengthening country frameworks has to be the basis for FAO's support, alignment, improvement and programming work.

17. For the implementation of development programs, regions and countries have put in place tools to enhance their country owned, coordinated and inclusive actions in support to agricultural development. A concrete example of how the evolution of the international agreements has been mirrored at the program

level is the Comprehensive Africa Agriculture Development Program (CAADP) of the African Union. A program under the New Partnership for African Development (NEPAD), it was endorsed by African Heads of State in 2003 as a common framework, tool and process for the restoration of African agriculture in pursuit of MDG 1. Although a continental program, the main thrust of implementation is at the country level. Quality investment plans are the key mechanism for national CAADP implementation. Initially, CAADP was seen as predominantly a government affair. Over recent years, countries and development partners have recognised the importance to strengthen the participation of non-state-actors (NSA) in CAADP processes. These are in particular producer organisations and the wider private sector, and civil society organisations. Building stronger CAADP Country Teams which include representatives from various stakeholder groups has become a focus in CAADP country support, in particular by some Regional Economic Communities (RECs). A *Grow Africa* Initiative has been launched by the African Union and NEPAD in partnership with the World Economic Forum (WEF). Its goal is to strengthen collaboration with the private sector in CAADP and promote public-private partnerships for investments. The CAADP Mutual Accountability Framework which provides concrete accountability mechanisms at the continental programme as well as the country level was adopted in 2011.

18. **Institutional capacity development in planning and policy design and implementation is of primary importance.** Country-owned development programs have made evident the need for institutional capacities to perform the necessary planning activities and the design and implementation of policies and normative frameworks that are needed to attain the desired development objectives.

19. A third area of growing importance to the development context is the increasing level of decentralization of centrally-managed, command and control structures and the transfer of management responsibilities, based on the principles of subsidiarity, or moving decision-making and implementation processes closer to the primary stakeholder or beneficiary. These tendencies are evident at country level, and in international organizations. A number of countries have decentralized the responsibility for primary education and health services to the provinces and/or states. These new responsibilities have exposed the need for strengthened institutional capacity to design, develop and administer new implementation modalities and manage new responsibilities.³⁰

Implications of the Trend

20. Governance, as a means to manage resources and respond to cross-cutting issues, guide the processes by which decisions are made and implemented, and reconcile conflicting interests has direct implications for all of FAO's work from the local, small-scale producer through to the national, regional and global levels. For many sectors in food and agriculture, there is a gradual movement away from top down, command and control approaches towards more participatory, stakeholder driven and market-based approaches. Gradually changing modalities of governance are shifting towards increasingly participatory and decentralized processes and the heightened focus on national priorities. Yet, the nature of current global challenges are cross-cutting, transcend national and regional boundaries and are increasingly placed within the context of calls for increased multi-stakeholder and intergovernmental platforms to achieve global consensus.

21. The observed trend is likely to: a) change the demands that countries place on FAO, b) redefine FAO's comparative advantages and major strengths and c) create the need to revisit the basic organizational and managerial structures in FAO to adjust to the new conditions.

