BOLOGNA, SEPTEMBER 2007

EUROPEAN AGRICULTURE OF THE FUTURE

THE ROLE OF PLANT PROTECTION PRODUCTS

Nomisma

NOMISMA – Società di studi
economici S.p.A.
Palazzo Davia Bargellini
Strada Maggiore, 44
40125 Bologna
tel +39-051.6483149
fax +39-051.6483155
www.nomisma.it

Founded in 1981 and located in Bologna, Nomisma is an economic research institute with more than 80 shareholders, including industrial groups, insurance companies, and Italian and foreign banks. "Nomisma" is an ancient Greek word that signifies "the real value of things": it is in this spirit that Nomisma operates as an observatory on the main trends in the real economy and contemporary society. Nomisma engages in research at international, national and local levels focused on production factors, on the economics of sectors and businesses, on development problems and – in general – on the trends that affect the structure, the behaviour and outcomes of contemporary economics.

The study was undertaken following requests from various companies and organisations operating in the agri-food sector to provide a scientific evaluation of the potential impact on European agriculture resulting from the proposed new regulations on market access and use of crop protection products. The study benefited from various contributions and sponsorship from Bayer Crop Science and Syngenta.

PROJECT STAFF
ERSILIA DI TULLIO
(PROJECT LEADER)

STEFANO BALDI
PAOLO BONO
JULIA CULVER
ROMINA FILIPPINI
ENRICA GENTILE
PIERA MAGNATTI
DOMENICO PIPIA
MASSIMO SPIGOLA
ANDREA ZAGHI

INTRODUCTION

Agriculture is characterised by several peculiarities that make it unique in comparison with other production sectors. First of all, using land as a primary factor of production leads agriculture to closely interact with the surrounding environment and also play an active role in its management. For this reason, agriculture represents the main economic resource in rural areas, guaranteeing the preservation of the territory, providing employment and functioning as an important instrument in counteracting the depopulation of rural areas.

In strictly economic terms, agriculture enjoys intrinsic links and synergies not only with the food industry and non-food production (agricultural inputs for pharmaceuticals/new materials, bio-energy/bio-fuels, forestry, etc.), but also with the agricultural input industry (machinery, plant protection, fertilisers, seeds, feed, etc.) and the other economic sectors (wholesale and retail trade, services to companies, financial activities and transport, tourism, etc.). Agriculture, in fact, represents a system that is intimately connected to a variety of activities, so that any change to any link in the value chain has repercussions throughout the whole complex of relationships.

Agriculture has a particularly strong link with the food industry; thus, in this study attention will be focused on the Agri-food sector in general, representing the aggregated whole of agriculture and food. The consequent synergies between agriculture and food guarantee quality and control over production processes and final products – representing one of the main strengths of the European production model.

The main goal of this study is to define the importance of the European Agri-food sector within the socio-economic context of the European Union in a global perspective characterised by rapidly changing factors (world demographic dynamics, economic growth of emerging countries, progressive liberalisation of markets, increased attention to health and environmental issues) and to identify possible scenarios for the sector as a result of modifications to the legal and normative framework for plant protection products (PPPs). The European Parliament is currently discussing changes (revision of Dir. 91/414/EC) to the system regulating the commercialisation of PPPs, products used in agriculture to manage pests, diseases and weeds. PPPs play a crucial role in the competitiveness and long-term viability of farming and the Agri-food sector in Europe.

The study will examine the strategic role of agriculture and the Agri-food sector in general and of plant protection products in particular as a field of innovation within the context of the Lisbon Strategy to transform Europe into the "most competitive knowledge-based economy" by 2010.

If approved in their current form, or as revisions currently being discussed in the European Parliament, the modifications to PPP market-access regulations will generate significant impacts not only on the European agrochemical sector, but also will lead to important changes in the European Agri-food system. The objective of this document is to highlight these dynamics and to provide an informed contribution to the current debate.

This report presents the most important considerations that have emerged from the analysis of the European Agri-food sector and the main trends and factors that affect its development. The analysis represents a preliminary contribution to the development of a more detailed study, coherent with the above-mentioned goal, which will be presented at the end of the year.

INDEX

1 THE DEVELOPMENT OF THE EUROPEAN AGRI-FOOD MODEL AND THE ROLE OF THE CAP

In order to understand the complex relationship and the value of the agricultural sector in the European socio-economic system, it is necessary to outline the evolution of agricultural policy. In 1958 the Treaty of Rome went into effect, formally marking the beginning of a united Europe in a process leading to the progressive integration of 27 countries – including some important parts of the ex-Soviet Bloc – over a period of a half a century. The same period saw the launching of the Common Agricultural Policy (CAP), which today remains the principal and most durable integration experience of the economic policy actions of the united Europe.

For rural Europe in the early 1950s, the objectives of the CAP were mainly aimed at increasing agricultural productivity in order to guarantee food self-sufficiency and providing income support for rural populations in response to post-war food shortages. Over the course of successive years, rising productivity linked to technological innovation and strong support from the CAP allowed achieving and exceeding these objectives. Yet the rigid system of CAP regulations also generated serious distortions in the market and permanent surpluses in major farm commodities (for example, beef, cereals and butter). When the increases in stocks became excessive or it was not possible to export them, despite high subsidies, these surpluses were even destroyed. In order to also guarantee subsidies to farmers, the cost of the CAP became particularly burdensome: from the end of the 1970s to the beginning of the 1990s, the budget quintupled, accounting for more than 50% of the overall EC budget.

Within this context, new orientations – both external and internal to the EU – began to emerge, contributing to a change in direction of the CAP. On the one hand, within the General Agreement on Tariffs and Trade (GATT), the future World Trade Organization (WTO), there were mounting pressures on the EU to liberalise markets and reduce the level of support to agriculture as requested by developing countries. At the same time, the necessity to reign in the growth of the CAP budget and increased attention to environmental sustainability, food quality and security, and animal welfare led to the revision of the support system.

Consequently, at the beginning of the 1990s, Europe considered new priorities for the CAP and, through a series of important reforms (Mc Sharry, Agenda 2000, Mid term Review), established the foundations for the development of a new European agricultural model. While the new focus remained principally on major issues linked to the competitiveness of the European agricultural system, progressively more attention was being devoted to the multifunctionality of agriculture and rural development (food quality and safety, protection of the environment and rural areas, sustainability of agricultural activities and animal welfare).

The latest CAP Reform of 2003 confirms and expands on this approach and imposes a reduction in the financial resources destined for the CAP through 2013. In fact, the Mid-term Review reoriented the incentive system for the agricultural sector by

BOX 1 | **THE MID-TERM REVIEW (FISCHLER REFORM)**

The Fischler Reform was implemented in 2003 and entered into force in the period 2007–2013. With the latest agricultural reform, the European authorities have addressed the above-mentioned issues by introducing several new instruments. Certainly, the most important of these is the single farm payment independent of production level (decoupling), which will likely make farmers more competitive and market-oriented than in the past. In addition, a very significant role has been assigned to the issue of "cross-compliance": support payments will be linked to the respect of environmental, food safety, animal and plant health and animal welfare standards, as well as the requirement to maintain farmland in good agricultural and environmental condition.

In the same time, agricultural support to market measures has been reduced, even though a share of direct payments (modulation) has been redirected to rural development, which in the European Commission's strategy will gain increasing importance over the next few years. Among the main drivers of the progressive strengthening of rural development policy are the increasing policy requirements, as voiced by European citizens, for attention to issues such as food quality and safety, environment, animal welfare, etc. and to make agricultural support compatible with international requirements defined by the WTO to avoid distorting international trade.

A "CAP Health-Check", scheduled for 2008, will evaluate the effects of the Reform and may introduce further innovations, whereas in 2013 new major changes to the system of agricultural support and a redefinition of the budget are expected.

separating the allocation of support from production (decoupling). This new support system is contributing to a reorientation of European agricultural production toward the market and is providing incentives for the development of multifunctionality, due to increasing attention dedicated to rural development policies.

This policy shift is coherent with the desires of European citizens: in the latest Eurobarometer (2007) – a tool used by the Commission to monitor European public opinion – almost nine of every ten respondents recognised the importance of European Agriculture and Rural Areas. European consumers mainly expect farmers to play a role linked to ensuring food supply and safety; but after this concern, consumers also feel that farmers should protect the environment and animal welfare, coupled with the requirement to produce a variety of quality food products. Finally, farmers are regarded as having a role in guaranteeing good living conditions for rural populations and maintaining economic activities in rural areas, in addition to ensuring food self-sufficiency and non-food production.

These main issues are also the general axes that will guide the evolution of the new European model of agriculture, endowing it with a strategic role in the European socio-economic framework of the future.

TABLE 1 | **EU-25: ROLE OF FARMERS IN THE SOCIETY**

IN YOUR OPINION, WHICH SHOULD BE THE 2 MAIN RESPONSIBILITIES OF FARMERS IN OUR SOCIETY?	
Supplying the population with healthy and safe food	55%
Protecting the environment	29%
Supplying the population with a diversity of quality products	22%
Ensuring the welfare of farm animals	21%
Favouring and improving life in the countryside	15%
Maintaining economic activity and employment in rural areas	14%
Ensuring the food self-sufficiency of the EU	9%
Supplying alternative energy sources such as bio fuel and non food agricultural products	6%
Don't know	12%

Source: Special Eurobarometer 276 (2007).

2 CHANGES AFFECTING AGRI-FOOD SECTOR DEVELOPMENT OVER THE MEDIUM TO LONG TERM

Agriculture and the food industry are sectors characterised by a high level of integration: production and transformation of primary agricultural resources are intrinsically linked. These synergies guarantee quality and control over production processes and final products – representing one of the main strengths of the European production model. Moreover, this high level of integration deeply influences the quality of the final products and the overall competitiveness of the food chains. Therefore, in this study the term Agri-food is considered to comprise the aggregation of all branches of agriculture and the food industry (including drinks and beverages).

Over the next few years, the European Agri-food sector will face new challenges associated with different drivers that characterise the evolution of the European and global scenario. First of all, stimuli will come from European policies that are specific to the sector and have cross-cutting effects throughout the EU-27, as well as from developments in international agreements, particularly decisions made by the World Trade Organization (WTO).

Further challenges are expected from shifts in the global balance of supply and demand for agricultural and food products due to the new role played by emerging economies. Within the European Union itself, changing expectations and behaviour of citizens/consumers with regard to the quality of life, preservation of the territory, and consumption of food products will play an important role in shaping the context for Agri-food development. Finally, increasingly interlinked environmental challenges (for example, climate change, biodiversity conservation, etc.) require adaptation to maintain the sustainable development path undertaken, including increased utilisation of bio-energies, with important consequences for agricultural production.

TRADE LIBERALISATION AND AGRI-FOOD SECTOR

Over the next few years, the European Agri-food sector will be affected by many relevant drivers associated with trade liberalisation and market globalisation. The main issue of concern is the multilateral negotiations of the World Trade Organization (WTO), the successor to the General Agreement on Tariffs and Trade (GATT) created in 1947. Over 60 years, many achievements have been made in terms of trade flow liberalisation in all economic sectors. While agricultural and food trade had been essentially excluded from the negotiations until 1994, with the Uruguay Round some liberalisation was introduced. Further liberalisation in agricultural and food trade is the main objective of the current negotiations, the Doha Development Agenda (DDA) launched in 2001 in Doha, Qatar; however, the talks are proceeding very slowly.

The current debate is between two opposing positions: that of the industrialized countries (EU and USA above all), which seek to continue supporting their farmers with financial assistance and import tariffs on external agricultural products, and, on the other hand, the developing countries and emerging economies (Brazil, China, India, etc.). The latter countries seek to achieve greater liberalisation of world agricultural trade in order to gain larger market shares by exploiting their competitive advantages, such as cheaper labour, availability of land and larger average farm size, depending on the particular country.

It is still uncertain if these talks will achieve a positive outcome; for this reason and given the great success of the "European Union" model, many countries also have adopted a "second best" strategy, which calls for the implementation of free trade agreements among two or more nations (i.e. NAFTA, Mercosur, Andean Community, ASEAN, etc.).

The EU, aware of the fact that agricultural trade is extremely important for developing countries, has committed itself to various bilateral agreements or negotiations involving groups of these countries: "Everything But Arms" (EBA), African, Caribbean and Pacific (ACP) countries, Euromed,

Mercosur, and Balkans. At the same time, several trade protection instruments, such as anti-dumping measures and other non-tariff barriers, have been implemented in order to enforce respect for European standards of food safety or fundamental workers' rights.

Over the long term, however, it is expected that there will be a substantial liberalisation of agricultural trade flows, with two likely effects on EU agriculture (Nowicki et al., 2007):

1. The first important consequence will be a restructuring of the sector, with a decline in the number of farms and a decrease in agricultural labour, accompanied by an increase in competitiveness of farmers who are able to ride the market – these farms will likely experience a marked increase in average size;
2. A second effect will be a reduction in overall agricultural output, since several extra-EU commodities will be more competitive than those from the EU.

The European food industry will probably be able to adapt to the challenges of future trade liberalisation – at least over the next few years – due to easier access to raw materials, both internal and external, and the presence of many European multinational corporations and large companies in the sector. Yet because of the restructuring of the agricultural sector, as mentioned above, European farmers may find it more difficult to respond to these changes in market conditions.

Whatever the outcome of multilateral or bilateral negotiations, it is clear that the volume of international agricultural and food trade will continue to increase over the next few years, as it has happened over the past two decades. Indeed, in the period 1985–2005 global trade in agricultural products and food has more than tripled (in terms of US dollars at current prices, WTO); over the last decade for which data is available (1995–2005) world trade in agriculture products and food has increased by 45% and 51%, respectively. Consequently, there will also be growing market opportunities: the partial homogenization of consumer tastes, coupled with the increased purchasing power of consumers in emerging economies, will contribute to a progressive expansion of the market for high value-added products that are characteristic of the European productive system.

DEMOGRAPHIC, INCOME AND FOOD CONSUMPTION TRENDS: THE IMPORTANCE OF EMERGING ECONOMIES

Recent trends have shown an increase in demand for food in general and for higher value added products in particular. Population growth and rising incomes in various areas of the world are fuelling this development. The United Nations projected that world population would reach around 8.2 billion by 2030 (UN, 2005 revision). Recent estimates for 2006 indicated a world population of 6.5 billion people, which is expected to grow at a rate of more than 1% annually through 2016 (OECD-FAO, 2007). Most of the growth will occur in developing countries – with the highest growth rates in Africa and Latin America; however, given its huge share of world population (63.5%), Asia's 0.98% annual growth rate will account for the largest absolute increase in population. In most regions, income is expected to expand at higher rates than in the previous period, except in Europe and Oceania – largely reflecting the maturity of the major economies in the respective regions. While Africa accounts for the highest income as well as population growth rates, the continent accounted for only 1.8% of global income but 14% of the population in 2006. Asia is the most populous region in the world and is experiencing growing prosperity, as income is projected to increase by more than 4% annually through 2016. Increased purchasing power in developing countries will translate into new markets for European food and beverages – with most of the market expansion occurring in Asia.

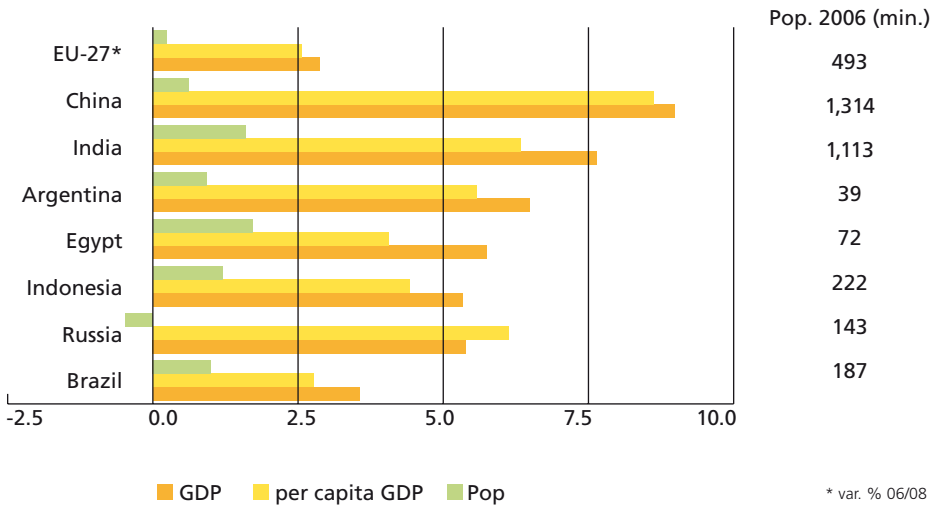
TABLE 2 | **ESTIMATES OF POPULATION AND INCOME GROWTH**

POPULATION IN 2006, AVERAGE ANNUAL GROWTH RATES OVER 10 YEAR PERIOD AND INCOME SHARE, %

	POPULATION			INCOME		
	1997–2006	2007–2016	2006	1997–2006	2007–2016	2006 income share
	%	%	Million	%	%	% world
AFRICA	2.20	2.04	923	4.21	4.32	1.8
LAT. AMERICA/CARIBBEAN	1.40	1.17	564	2.27	3.79	5.9
NORTH AMERICA	1.02	0.86	332	2.81	2.62	32.3
EUROPE	0.29	0.06	527	2.20	2.13	27.6
ASIA	1.15	0.98	4,150	3.55	4.02	30.3
OCEANIA	1.36	1.08	33	3.33	2.72	2.0
WORLD	1.23	1.08	6,530	2.86	3.05	100

Source: Nomisma elaboration on OECD-FAO, 2007.

FIGURE 1 | **EMERGING COUNTRIES: TRENDS IN SOCIO-ECONOMIC INDICATORS** (% CHANGE PROJECTED AVERAGE 2006/2010)



Source: Nomisma elaboration on IMF, FAPRI and Eurostat Data

In this context, the most important new development is the growing presence of some emerging economies in the international market. Thanks to their high potential for economic and population growth, these countries will become new key actors in the international scene in coming years, redefining the landscape of production and consumption of food products and, consequently, international trade.