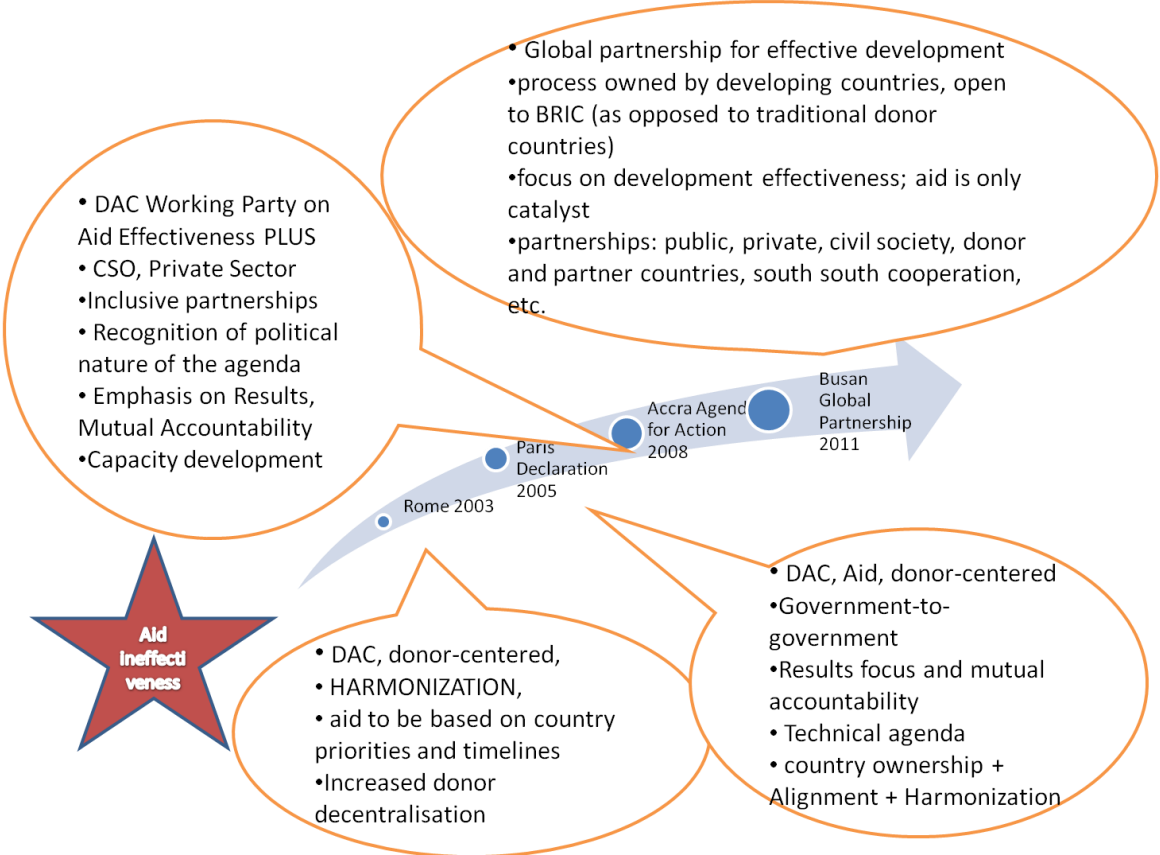
22. Some possible potential consequences of this evolving scenario are:

1. FAO should enhance its support to existing country and regionally owned processes and frameworks. This would increase FAO impact at country level; FAO should support countries' efforts to own, coordinate and organize their food and agricultural policies and actions, through aligning itself to country processes, be a catalyst for their effective implementation and strengthen national institutions involved;

30 One of the key priorities of FAO as part of its renewal process is to accelerate its own decentralization, recognizing that FAO needs to enhance how it translates global normative and standard-setting work in ways to help support country-led and identified priorities. The finalization of the FAO approach to decentralization and its associated strategy is currently underway.

2. It should do it in partnership with other stakeholders (other UN agencies, civil society, private sector, other DPs) in the context of on-going initiatives (sections 1 and 2) by defining its best contributions and roles complementary to the roles of others;
3. FAO Representatives can become key facilitators at country level. All FAORs would need/deserve further capacity development support to fulfill this type of role;
4. To ensure effective ownership, FAO must focus its assistance at country level on providing capacity development support to increase countries' ability to lead, prepare, implement and evaluate, effective national policies, strategies and investment plans and programs;
5. FAO should provide practical guidance and capacity development in support of policy, strategy, investment and program development level, to assist countries to incorporate key strategic considerations related to agriculture and food security at the outset, bringing FAO's technical knowledge to bear at the strategic level;
6. FAO needs to strengthen capacity not only of government staff but also of key civil society stakeholders and producer organizations to allow them to become effective collaborators in national strategy and program design and implementation, i.e. enabling inclusive development actions. FAO must strengthen its dialogue and consultation with the private sector, farmers organizations, NGOs at national and international levels and promote partnerships where appropriate;
7. FAO should further engage in the global processes and bring global insights to bear on its country support and country work;
8. FAO should assist countries in establishing sound, inclusive and coherent governance systems for agriculture and food/nutrition security from the local level to the national and global level;
9. FAO should support resource mobilization at the national level in support of country programs, rather than stand alone FAO projects, and this should be done by assisting agricultural/food security stakeholders at country level to mobilize resources for agriculture and food/nutrition security, including from the national budget through Ministry of Finance and development partners.
10. FAO should find new ways to anticipate and accommodate what may be a continued upward trend in calls for global governance mechanisms that are focused on finding ways to address a growing number of stakeholders from a wider variety of sectors.
11. FAO may be called upon to play an increasingly substantive role in the implementation and monitoring of global governance mechanisms/guidelines, thus, it needs to be prepared to significantly scale up its capacity to understand its potential monitoring role and capacity to use an evidence base derived across and through a wider variety of disciplines to assist countries in the achievement of their national priorities.