Projected income growth in developing and emerging countries means that more income will be spent on food (especially high added-value items such as meat and dairy products, which in turn also require livestock feed). According to recent FAO analyses (Bruinsma, 2003), the average caloric content over the next 30 years is projected to rise from 2,800 kcal/person/day to 3,050 kcal/person/day on a global level, whereas for developing countries the average caloric content is expected to rise from 2,680 kcal/person/day to 2,980 kcal/person/day, with vast differences remaining between countries and regions within countries.

The other direct effect of the increase in disposable per capita income will be changes in dietary habits, with rising demand for products with a higher value (protein content). It is assumed there will be stable or declining per capita grain/cereal consumption, while consumption of dairy and livestock products and fruit & vegetables will rise.

TABLE 3 | **PER CAPITA CONSUMPTION OF FOOD PRODUCTS (ESTIMATED CHANGE % 2006/2010)**

	WHEAT	RICE	LIVESTOCK	BUTTER	CHEESE	NFD MILK	FRUITS*	VEGETABLES*
EU-25	3.9	3.9	1.0	–2.3	6.6	–5.2	4.2	1.7
RUSSIA	1.3	–1.1	6.5	9.7	14.2	14.4	34.9	9.2
CHINA	–3.1	–4.8	7.6	13.7	9.1	26.6	8.7	40.0
INDIA	1.9	n.a.	3.1	15.1	n.a.	22.0	0.0	8.0
INDONESIA	n.a.	–1.9	5.2	7.2	11.2	11.8	8.2	0.0
ARGENTINA	1.1	3.4	1.9	14.4	12.4	17.4	10.1	0.0
BRAZIL	4.4	–0.9	4.1	0.7	3.3	14.4	0.0	n.a.
EGYPT	0.4	0.2	3.3	0.5	0.2	3.4	–1.9	2.9

*Change % 2000/2005. Source: Nomisma elaboration on FAPRI and FAO Data.

Urbanisation also has had a significant impact on both agriculture and food consumption. Continued migration to cities and peri-urban areas has led to both a loss of agricultural land (in countries such as China and India) and deforestation (in countries such as Brazil and Indonesia), although the urbanisation rate will slow from 2.04% in 2000–2005 to 1.57% projected for 2025–2030. The overall urban share of population is expected to rise to about 60% by 2030, totalling around 4.9 billion. In developing countries urbanisation has contributed to changing the consumption model. Increased female employment outside the home, aging of the population, and smaller family size have led to shifts in diet toward processed and prepared foods that are readily available from vendors or supermarkets.

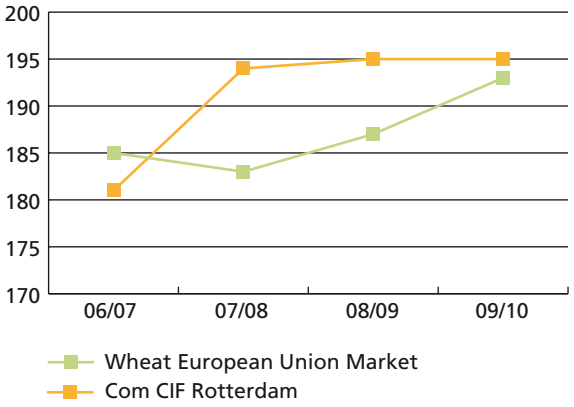
Several emerging countries, including China, Russia, Egypt, Indonesia and Brazil, have become important net importers of dairy products, while net European exports of these products are diminishing. If meat trade is taken into consideration, it is expected that Europe will enjoy a further consolidation of its position in international markets for pork, while Brazil, Argentina and India will maintain stable positions in the beef market. Import demand from Russia will continue to grow, but the quantities are projected to decline through 2016, especially for pork and poultry imports.

Demand for primary products will continue to increase even in less developed countries, where domestic production is unable to sustain the increase in demand linked to high population growth rates. Over the next five years a number of countries in Africa (especially North African countries, Algeria, Egypt and Morocco) and Latin America (except for Argentina, which will continue to play an important role in exports of both agricultural products and food) will emerge as net importers of grain.

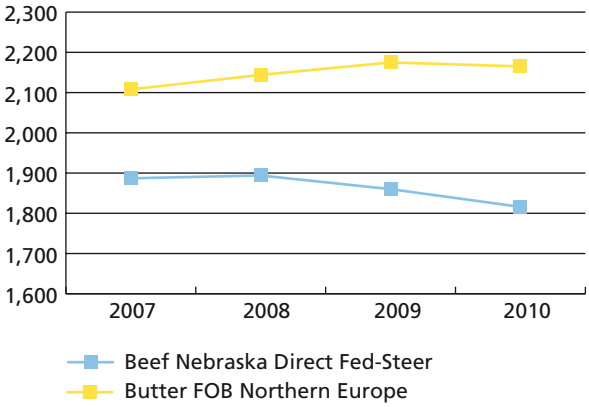
The increase in demand for food will contribute to some shocks on the world market over the short term, with possible effects on price levels. Thus, it could be that over the long term some difficulties will be experienced by the EU Agri-food sector in gaining access to extensive supplies of raw materials. On the demand side, the competition with emerging economies will become very intense and the prices of the main agriculture products are likely to rise.

FIGURE 2 | **COMMODITIES PRICE PROJECTIONS (2006–2010)**

Cereals	$/tonn.	06/07	07/08	08/09	090/10
Wheat	European Union Market	185	183	187	193
Corn	CIF Rotterdam	181	194	195	195



Livestock	$/tonn.	2007	2008	2009	2010
Beef	Nebraska Direct Fed-Steer	1,887	1,894	1,860	1,816
Butter	FOB Northern Europe	2,108	2,144	2,175	2,165



Source: Nomisma elaboration on FAPRI Data.

Over the long term, Europe will face very different dynamics affecting primary agricultural resources and food product markets. With regard to the former, it will have to compete with the emerging economies that are progressively developing capacities to produce the required commodities and where low labour costs allow the maintenance of lower prices. Despite the expected increases in production, there will be inevitable moments of market tension due to increasing global demand for agricultural foodstuffs and expansion of non-food demand, such as for biofuels that use primary agricultural products as inputs. The European food industry could therefore experience increased difficulties in accessing supplies of primary agricultural materials.

GROWING INTEREST IN HEALTHY AND SAFE FOOD

In Europe, demographic trends, such as smaller families (including increasing numbers of single person households), expanding shares of older (65+) and very old people (80+), and growing immigrant populations, have had substantial effects on food consumption patterns, particularly with respect to type of preparation, origin and quality. Overall, consumers are better informed and tend to have a greater interest in higher value products, including typical and quality products (wines, cheeses, fruits & vegetables, meats), ready-to-eat prepared foods, ethnic foods and organic products.

Furthermore, following several significant food scandals (particularly in the aftermath of BSE) in recent years, European consumers are focusing more attention on food safety. The European citizens' perceptions of risk in food, fuelled by media hype, have pushed the European Union to

undertake a series of wide-ranging interventions in order to re-establish a climate of trust. These actions for improved coordination and strengthening of the system to ensure food safety have made the EU a model of excellence for the rest of the world.

As income rises, increased attention to food safety and quality is also being addressed in emerging economies such as China, Brazil, India and Russia, which account for growing shares of European food exports. For example, in Russia increasingly strict phytosanitary standards are being applied. Consumers are better informed about products and their potential benefits and hazards, and tend to have a greater interest in healthy and quality food. In many emerging economies, consumers now have access to an unprecedented variety of food and are also more willing to pay higher prices for better quality and safer products.

Unlike many developing countries that suffer from extensive health problems linked to poverty and malnutrition from the lack of food, Europe and other developed countries do experience various problems associated with unbalanced diets. Despite general abundance of food in the European Union, many people suffer from insufficient access to healthy food of high nutritional value. Recent dietary surveys suggest that there are continuing problems of deficiencies in micronutrients (in particular iron, iodine and folate) affecting all Member States to various degrees. This is partially due to lower than recommended intake of fruit and vegetables, especially in the New Member Countries and in most socio-economically disadvantaged groups, and the consumption of cereals that has fallen by one quarter since 1960 for Europe as a whole, with relevant problems for digestion. On the other hand, dietary intake of fat, and especially saturated fats, is high in almost all EU Member States, and obesity is an growing problem, increasing risks of many chronic diseases, e.g. cardiovascular disease, type 2 diabetes, and certain types of cancer.

The heightened attention devoted by the European Commission to health and nutrition issues was evidenced by the launching of the Diet, Physical Activity and Health – EU Platform for Action in March 2005, followed by the development of a new Health Strategy which the Commission plans to adopt in 2007. The Health Strategy seeks to provide, for the first time, an overarching strategic framework spanning core issues in health, its links to other policies and global health issues. Besides trying to reduce smoking, the Commission supports various initiatives to combat obesity and promote better nutrition, since obesity has become a major health concern. Around a third of the people living in the EU are overweight and more than 10% are clinically obese, with medical costs of obesity estimated at around € 70–130 million per year. In May 2007 the Commission issued its White Paper "A Strategy for Europe on Nutrition, Overweight and Obesity-related health issues",

BOX 2 | **FOOD SAFETY AND QUALITY ASSURANCE**

After several food scares in the 1990s, the EU adopted an integrated approach to food safety. This approach was aimed at assuring consumers of a high level of food safety, plant health, and animal health and welfare within the European Union through coherent "farm-to-table" measures and adequate monitoring, while also allowing the effective functioning of the internal market.