Figure 1: From Aid Effectiveness to Development Effectiveness: Evolving Commitments in the High Level Fora



TREND 10: INCREASED VULNERABILITY DUE TO NATURAL AND MAN-MADE DISASTERS AND CRISIS

1. The multiple threats to food and nutrition security, their negative and cumulative impact, and the clear links between shocks and hunger reveal the fragility of current food production systems and their vulnerability to disasters, crisis and conflicts.
2. Disasters have adversely affected the lives and livelihoods of millions over the past years with particular deleterious consequences for the poor and politically marginalized.. The impacts of the catastrophic earthquake in Haiti in January 2010 and floods in Pakistan in July 2010 show how disaster risk and poverty are closely interlinked. The 2011 Horn of Africa drought crisis also stresses the inter-connection between natural disaster and conflict situations, magnifying the impact of the drought. Meanwhile, in 2011, floods in Australia, the earthquake in Christchurch, New Zealand, and the earthquake, tsunami and nuclear disaster wreaking havoc in north-eastern Japan are a stark reminder that developed countries are also very exposed. Less visible internationally, hundreds of smaller disasters associated with climate variability have caused enormous damage in Benin, Brazil, Colombia, the Philippines, Indonesia and other countries. These events reveal how risks are continuously constructed through existing development gaps and growth in economic and population exposure. Moreover, as the Japan disaster highlighted, there are emerging risks and new vulnerabilities associated with the complexity and interdependency of the technological and ecological systems on which modern societies depend. Large scale or mega-disasters with interactions between physical and technological hazards and the exposure of countries to a wide range of emerging risks and new patterns of vulnerability can trigger cascading and concatenated system breakdowns at different scale which are difficult to model or to prepare for, but which can exponentially magnify negative impacts and affect multiple countries or regions or even the planet³¹.
3. The vast majority of damages, losses and impacts are extensive in character, occurring throughout a country's territory. A rising number of localized disasters, are responsible for significant impact on human and natural resources such as housing, crops, livestock and local infrastructure, and particularly affect low-income households and communities³². The past 20 years have seen an exponential increase in the number of local areas reporting losses (see figure below). Increasing extensive risks is closely related to the challenges low- and medium-income countries face in addressing underlying risk drivers and reducing vulnerability. Most governments have yet to find effective ways of reducing and managing natural and man-made disaster risks.
4. Assumptions about disasters are being increasingly challenged, as new drivers of risk emerge and interact. A number of potential and plausible risks are difficult to identify or have profound potential consequences, that it is difficult to find an entry point for risk modeling and analysis³³. There may be no precedent for the emerging risks associated with low probability hazards as research reveals the increasingly complex vulnerabilities related to the growing interconnection and interdependency of societies. The risks associated with increased incidence and spread to new geographic areas of transboundary plant pest and animal diseases, also loom ahead³⁴. As such, there is a growing probability

³¹ Extracted from UNISDR 2011 Global Assessment Report on Disaster Risk Reduction. This second edition of the United Nations Global Assessment Report on Disaster Risk Reduction provides a current resource for understanding and analyzing global disaster risk. Drawing on a large volume of new and enhanced data, it explores trends and patterns in disaster risk globally, regionally and nationally. In parallel, more than 130 governments are engaged in self-assessments of their progress in implementing the Hyogo Framework for Action (HFA), contributing to what is now the most complete global overview of national efforts to reduce disaster risk.

³²FAO in its "save and grow" policy guidance indicates that about 2.5 billion of small holders are particularly at risk with vulnerable livelihoods.