Following the publishing of the **Commission's Green Paper on Food Law** (COM(97)176 Final), the **White Paper on Food Safety** (COM(1999)719 Final) outlines the Commission's "Farm to Fork" approach, adopted to guarantee the traceability and safety of food, carefully tracking feed and food from production to consumption and ensuring a high level of health and consumer protection. This integrated approach covers all sectors of the food chain, including feed production, primary production, food processing, storage, transport and retail sale. EU authorities evaluate risk and seek the best possible scientific advice before banning or permitting any product, ingredient or additive in a policy that applies to all feed and food, from inside or outside the EU.

Food safety is further ensured by a series of laws on product origin and phytosanitary standards at Community and national levels. In particular, EC Regulation 178/2002 spells out the general principles and requirements of food law, establishes the **European Food Safety Authority (EFSA)** and lays down procedures in matters of food safety. The EFSA plays a key role in providing independent scientific advice, guidance and clear communication on existing and emerging risks to food safety. Regulation No. 882/2004 seeks to ensure verification of compliance with feed and food law, animal health and animal welfare rules.

The Commission also funds projects such as SAFE FOODS, which seeks to refine risk analysis practice for food safety at the global level, and the new initiative "Better Training for Safer Food", aimed at organising a Community (EU) training strategy in the areas of food law, feed law, animal health and animal welfare rules, as well as plant health rules. Furthermore, there are a variety of quality assurance schemes operated by sectoral organisations at the European and national (and even regional) levels.

The high level of attention to food safety applied within the EU food chain is one of the most important guarantees of quality for consumers and has allowed European-produced food to enjoy an unrivalled reputation for quality and safety in global markets (witnessed by Europe's leading role in world Agri-food markets).

which spells out the objectives of the Programme for Community Action in the field of Health 2007–2013.

Increasing concern about health issues in Europe focuses not only on improper nutrition and obesity, but also global health issues including diseases and epidemics (AIDS, malaria, diabetes, hepatitis, tuberculosis, Avian Flu, BSE, etc.), and malnutrition which takes a dramatic toll on human life, mainly in developing countries. One of the outcomes of global warming (IPCC, 2007) is likely to be an increase in diseases associated with malnutrition, lack of clean water and sanitation and the spread of insects to new areas. The latter is considered to be among the biggest problems for Europe – particularly the spread of ticks and Visceral Leishmaniasis. The northward movement of pests and diseases will not only affect agriculture and the food supply, but can also have impacts on human health (food-borne diseases and zoonoses). The avian flu problem has shown how quickly animal diseases can spread from one area to another with grave consequences for farmers and the food supply, and potentially the human population.

THE ENVIRONMENT AND IMPORTANT IMPLICATIONS FOR AGRI-FOOD

Current EU environmental policy seeks to prevent environmental degradation and limit the effects of climate change by decreasing emissions of greenhouse gases, preserving biodiversity, counteracting desertification, deforestation, erosion and soil threats, and diminishing the impact of pollution and waste. One of the main goals of EU environmental policy is achieving sustainable development through rational use of water and soil resources and promoting the use of carbon neutral energy resources.

The EU seeks to limit the average global increase in temperature to 2°C above pre-industrial temperatures, mainly through energy savings and switching to renewable energy sources (including biofuels). Under the Kyoto Protocol, the EU is committed to reducing emissions of greenhouse gases (GHG) from 1990 levels by 8% during 2008–2012 and 15% by 2050. Under the March 2007 proposal for an integrated energy and climate change package, the EU asked Member States to agree to an even more ambitious target of at least a 20% GHG reduction by 2020. In this context, it is important to underline the role of agriculture with regard to mitigation potential (GHG reductions that can be achieved), through carbon sequestration in soils with a high amount of organic material. At the global level, it is estimated that about 100 billion metric tons of carbon over the next 50 years could be sequestered (Intergovernmental Panel on Climate Change-IPCC, 2001) through forest preservation, tree planting and improved agricultural management with the potential to offset 10–20% of the world's projected fossil fuel emissions.

The European Commission considers climate change, linked to global warming, to be one of the most important challenges for this decade and beyond (European Commission, 2005). Climate is a major factor in agricultural productivity, determining the types of crops that can be grown and their yield, and also affecting livestock production. Consequently, climate change can have profound effects on food security and quality-related issues.

Climate-induced impacts are not evenly distributed and are unpredictable. Since the 1990s various models have shown that regional impacts will be more pronounced than overall global impacts and that developing regions as a group will be most hurt by climate change. Climate models taken into consideration by the Intergovernmental Panel on Climate Change (IPCC) in the most recent assessment report (2007) have projected that the mean global surface temperature could increase from 1.1°C and 6.4 °C over 1990 levels this century, and that the global mean sea level could rise by 18 to 59 cm (IPCC, 2007). This would be accompanied by changes in the location and seasonality of precipitation patterns. For example, in some African countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020, further exacerbating food insecurity and malnutrition. Crop yields could decrease up to 30% in Central and South

Asia by the middle of the century, and the region is at increased risk for floods and water-borne diseases. Latin America faces significant risks to biodiversity and negative impacts on production, except for soybean output. Food security is at risk in many developing countries, given highly variable capacities to adapt to the challenges of climate change. In turn, food security problems in developing countries will affect world food markets, further fuelling political and economic instabilities and population migrations.

In Europe regional differences in climate and growing conditions are expected to be exacerbated by climate change, and more than half of Europe's plant species could be vulnerable or threatened by 2080 (Alcamo et. al., 2007, European Commission, 2007). The effects of climate change are multiple, interlinked and complex, with economic, social, health, environmental and political implications. A major question is "what are the vulnerabilities and how can European agriculture adapt to climate change" in order to remain sustainable, competitive and self-sufficient over the medium to long term?

Much will depend on the success of crop management systems and the use of adapted plants (i.e. stress-resistant crops) to react to the effects of climate change. These include longer growing seasons, shifting precipitation patterns, and more/or less moisture, and greater contrasts between winter and summer climate and temperature extremes, as well as more severe weather events and varying responses of pests, fungi, weeds, and moulds to higher temperatures. Farmers may have to substitute other crops that are better suited for the new climate conditions or other variations of the same crop. Spread of cultivation to new areas (especially in North Europe) and changes in crop composition in southern areas are likely outcomes. In southern areas, there will be greater need for irrigation and crops that can survive dry climates; in the north there will be an expansion of cultivation, but more exposure to pests and diseases, risk of rotting due to standing water, greater need for coastal defences and flood control mechanisms.

Another main priority in European environmental policy is the protection of biodiversity, which is a key element in sustainable development. Maintenance of agricultural biodiversity is critical to the future of agriculture in Europe. Biodiversity (both agricultural and wild) provides farmers with a larger range of varieties and species that might be better able to adapt to changes in the environment or pest spectrum, and offers a gene pool for future selective breeding. Furthermore, given that many pharmaceutical components are derived from plants (as well as from moulds, fungi and micro-organisms) and cannot necessarily be synthesized in laboratories, it is important to maintain biodiversity of plant life. Only some pharmaceutical uses of plants are currently known, whereas ongoing research makes new discoveries – but the potential depends on availability of a widely diverse natural endowment.

BOX 3 | **SUSTAINABLE DEVELOPMENT AS A KEY PILLAR OF EU POLICY**

Protecting the environment is part of sustainable development, which is a key EU policy objective, outlined in the **6th Environment Action Programme (EAP).** It addresses four priority areas: climate change and global warming; protecting natural habitats and wildlife, hence biodiversity; environment and health and quality of life issues; natural resources and waste management.

The EAP provided the framework for the development of the **Thematic Strategy on the Sustainable Use of Natural Resources COM(2005) 670 Final** (2005), which calls for reducing environmental impacts associated with resource use while maintaining competitiveness and growth as a decisive factor in helping the EU achieve sustainable development.

This strategy plays a key role within the overall, cross-sectoral policy framework provided by the **Renewed EU Sustainable Development Strategy** (2006). The renewed strategy complements the Lisbon Strategy by functioning as a third, environmental pillar and sets overall objectives, targets and concrete actions for seven key priority challenges through 2010, including climate change and clean energy; sustainable transport; sustainable consumption and production; public health threats; better management of natural resources; social inclusion, demography and migration; and fighting global poverty. Given the cross-sectoral nature of agriculture and the food industry, important synergies exist with all of the key priority challenges, both within the EU and in relations with third countries.

Sustainable use of resources in agriculture puts a premium on maintaining soil quality, clean water, and air purity, with careful attention to using agricultural technologies and practices without upsetting the balance of ecosystems, while at the same time allowing farmers to remain productive and competitive.

Around 99% of agricultural production depends on only 24 different domesticated crops. Cultivated varieties include "modern varieties" and "farmers" or traditional varieties (landraces). The former are the result of scientific breeding, tend to have high yield and genetic uniformity. The latter have higher levels of genetic diversity and are the objective of most conservation efforts, playing a key role in food security, maintenance of genetic heritage as well as sustainable production and functioning of agro-ecosystems. High reliance on one commercially cultivated crop strain can create particular vulnerabilities to climate change and new pests, as seen in the practice of monocultures which contributed to several agricultural disasters in history (i.e. Irish Potato Famine). Europe continues to produce a wide variety of crops – in sharp contrast to the extensive monocultures practiced in countries such as USA, Brazil, Argentina and Australia.