³³ Between 1601 and 1603 Russia suffered the worst famine in the country's history. It is estimated that over two million people starved to death in Russia as a whole. It was only recently, however, that climate researchers established a conclusive link between the failure of harvests in Russia in 1601 and the ash cloud produced by the catastrophic explosion of the Huaynaputina Volcano in southern Peru on 19 February 1600.

³⁴ As seen with the bird flu-H5N1 and H1N1 pandemics.

of ‘simultaneous crisis’ where different hazards/shocks occur at the same time, ‘sequential crisis’ where hazards trigger cascading disasters in a range of interlocked systems, and ‘synchronous failures’ (i.e. the March 2011 Japan earthquake-tsunami-nuclear crisis) where different risks converge and interact.

5. Countries with weak governance, political instability or in conflict (complex emergencies or protracted crisis) are likely to find it difficult to address underlying conflict and disaster risk drivers (i.e. degradation of hazard-regulating ecosystems such as wetlands, mangroves and forests, high levels of poverty and political/economic marginalization, badly managed urban and regional development, etc.). Extreme hazards and events are not synonymous with extreme risks. When similar numbers of people are affected by hazards of similar severity, wealthier and poorer countries generally experience radically different losses and impacts. Poverty is both a cause and consequence of disaster risk³⁵. Across all the major hazards, poorer countries with weaker governance³⁶ tend to experience higher mortality and greater relative economic loss compared to wealthier countries with stronger governance. Mortality risk, for example, is approximately 225 times greater in low-income countries compared to OECD countries, when similar numbers of people are exposed to tropical cyclones of the same severity³⁷. Whereas relative wealth is a key determinant, governance factors such as the strength of democracy and voice and accountability, all play roles in the social construction of risk. The quality of a country’s governance appears to have a significant influence on the underlying drivers of risk. Risk drivers and increasing poverty and inequality, interact through multiple feedback loops and together translate hazards into disaster risk. Mortality is still rising in the countries with the weakest risk governance capacities, affecting particularly women and children.

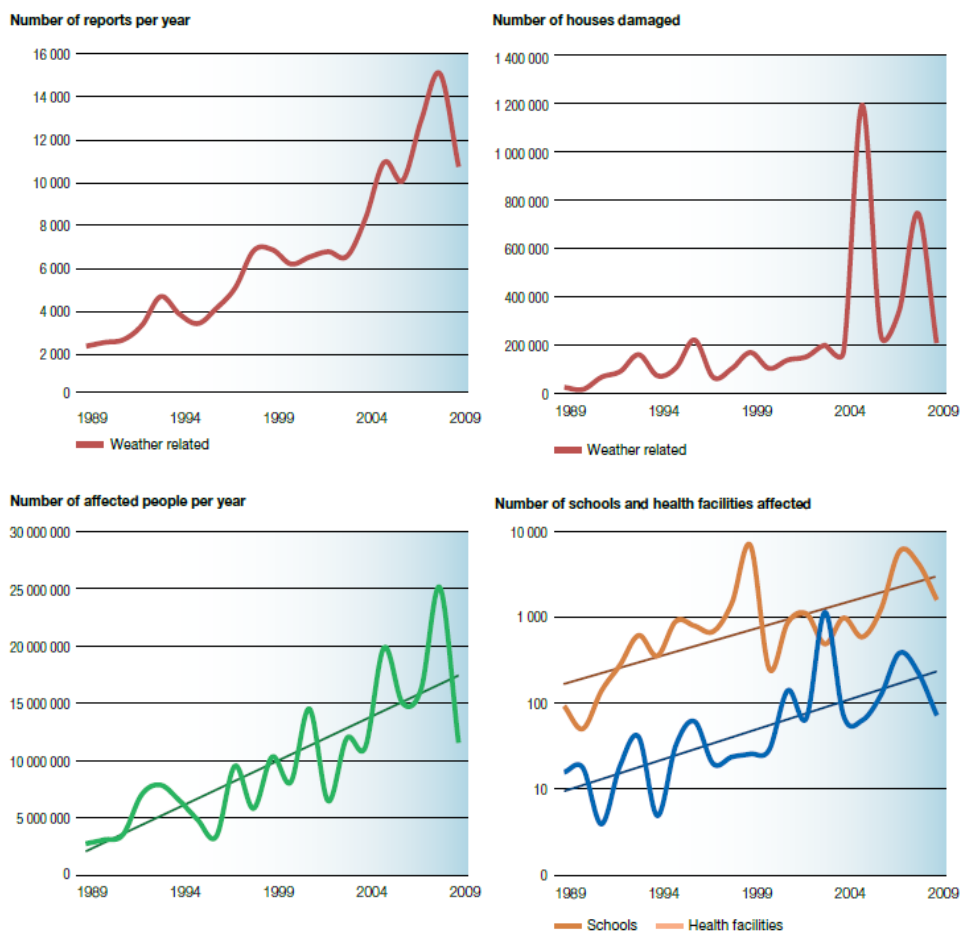
6. As with disaster and crisis risk management in general, the additional challenge of adapting to climate extremes/change requires increased attention to underlying conflict and disaster risk drivers, reducing vulnerability, and strengthening risk governance capacities. If disaster risks can be reduced, then the magnifying effect of climate change will also be reduced and adaptation will be facilitated. Short, medium and long term humanitarian and development policies/strategies/programmes and actions must urgently be redefined to take into account and reduce the various and interconnected risks to reach millions of risk-prone citizens. Future investment must be guided by the dual principles of both promoting prosperity and peace.

³⁵ Extracted from UNISDR 2009 Global Assessment Report (GAR).

³⁶ Governance refers to the actions, processes, traditions and institutions by which authority is exercised and decisions are taken and implemented.

³⁷ Extracted from UNISDR 2011 GAR.

Figure: Extensive risk trends by indicator (for the 21 countries and states included in the GAR11 analysis)



7. The alleviation of hunger and poverty is strongly correlated with disaster risk reduction (DRR). The Millennium Development Goal 1 strives to eradicate extreme poverty and hunger, and aims to halve by 2015 the proportion of people who suffer from hunger³⁸. The World Food Summit goal is to reduce, by 2015, the number of undernourished people by half. Yet these targets are compromised by natural disasters, protracted crises and armed conflicts that reverse development and poverty-reduction gains, destroy livelihoods, reduce food production and increase hunger. Worldwide, there are 925 million undernourished people, and hungry people account for 16 percent of developing countries' populations.³⁹

8. Floods, hurricanes, tsunamis and other hazards destroy agricultural infrastructure and assets, crops, inputs and production capacity. Drought alone has caused more deaths during the last century than any other physical hazard. Asia and Africa rank first among continents in the number of people directly affected, while Africa has a high concentration of deaths associated with drought⁴⁰. These natural hazards have a direct impact on agriculture and food security. They interrupt market access, trade and food supply to the cities. They reduce income, deplete savings, and erode livelihoods. They also have a negative consequence for animal production by reducing range productivity and rangeland yields, leading to food insecurity, overgrazing and degradation of ecosystems. Livestock is central to the livelihoods of the poor. It forms an integral part of mixed farming systems. It is an important source of employment, income, quality food, fuel, draught power and fertilizer.

9. Fisheries and aquaculture, a sector that is a critical contributor to food supply, income generation and food security, also suffers tangible losses as a result of natural disasters, including damage to fishing infrastructure and productive assets such as docks, landing and processing facilities, boats and fishing

³⁸ Millennium Development Goal, target 1C

³⁹ The State of Food Insecurity in the World. 2010. FAO, WFP.

⁴⁰ Global Assessment Report on Disaster Risk Reduction. 2011. UNUNISDR.

gear. In addition, diseases threaten fish and contribute to food and nutrition insecurity among rural populations dependent on fish farming. Over 500 million people depend, directly or indirectly, on fisheries and aquaculture for their livelihoods. Fish also provides essential nutrition to three billion people, including at least 50 percent of the animal protein and essential mineral intake of 400 million people in the poorest countries. New transboundary aquatic animal diseases continue to appear, causing losses in aquaculture and capture fisheries and adversely affecting local economies. For example, in 2009, fish stock in the Zambezi River Valley was infected by Epizootic Ulcerative Syndrome, threatening to spread the disease to seven countries surrounding the river basin and potentially affecting the food security and livelihoods of 32 million people.