The environmental requirements of the revised CAP and the 6th EAP emphasise the need for soil preservation and water protection in agriculture. Environmentally sound soil and water use practices require careful management of these resources in order to preserve their quality and prevent waste or degradation. Soil and water quality may be degraded by fertilisers and PPPs leaching into the soil and run-off, or via improper use. Excessive use of water for irrigation is also not sustainable in arid areas.

Agriculture accounts for around 30% of total water use in Europe as a whole, with irrigation consuming over 60% in some Southern European countries. Irrigation depends on climate, crop type, soil characteristics, water quality, cultivation practices, and irrigation methods. With climate change, the amount of water needed for irrigation in some parts of Europe could increase sharply, intensifying competition for clean water resources. The EU has passed regulations to protect water quality with regard to PPPs and nitrates from fertilisers. The Water Framework Directive provides an integrated framework for assessment, monitoring and management of surface waters and groundwater based on ecological and chemical status, requiring measurements be taken to control emissions, discharges and losses of hazardous substances. With regard to soil, the CAP seeks to ensure respect of standards to protect soil from erosion and maintenance of its organic matter and structure, while the 6th EAP calls for an EU strategy on soil protection, supplementing various national soil protection programs. The Commission's communication "Towards a thematic strategy for soil protection" spells out EU actions to prevent soil degradation, mapping national actions and identifying gaps that could be addressed at the EU level. Possible actions following this strategy include new legislation on use of sewage sludge in agriculture and compost and proposed soil monitoring legislation. Agri-environmental measures such as organic farming practices, conservation tillage, terracing, safer PPP use, integrated crop management (ICM), management of low-intensity pasture systems, lowering of stock density and use of certified compost can help build-up of soil organic matter, enhance soil biodiversity, and reduce soil erosion, contamination and compaction.

Due to its inherent dependence on geo-physical, hydrological and climatic elements of the natural environment and its function in food production and land use, agriculture plays crit-

BOX 4 | **BIODIVERSITY**

Biodiversity is linked to the complex functioning of ecosystems, depending on climate, altitude, soils and the presence of other species, and is an essential element of sustainable development and preservation of the natural landscape. Climate change coupled with human activities and introduction of exotic or alien species (either intentionally or through natural spread, facilitated by climate change) can have a significant direct and indirect negative impact on biodiversity. One of the biggest economic threats to agricultural biodiversity is the spread of Invasive Alien Species (IAS), as they often out-compete or crowd out native species and hence threaten the conservation of local, national, regional or global biodiversity, as seen in the cases involving Ambrosia in France and corn root worm in Austria and Germany.

The Convention on Biological Diversity (CBD), approved by the EU in 1993 and ratified by all Member countries, is the key instrument that drives biodiversity conservation worldwide. Its goal, re-invigorated at the 2002 World Summit on Sustainable Development in Johannesburg, is to achieve a significant reduction in the current loss rate of biodiversity by 2010. The Commission's Biodiversity Action Plan (2006) seeks to ensure that all EU legislation and policies (including agriculture) take into account impacts on biodiversity within and outside the EU. Specific legislative tools to protect biodiversity include the Habitats Directive, protecting plants and animals and their habitats and setting aside protected areas (Natura 2000 network), and the Wild Birds Directive.

ical roles in environmental protection as well as sustainable development. To respect the aims of EU policy on sustainable development is thus necessary to balance requirements for protection of the environment and health with the need to maintain agricultural competitiveness and food security.

BIO-ENERGY: RISKS AND OPPORTUNITIES FOR AGRICULTURE

The increasing global demand for energy products, especially in rapidly growing economies (like China and India) and the consequent increase in the price of petroleum have generated economic and political-strategic tensions in the international arena. The tensions have contributed to a significant increase in the use of renewable energy sources (RES). Among these, biomass energies play a fundamental role, representing an energy resource with vast potential that is still underexploited. A particular advantage of biomass resources is that they are widely present throughout the territory, easily accessible, and can benefit from mature transformation technologies.

The biomass sector is extensive and includes a number of different types of products, ranging from forest biomass to biofuels, from biogas to the organic emissions of urban solid refuse. The exploitation of biomass is generally associated with several possible environmental benefits, both at the "global" level, in terms of contributing to the capture of greenhouse gases (Kyoto Protocol), and at the "local" level, due to reduced emissions of Particulate Matter (PM) and other environmental pollutants. Even though the transformation of biomass to energy is not completely Carbon Neutral, the development of a locally based agro-energy value chain is commonly considered advantageous.

Generally speaking, there has been growing interest in the EU, USA and Brazil in developing energy resources from biomass. Enormous investments in bioethanol have been recently made in Brazil (in 2005 13 million tones were produced and an output of around 20.6 billion liters is forecasted for 2010) and in the USA (in 2005 there were 95 ethanol refineries operating in 19 states, with an output of almost 15 billion liters; by 2006 there were more than 100 facilities in operation, with another 49 under construction).

Agro-energy, i.e. energy gained from agricultural products, refers to different forms of biomass as well as types of energy gained from them. Among the main energy destinations of biomass from agriculture are the production of heat through direct combustion, the manufacturing of biogas (through fermentation), the distillation of biofuels (bio-ethanol from cereals and other starchy raw materials, bio-diesel from oilseeds).

In recent years, the European Commission has been fostering the development of bio-energy, and agro-energy in particular, through a number of policy and legislative measures, including the set of specific targets for the use of bio-fuels in the share of total fuels consumption. The target share of bio-fuels in the total quantity of fuels placed on the market (EU-25) was set at 5.75% for 2010 and to 10% for 2020, thus determining a sharp increase in investments in productive capacity in most countries, with consequent direct and indirect effects on the related raw materials markets.

In fact, recent studies focused on the projected evolution of biofuels production in the EU and the associated demand for raw materials point out the substantial impact which is likely to affect the EU agricultural system, due to the "competition for land" between the requirements from the food industry and growing needs from the expanding bio-energy industry. Possible tensions could emerge between competing demands for arable land. In the 2020 scenario (10% minimum share of biofuels) in which only primary resources of European origin are used, the agricultural area involved would have to expand from the current 3% to 15% (European Commission, 2006, 2007).

TABLE 4 I **LAND USE UNDER 10% MINIMUM TARGET IN THE EU-27 (MILLION HA) AND SHARE IN TOTAL ARABLE LAND**

	2006 (TARGET 1.2%)		**2020** (TARGET 10%)	
	Million ha	**Share in total area**	**Million ha**	**Share in total area**
Area bioethanol	1	1%	12.9	11%
Area biodiesel	2.1	2%	4.6	4%
TOTAL AREA BIOFUELS	**3.1**	**3%**	**17.5**	**15%**
Cereal area	59	52%	62.5	55%
of which bioethanol	0.9	1%	12.3	11%
Oilseed area	8.8	8%	8.5	8%
of which biodiesel	2.1	2%	2.9	3%

Source: DG AGRI – Note to the file: The impact of a minimum 10% obligation for biofuel use in the EU-27 in 2020 on agricultural markets

With regard to domestic production of energy feedstocks, output will likely be increased by using set-aside lands for energy crop purposes and the cultivation of lands formerly used for sugar beets. The market for animal feed is forecasted to remain quite stable, given the general stability of the European population and its aggregate meat consumption; thus pressures from feed demand are expected to be minimal. Combined with additional land under cultivation, a share of growing demand for bioenergy feedstocks will likely be satisfied by higher yields, thanks to continuous improvements in research (i.e. a better genetic selection, more effective contribution of plant protection products, etc.) applied to conventional agricultural models. In any case, it is likely that growing demand for agricultural commodities from the European biofuels industry will be satisfied both by increased European production as well as rising imports of raw materials.

However, in a situation where high demand is faced with a fairly inelastic supply, this will certainly also affect the level of prices of the agricultural commodities used as energy feedstocks (cereals, oilseeds etc.) with even stronger dynamics than an increase in production. An impressive example of these dynamics is seen in the rapid rise (with price increases greater than 60% over a few months) of international maize prices that occurred from the second half of 2006 onwards, driven by the strong demand of the US bioethanol industry. A direct consequence during the current year has been a tremendous expansion in US maize cultivation in areas once subject to wheat cultivation, with the predominance of maize cultivation for the first time in more than 60 years. This has also had an effect on wheat prices. Indeed, the forecasted reduction of US wheat production, coupled with the very poor harvest in Australia and the increasing demand from emerging economies, has prompted a sharp increase in wheat prices over the last few months.

Over the short term, on the basis of these developments, a rise in international prices for primary agricultural resources for food and fuel seems inevitable. The level of this price increase is heavily dependent on several factors, such as the growth in fuel demand, the trends in food consumption in developing countries and the state of harvests in key areas. But over the medium- to long-term perspective, various developments in the international scenario could mitigate these tensions, particularly the diffusion of "second-generation" biofuels that use wood cellulose as a primary raw material. While this increase in agricultural prices represents an important opportunity for farmers to increase their earnings, for the food branches involved (i.e. cereal milling, starch industries, oilseed crushing, baked goods, pasta etc.) it signifies an additional cost with a consequent reduction in margins, at least over the short term. However, over the medium-term, they are likely to increase their selling prices and recover their profits.

3 AGRI-FOOD: A STRATEGIC SECTOR WITHIN THE EU-27

The European Agri-food sector (agriculture and food industry) has a strategic role in the economy due to its significant dimensions, as well as its strong links to other production sectors, for which it is a supplier of intermediate inputs or a consumer, for example of agricultural inputs (machinery, plant protection products, fertilisers, seeds, feed, etc.), services, retailing, transport, energy, etc. Changes in the Agri-food sector can have repercussions throughout the entire value chain, also affecting the performance of dependent sectors and the global economy.

The EU-27's Agri-food value chain plays a key role at the global level, maintaining a leading position in agricultural output, in the food industry and in Agri-food trade flows. Its role within the European socio-economic system is also substantial, especially in terms of employment and in the generation of value, when compared with other economic sectors.

THE ECONOMIC ROLE OF EUROPEAN AGRI-FOOD

In 2004, Europe was the world leader in agricultural production; in terms of added value, the EU-27 accounted for 19% of world agriculture, followed by China (17%), USA (11%) India (9%) and Brazil (4%).

Agriculture in the EU-27 is undertaken in approximately 40% of the territory (172 million ha), with a large part of the utilised agricultural area (UAA) dedicated to seed crops (61%). The value of agricultural production in 2005 reached € 310 billion; livestock (44%), fruits and vegetables (24%) and commodities (24%) were the most important contributors to generated value.

The productive fabric is comprised of a very large number of small operations (14.2 million): the average size of a European farm is 12.1 ha UAA per farm, though in the 12 New Member States the size is significantly smaller (5.6 ha per farm). This production structure differs sharply from those found in the other main world agricultural producers (for example, USA and Brazil), which have much larger farms and fewer farmers. The emerging economies, even though the Chinese case still shows some elements of backwardness, can count on increased availability of low-cost labour resources. Once the development processes in these countries reach a certain level of advancement it is expected that the significant restructuring of production units will lead to a substantial gain in efficiency and competitiveness. In comparison, the main strength of European agriculture is represented by its capacity to produce products that have a strong territorial identity as opposed to mainly producing large quantities of commodities, as is the case for the main competitors.

BOX 5 | **EU-27: KEY INFORMATION ON THE AGRI-FOOD SECTOR (2005)**

- With an added value of 395 billion, the Agri-food sector accounts for 4% of the EU-27 added value.
- The EU-27 Agri-food sector provides employment for more than 18 million people, 8.4% of the European total.
- Europe is the world leader in agricultural output; in terms of added value, the EU-27 represents 19% of global agriculture, ahead of China (17%) and the USA (11%).
- In terms of turnover, the EU-27 food industry is the world leader (€ 836 billion, 1.5 times the food industry turnover of the USA, the second most important global player).
- 7.4% of total European output is produced to satisfy agricultural and food demand (5.9% in terms of added value).
- The EU is the world's largest importer and exporter of agricultural products. It accounted for a 21% share of total world agricultural exports in 2006, followed by the USA (18%) and Mercosur (13%)
- Trade in Agri-food products accounted for some 5% of the total EU-27 trade in goods with extra-EU-27 countries.

Source: Nomisma elaborations of Eurostat data.

TABLE 5 | **AN OVERVIEW OF EU AND OTHER IMPORTANT WORLD AGRICULTURAL PRODUCERS**

PARAMETERS	EU-27	UNITED STATES	BRAZIL	CHINA
Population (2006)	494.8 million	299 million	188 million	1,314 million
GDP index (2006) EU27=100	100	91	7	18
GDP/capita index (2006) EU27=100	100	150	19	7
Agriculture of GDP (2004)	2.2%	1.3%	9.8%	13.1%
Agriculture Gross Value (bill. $ 2004)	278.8	151.8	59.2	253.0
Share of agriculture in employment	6% (2005)	1.8% (2002)	18.9% (2003)	39.5% (2005)
Agricultural land (mill. ha)	172 (2005)	377 (2006)	62 (2005)	155.5 (2005)
Number of farms (mill.)	14.2 (2005)	2.09 (2006)	5 (2006)	200 (2005)
Average farm size (ha)	12.1 (2005)	180.5 (2006)	430 (2005) °	0.6 (2005)
Demographics and farming	Low birth rates Aging population, abandon farming, high technology	Population growth (immigration) higher birth rates, high technology	Population growth, higher birth rates, low cost land & labour, high technology on large farms	Population growth slowing, migration to cities, low costs of labour
Main Products	Typical regional and territorial products	Large volume commodity crops	Large volume commodity crops	Mainly commodity crops

° Only commercial farms Source: Nomisma elaborations of USDA and European Commission data, OECD, World Bank, other data compiled by authors.

The EU-27 also is the world leader with regard to the economic dimensions of the food industry, both in terms of output value (€ 836 billion) and as a share of world exports (20.4%); in both cases, the United States is Europe's main competitor, with € 496 billion of sales and 10.5% of global exports.

After metallurgy, the food industry is the second most important manufacturing sector in Europe: in terms of added value and employment, it accounts for 12.3% and 13.8%, respectively, of the manufacturing total. The most important branches in terms of revenue are: "Meat products" (20%), "Beverages" (16%), "Dairy products" (15%), "Bread, fresh pastry goods and cakes" (9%), "Animal feeds" (7%), and "Processed fruits and vegetables" (6%).

In 2003, the sector was made up of around 283,000 enterprises, 99% of which were SMEs – accounting for a 48% share of total revenues. This production structure differs quite sharply from that in the manufacturing industry and within the main competitor countries, where the role of SMEs is more limited. Yet, despite the leadership position of the European food industry, among the world's 20 leading multinationals in the sector in terms of sales volume, there are only 5 companies from the EU-27, whereas 12 are from the USA, two are from Japan and one is from Switzerland.

Agriculture accounts for a much larger share of employment than the food industry, providing jobs for nearly 13 million people, compared with slightly more than 5 million involved in food production. The sharp difference in absolute value generated per employee corresponds to a substantial variation in productivity: € 14,000 of added value generated per agricultural labour resource compared with € 41,000 per labour resource in the food industry, which is only slightly below the average productivity value of € 46,000 generated by the European economic system as a whole.

However, the above statistics do not reveal the profound differences that exist within the EU: in the 12 New Member Countries, due to lower levels of economic development, the Agri-food sector plays an even more important role compared to the rest of the EU (8.5% of total added value), particularly in terms of employment (20.1% of overall labour). On the other hand, a far larger share of Agri-food added value is produced in the EU-15 (€ 157.7 billion, 85% of total). In a medium to long-term perspective, however, Central and Eastern Europe show far more dynamic development trends than the rest of Europe, due to modernisation and restructuring processes that involve the entire economy. For this reason Central and Eastern Europe will progressively make a larger contribution to the European Agri-food sector, leading to its further overall strengthening.

TABLE 6 | **EU-27 AGRI-FOOD SECTOR: MAIN ECONOMIC DATA (2005)**

EU-27	AGRICULTURE	FOOD, BEVERAGES AND TOBACCO	AGRI-FOOD TOTAL
GVA (Billion €)	186.2	208.3	394.6
GVA (% on Tot Economy)	1.9%	2.1%	4.0%
Enterprises (,000)	14,200	283	14,483
Employment (Mln People)	12.9	5.1	18.0
Employment (% on Tot. Economy)	6.0%	2.4%	8.4%
GVA per person employed (€)	14,000	41,000	–

Source: Nomisma elaboration on CIAA and Eurostat data.

The performance of the Agri-food value chain is closely correlated to the weight and the characteristics of the internal consumption market. In the EU-27 the European expenditure on food and beverages accounts for 14.4% of the private consumption of families – a much higher level than in most of the advanced market economies. Food consumption structures show that Europe, along with the United States, is a principal consumption market for products with high protein content such as meat (98 kg/capita for EU-15 in 2003), drinking milk (86 kg/capita for EU-15 in 2003) and cheese (18 kg/capita for EU-15 in 2003).

An important characteristic of the European Agri-food sector is its extensive integration. In fact, the EU food industry acquires and transforms around 70% of internal agricultural production. This link provides Europe with a particular competitive advantage in the global market, representing one of the keys to the success of the quality products (such as wine, oil, cheese, processed cereals and meats, etc.) and offers important guarantees in terms of food safety.

Another element characterising the European Agri-food sector is the high level of hygienic and health guarantees that are offered by the European production system, following several serious food scares. The BSE epidemic led to the introduction of the identification and registration of bovine animals and the labelling of beef and beef products in 2000. Subsequently, the EU's General Food Law entered into force in 2002: from 01/01/2005 it requires that all food and feed operators implement special traceability systems "from farm to fork".

The heightened European attention to quality associated with specific territories is seen in the success of the Protected Domination of Origin (PDO) and Protected Geographical Indication (PGI) products. These products provide a guarantee to the consumer of the traditionality of the transformation process and the territorial origin of the primary agricultural materials while respecting specific Community norms. There is a total of 754 European food products registered in the Community Register of geographical indications (PDO and PGI). Meats, cheeses and fruit, vegetable and cereal products are the most prevalent categories of goods. The countries with the largest numbers of PDO and PGI products are Italy, France, Spain and Portugal, which together account for 70% of all denominations of origin, with a combined product value estimated at around € 9 million (2005).