10. Transboundary plant pests and diseases, such as locusts, armyworms and wheat rust, and transboundary animal diseases such as African swine fever, foot-and-mouth disease and Rift Valley fever, have a direct economic impact by reducing or eliminating agricultural and livestock production. Furthermore, pests and diseases may adversely affect prices and trade, negatively affecting farm income. Reduced productivity of crops or animals can have a long-lasting effect as well. Pest infestations can impair fertilization rates or seed recovery. Diseases can have lasting effects on livestock output by delaying reproduction, leading to a reduced population and extended food and nutrition insecurity.

11. Wildfires in forests and other natural resources also affect rural livelihoods. An estimated 150 to 250 million hectares of tropical forests are affected by wildfire annually. Close to 1.6 billion people – more than 25 percent of the world’s population – rely on forest resources for their livelihoods and most of them (1.2 billion) use trees on farms to generate food and cash. Moreover, many countries in the developing world draw on fuel wood to meet as much as 90 percent of energy requirements and this creates additional energy risks.

12. The natural resources degradation or environmental factor: as highlighted by the United Nations International Strategy for Disaster Reduction, “the environment and disasters are inherently linked” because of the strong dependency and interconnectedness of natural resources with the environment⁴¹. Deforestation, degradation of catchments/watersheds, degradation of land and desertification, depletion of reefs and coastal ecosystems especially of corals and mangroves, among other factors, reduce nature’s defense capacity against hazards and aggravate the impact of disasters such as floods, landslides, storm surges, hurricanes and drought. Disasters in turn contribute to ecosystem degradation and loss, including increased soil erosion, declining rangeland quality, salinization of soils, and biodiversity loss. Increasing environmental degradation reduces the availability of goods and services to local communities, shrinks economic opportunities and livelihood options, and ultimately contributes to greater food insecurity and hunger. It further drives increasing numbers of people to marginal lands and fragile environments.

13. Water scarcity, projected to increase worldwide even without climate change, is also intricately linked to disaster risks and food insecurity. The exploitation of subterranean water reserves, for example, is contributing to desertification in many parts of the world; as subterranean water levels recede, the soil near the surface dries out and plants wither and die. With continued deforestation and exploitation of subterranean water reserves it is likely that many more parts of the world will face severe water shortages. Agriculture accounts for more than 70 percent of the world’s total water use. Irrigation is a direct source of livelihood for hundreds of millions of the rural poor in developing countries. As farmers face the challenge of accessing an increasingly scarce resource, groundwater levels continue falling each year, causing more rivers to dry up. In arid and semi-arid regions water scarcity is almost endemic, placing greater pressure on both surface and groundwater resources to meet domestic and irrigation demands. Drought is another major cause of water shortage with devastating impacts, especially in countries with reduced capacity to absorb the shocks. Prolonged or frequent drought episodes can lead to the irreversible stage of desertification unless adequate measures are taken to increase the resilience of countries prone to such phenomena. DRR efforts need to support enhanced management and conservation of water resources. This includes improved capture and utilization of rainfall, such as rainwater harvesting, and the adoption of water conservation technologies and practices that use less water and reduce water loss, such as using drip and furrow irrigation to increase water productivity.

⁴¹ *Living with Risk: a Global Review of Disaster Reduction Initiatives*. United Nations International Strategy for Disaster Reduction. 2004

14. To reduce risks, it is vital to build the resilience of the natural resource base, and to promote sound environmental and natural resource management practices and the sustainable use of ecosystems. Healthy and diverse ecosystems are more resilient to hazards. Forests are estimated to save between USD 2–3.5 billion per year equivalent in disaster damage restoration of key forest ecosystems⁴². They can be used as shelterbelts and windbreaks, and also play an important role in protecting against landslides, floods and avalanches. Trees stabilize riverbanks and mitigate soil erosion, while woodlots provide fuel wood, timber and fodder. Wetlands serve to store water, provide storm protection, flood mitigation, shoreline stabilization and erosion control. Barrier reefs, barrier islands and mangroves can help mitigate hurricane risk, storms and tidal surges. Getting the right energy source and technology can play a significant role in managing the environment in support of risk reduction, such as in the productive use of land (e.g. liquid fertilizer from biogas) and/or by reducing deforestation through the use of improved or non wood-dependent cook stoves.