In addition, a number of different quality assurance schemes (QAS) are applied throughout the EU, some mainly meant to provide guarantees on the producing firm and/or its organization (e.g. ISO 9001, ISO 14001, IFS, BRC), others mainly focused on products and their specific characteristics. As for the latter, in fact, it should be noted that over the last decade, quality labels have assumed an important role in the marketing and labelling of Agri-food products, not only in the Mediterranean countries (Italy, France and Spain, where their diffusion is particularly high), but also in the Central and Northern European countries, and particularly in Germany, Denmark, United Kingdom, Austria, and the Netherlands. In all these countries, the number as well as the diffusion of quality labels has been continuously growing (for example, Eqwalis in Belgium, Czech Made in the Czech Republic, Red Seal in Denmark, Uniquely Finnish in Finland, SafetyCert® in Latvia, Label Rouge in France, QS Qualität und Sicherheit GmbH in Germany, PDZ Label in Poland, Produccion integrada in Spain, FABPIG Farm Assured British Pigs and FABBL Farm Assured British Beef and Lamb in United Kingdom).

In response to the increasing segmentation of the consumer market in Europe, organic production has also developed a niche. Organic land area in Europe (equivalent to 3.9% of UAA) accounts for a substantial share of total utilised agricultural area, compared with 1.3% in Canada, 0.24% in Brazil and 0.23% in the United States (Lampkin, 2004).

BOX 6 | **MULTIFUNCTIONALITY OF EUROPEAN RURAL AREA**

- EU-27 rural areas account for 92.7% of territory and 58.3% of population
- Agriculture and forestry represent 78.3% of land use in EU-27
- In EU-25 13.2% of territory is subject to Natura 2000 schemes
- 17.4% of EU-27 forestry area is covered by environmental protection schemes
- In EU-25 3.9% of UAA is under organic farming system
- 1,383,000 ha of EU-27 UAA is devoted to energy and biomass crops
- 31% of European farmers in EU-25 have another gainful activity besides agriculture
- 73.8% of bed places (in hotels, camp grounds, holiday dwellings, etc.) in EU-27 are in rural areas
- In the EU-27 there are 754 PDO & PGI products (September 2007)
- In the EU-15 there are 893 Local Action Groups (14.3% of population and 48% of territory)

Source: European Commission (2006)

THE MULTIFUNCTIONALITY OF AGRICULTURE

Besides its fundamental role of producing primary resources for food consumption, agriculture performs other important functions, such as environmental protection (landscape preservation, protection of hydro-geological resources, biodiversity and natural habitats, etc.), forestry preservation and promotion, rural population inflows (rural tourism, preservation of agricultural culture and traditions, etc.), and protection of animal health and welfare, etc.

As mentioned above, these objectives enjoy a broad consensus of public opinion and are gaining increasing attention in the definition of EU policies. In fact, since its formal recognition, with the adoption of Agenda 2000 and the launching of a coordinated series of measures, rural development has become the second pillar of European agricultural policy alongside the CAP. Today the multifunctionality of agriculture is a very dynamic social and economic reality, supporting and complementing the primary function of producing agricultural foodstuffs.

THE AGRI-FOOD TRADE BALANCE, THE GUARANTEE OF SELF-SUFFICIENCY AND FOOD SAFETY

The EU is the world's largest importer and exporter of agricultural products. Its share in total world exports is 21%, followed by USA 18% and Mercosur 13%. EU trade policy seeks to achieve progress in international Agri-food trade in order to support sustained and continued economic growth in all countries. Various steps (including tariff cuts, reductions in both export subsidies and domestic market support) towards reducing protectionism have been made since GATT and the subsequent WTO negotiations.

In 2006, trade in agricultural raw products and food accounted for some 5% of the total EU-27 trade in goods with extra-EU-27 countries. Observing the development of this share over time, we see a steady decline in its importance in total EU trade. This development is mainly due to the dynamic increase of trade in industrial products over the last decade; the value of Agri-food trade in fact increased by € 31.7 billion, up 33.8% compared to 1999.

In absolute terms, total trade in Agri-food products was valued at € 125 billion, divided nearly equally between EU-27 imports from third countries (€ 64 billion) and exports (€ 61 billion). Compared to 1999, exports increased more than imports, indicating a gradual reduction of the Agri-food deficit during the period through 2006. In particular, stronger growth in food trade over the years (+38% versus +24% of agricultural products trade) shows a high level of specialisation of the EU in the production and exports of processed products.

Since the 12 New Member Countries (NMC) are now in the process of developing their Agri-food industry, in 2006 the EU-15 still accounted for most of the overall EU-27 trade balance. This means that references to EU-27 Agri-food trade actually imply EU-15 trade. However, the trade flows between the EU-15 and the 12 NMC also have to be taken into account. Beginning first with free trade agreements and then continuing with the Accession process and Enlargement, the Agri-food trade flows of the 12 NMC have shifted from Russia to the EU-15, strongly enhancing their trade relationship.

Over the course of the last few years, the overall Agri-food trade balance has improved somewhat: the deficit, in fact, declined from € 4.3 billion to € 3.0 billion.

Yet in order to better understand the structure of the trade balance, it is essential to compare agricultural raw materials trade with processed products trade. In fact, the EU-27 is a net importer of primary agricultural products, with a global trade deficit of about € 17 billion in this category and a net exporter of processed food products, with a global trade surplus of about € 14 billion.

This trade deficit in primary agricultural products has increased significantly over time (+20% from 1999 to 2006), further contributing to the progressive loss of self-sufficiency in raw materials experienced by the EU-27.

The most significant contributor to the € 17 billion deficit in agricultural trade is imports of fruit (in particular, tropical products), followed by imports of coffee, tea and spices and oilseeds. On the other hand, the EU-27 trade in livestock and cereals is fairly balanced, as exports are slightly higher than imports. It should be noted, however, that the cereals and meat sector trade surplus has been consistently eroded since 1999 due to an increase in the import quantities (exports were steady over the years).

In the future, EU agriculture could experience increasing difficulties in offering an adequate response to the demand for primary resources from the food industry for the production of final products destined for growing

TABLE 7 | **EU-27 AGRI-FOOD TRADE BALANCE (2006)**

BILLION €	**1999**	**2001**	**2005**	**2006**
AGRICULTURE	–14.3	–16.2	–17.1	–17.1
FOOD	10.0	11.9	11.7	14.1
AGRI-FOOD	–4.3	–4.2	–5.4	–3.0

Source: Nomisma elaborations on Eurostat–Comext data.

TABLE 8 I **AVERAGE EXPORT UNIT VALUE (2005)**

$/kg	WINE	CHEESE	PROC. MEAT
AUSTRALIA	3.04	3.08	4.23
BRAZIL	0.77	2.63	1.71
CHINA	4.77°	2.87	2.74
USA	1.79	3.50	2.55
EU-25	2.75*	3.89	3.64
EU-15	3.48	4.70	4.22

° Low quantity * data refer to EU-27.
Source: Nomisma elaborations on Comtrade and Faostat data.

internal demand and increasing extra-EU exports. In fact, future projections of EU-27 production and trade suggest that this gap will expand (European Commission, 2007).

The recent market-oriented CAP reform is progressively contributing to a loss in self-sufficiency regarding commodities. One noteworthy example is sugar, which the reform has decisively pushed towards a contraction of output (defined by the specific regulation as around 18% of EU-25 production due to the low level of international prices) and the level of self-sufficiently has declined from 122% in 2005 to 91% in 2006. Yet also butter experienced a contraction (from 113% to 109%) as did oilseeds (from 52% to 46%). It is therefore possible that over the next few years there will be some important changes in the agricultural production structure of the EU-27.

A lower level of EU-27 self-sufficiency could be compensated to some extent by a further increase in imports from extra-EU-27 countries. This development would not be particularly preoccupying, if over the last few months there had not emerged numerous signs of possible tensions on international markets regarding the supply of primary agricultural resources. The main actors responsible for increased demand are the emerging economies (in Latin America and Asia, especially China and India), which are characterised by high demographic growth and accelerated economic development that are contributing to increasing food consumption in terms of both quantity and quality. Furthermore, the increased investments made in the production of biofuels can also contribute to market shocks for specific primary resources such as cereals and oilseeds.

Over the long run, a stabilisation of the market is possible, due to the increased availability of agricultural products from emerging economies and developing countries and also from advances made in the WTO negotiations, which will progressively favour agricultural production in these countries. Over the short to medium term, however, there could even be market tensions. The price pressures that have occurred in world cereal prices over the past few months – due to the Australian production crisis and rising demand for biofuels production as well as demand from emerging economies – could be considered an early signal in this direction.

In contrast, the food industry appears to be a major strength of the EU-27 trading system given its positive trade balance. Since 1999, its trade surplus expanded sharply (+40%), demonstrating the EU-27 ability to carve out a market for itself in the area of high value final products.