15. Inadequate land-use planning and tenure contributes to increasing the vulnerability of communities exposed to hazards. Land zoning and land-use management, including regional and territorial planning, need to consider the spatial parameters of physical vulnerability based on hazard and risk mapping. Better land access and secure tenure enable food production and provide an incentive for landholders to invest in improving their land with soil protection measures, tree planting, improved pastures, water conservation technologies or sustainable crop production.

The effective management of land, water systems, forests, wetlands, soils, and other resources is necessary for redressing the root causes and environmental drivers of vulnerability and risks, especially for food and nutrition security.

16. The incidence of food crises, which are caused by severe adverse weather conditions, natural hazards, economic shocks, conflicts, or a combination of these factors, has been rising since the early 1980s. There have been between 50 and 65 food emergencies every year since 2000, up from 25 to 45 during the 1990s⁴³.

17. Economic crises constitute yet another threat that impacts on poverty and hunger. The past two years have witnessed a rapid increase in the number of hungry, largely influenced by the global food and fuel crisis. A similar pattern was observed between 2003 and 2005 and in 2007–2008, with high food prices followed by a rapid increase in chronic hunger. In 2008, 75 million people were added to the total number of undernourished relative to 2003–2005⁴⁴. World food prices surged to a new historic peak in February 2011 and these high prices are expected to persist in the future. These crises create poverty traps and increase the prevalence of food insecurity and malnutrition by reducing real income and forcing the poor to sell their valuable assets, decrease their food consumption and reduce their dietary diversity. The impact is strongly felt in low-income, food-deficit countries that may face problems in financing food imports, and for poor households that spend a large share of their income on food. The urban poor are particularly affected by soaring food prices. They do not produce food but rather invest the bulk of their income on food expenditures and have no alternative access to food other than local markets.

18. Countries in protracted crisis situations, which are characterized by recurrent natural disasters and/or conflict, longevity of food crises, breakdown of livelihoods and insufficient institutional capacity to react to the crises, show high levels of food insecurity. On average, the proportion of people who are undernourished is almost three times as high in countries in protracted crisis as in other developing countries⁴⁵. The level of undernourishment in this set of represent 166 million people, roughly 20 percent of the world's undernourished people (or more than a third of the global total if China and India are excluded). In countries in protracted crises the Millennium Development Goal 1 and the World Food Summit goal are very unlikely to be met by 2015. These poor food security outcomes are long-lasting and are closely related to recurrent natural disasters and/or conflict, the number of years in crisis, the breakdown of livelihoods, weak governance or public administration and most importantly the overall

⁴² *Environmental Guidance Note for Disaster Risk Reduction: Healthy Ecosystems for Human Security*. IUCN, United Nations International Strategy for Disaster Reduction. 2009

⁴³ *The State of Food Insecurity in the World*. 2008. FAO

⁴⁴ *The State of Food Insecurity in the World*. 2008. FAO

⁴⁵ *Ibid.*

insufficient capacity to react to the crises (in some of these countries crises are localized to only certain areas or regions)⁴⁶. Development and investments that generate or exacerbate inequalities or deepens exclusion can increase the risks of conflicts.

19. In conclusion, food and agriculture sectoral strategic guidance is needed to help countries to comply with the Hyogo Framework for Action (HFA) and to reduce and manage multi-hazards and various risks magnifying vulnerabilities to food and nutrition insecurity (especially for the poorest). At global, regional, national and local levels, coherent interventions and systems are needed to build, prevent, protect and restore resilient livelihoods of farmers, herders, fishers, foresters and other vulnerable groups (estimated to more than 2,5 billion small holders according to FAO “Save and Grow”) against various threats and shocks. Crisis and Disaster risk reduction and management for food and nutrition security is vital for ensuring one of the most basic human rights – “the right to food and freedom from hunger”. At all levels, correlated or nested governance, information and early warning, preparedness and crisis response systems or mechanisms for DRR for agriculture and food and nutrition security related sectors should be urgently developed to face the hunger and poverty challenges ahead.

⁴⁶ Extracted from “Addressing Food Crises - Towards the Elaboration of an Agenda for Action in Food Security in Countries in Protracted Crisis, High-Level Expert Forum (HLEF), Introduction –setting the context of 36th CFS recommendations on further analysis and actions on food security in protracted crisis. SOFI 2010 report.