Among the main Agri-food export partners, the USA still represents a large and important market for most EU-27 products. Russia, Switzerland and Japan are ranked 2nd, 3rd and 4th, respectively. In addition, recent EU Enlargement has brought Russia to the first and second position among the destinations of exports in agriculture and food trade, respectively.

Through a stronger focus on food safety and quality standards and the efforts of the industry to innovate and better exploit growth opportunities, the food sector is trying to maintain and strengthen its trade surplus. Thanks to sectors like beverages (especially wine), preparations of cereals and dairy products, the EU-27 has reached a high level of competitiveness in the international market. This competitiveness is particularly due to the elevated quality of its processed food products and of the raw materials used, in particular from the EU-15. Observing the food trade breakdown by category, exports are higher than imports in most branches, especially for beverages,

dairy and cereal preparations. The export unit value of the four main food product categories in different countries' trade indicates that EU exports belong to a higher quality level compared with that from other main trading countries.

In an international context which is moving toward a progressive liberalisation of markets, extra-EU commodities will be more competitive than those from the EU. The WTO negotiations, in fact, will inevitably make concessions to the requests for market opening from the emerging economies. These countries seek to dismantle trade barriers and achieve greater liberalisation of world Agri-food trade in order to gain larger market shares due to their competitive advantages in terms of cheaper labour and larger average farm size.

The main key to success for European Agri-food in international markets is to focus on its own quality products, which guarantee an adequate return to the food industry and allow transferring increased added value even to the level of agriculture. For this reason, the EU-27 considers it strategic to promote and protect food products that are recognised outside of the EU as PDO (Protected Designation of Origin) and PGI (Protected Geographical Indication). Yet an essential condition in guaranteeing the model of European quality production is for some key branches (for example, wine and cheese) to have access to primary agricultural resources produced according to European standards. In fact, the European food industry transforms around 70% of European agricultural production: quality is thus closely associated with the European production value chain. The same regulations that govern the PDO and PGI products require a certification of territorial origin for the primary materials that are transformed.

A decline in agricultural production would translate into a potential drop in food manufacturing output (in terms of both quantity and quality), which would undermine, first of all, the competitiveness of the EU-27 exports and secondly, the overall trade balance of the Agri-food sector. This would be even more serious at a moment in which the demand for quality products in international markets is showing important growth dynamics due to effects of the increase in disposable per capita income and of consequent changes in dietary habits. These international market segments, if satisfied by European production, could represent a further impulse for the growth of the Agri-food sector and the entire EU-27.

In a perspective of insufficient availability of raw materials or processed products in the EU-27, however there remain various elements of uncertainty regarding increases in imports from extra-EU countries.

The EU's ten most important suppliers accounted for nearly 50% of total imports of Agri-food products into the EU-27 in 2006, led by Brazil, followed by USA and Argentina. In observing the development of the trend over time, USA has lost much of its market share since 1999, while China has gained a share of 4.6%, becoming the fourth largest supplier of Agri-food products for the EU-27 in 2006. In particular, the EU-27 mainly imports primary agricultural products from countries like Brazil, USA, Norway and Turkey and processed products from Brazil, Argentina, USA and China.

At present, Europe continues to show strong resistance to the use of biotechnologies in agriculture. Currently, five countries (USA, Argentina, Brazil, Canada and India) representing the EU-27's main Agri-food suppliers account for 95% of the world's farmlands planted with transgenic crops. Brazil was able to boost its exports to Europe also because, in contrast to USA and Argentina, GMOs had been banned in this country until a few years ago (when in the vast majority of EU countries there was a moratorium against GMOs, now revoked). Now indeed, most Brazilian commodity crops (soybeans, cotton) are allowed to be produced from GMO seedstocks.

TABLE 9 | **EU-27 MAIN AGRI-FOOD SUPPLIERS (2006)**

BRAZIL	USA	ARGENTINA	CHINA	TURKEY	NORWAY	SWITZERLAND	CHILE	NEW ZEALAND	INDONESIA	REST OF WORLD
11.9%	8.5%	6.8%	4.6%	4.0%	3.9%	2.6%	2.6%	2.5%	2.3%	50.3%

Source: Nomisma elaborations on Eurostat-Comext data.

However, developing countries don't always have enough resources to monitor the whole Agri-food sector. As a result, sometimes these countries export goods without respecting the food safety standard levels of the importing countries. This represents a case of what is called "high-risk food" (i.e. potentially affected by Avian Flu from Asia, foot-and-mouth disease in meat coming from Brazil or Argentina and so on). At present, the European Commission is trying to establish a list of "high-risk" foods that would be subject to an increased level of scrutiny.

For the European Union, the strong linkages between the different parts of the food chain represent an important factor in guaranteeing the food safety of final products, since they are controlled by shared production standards. A decline in raw material availability can compromise this system of guarantees in the sense that it would make Europe more dependent on supplies of primary resources from extra-EU sources, which are not able to offer the same safety and health guarantees.

THE INDUCED EFFECTS OF AGRI-FOOD IN THE EUROPEAN ECONOMIC SYSTEM

The European Agri-food sector has a strategic role in the economy due to its significant absolute dimensions, as well as its strong links with other production sectors for which it is a supplier of intermediate inputs or a consumer (agricultural inputs, machines, services, retailing, transport, energy, etc.). Changes in Agri-food demand have repercussions throughout the entire value chain, also affecting the performance of dependent sectors.

Food is the European sector that is able to generate the largest output value: each 1,000 of demand in this sector is able to stimulate output in the entire economic system with an equivalent value 2,079, of which more than 900 is generated in other sectors. The same 1,000 of demand in the agricultural sector would lead to a stimulation of production value equal to 1,734. In the 12 New Member Countries (NMC), where agriculture has a significantly higher weight in the economic system, the effects resulting from an increase in 1,000 of demand rise to 2,036 (Nomisma elaboration on OECD Input/Output Tables, 2000).

Separating the effects of the effective demand for agricultural and for food products, it is possible to measure the weight of Agri-food in terms of activated production, taking into consideration all of the direct, indirect and induced effects on the economy. The result is that 7.4% of European output is produced to satisfy agricultural demand, primarily related to food. This percentage is even higher if only the 12 NMC are taken into consideration, since – as indicated above – the weight of Agri-food in these economies is much higher (12.4% of production).

BOX 7 | **IMPACT OF WINE EXPORTS TO CHINA ON EUROPEAN AGRICULTURE**

Agriculture receives its most important activation stimuli from the food industry: if the demand from the food industry increases, for example from emerging economies (such as China, India and Brazil), the demand for agricultural products also increases; if such demand cannot be satisfied internally it is necessary to resort to imports.

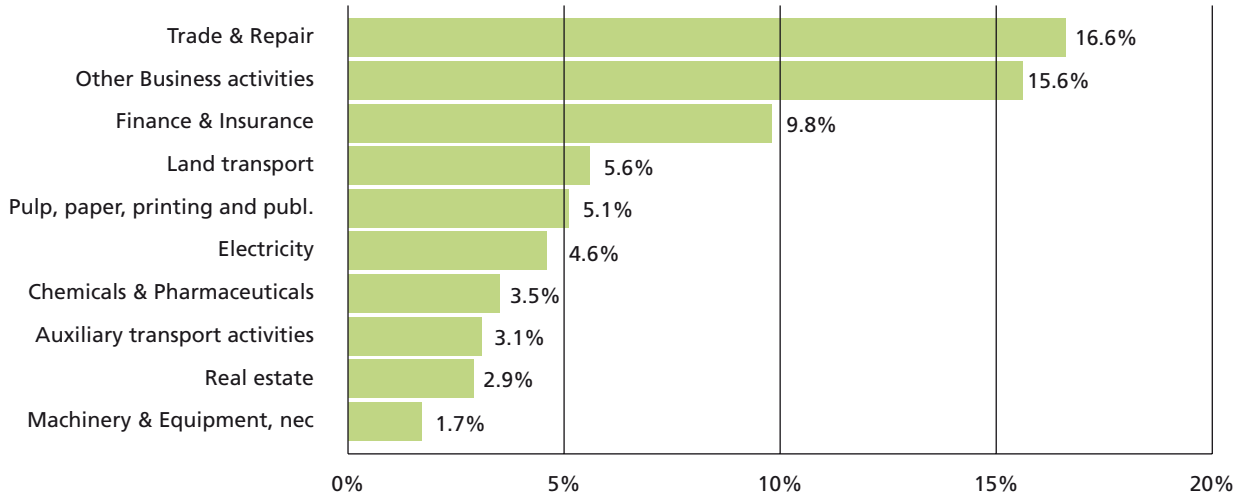
In 2006 European wine exports to China reached a total value of € 65.8 million (1.2% of total wine exports), rising at an average of more than 16% annually since 1999 (compared with 5.4% average annual growth of wine exports in general). In order to satisfy this level of demand, Europe's overall wine production generated an added value of € 137 million. Assuming that over the next five years wine exports to China will continue to grow at the rate recorded in recent years, these exports could reach a level of € 254 million in 2015. This would activate € 527 million of output.

Source: Nomisma elaboration on OECD Input-Output Tables (2000).

The more closely associated sectors that would most experience the impact of eventual changes in Agri-food demand are wholesale and retail trade (above all in the NMC), activities involving services to companies (including packaging and packing), financial activities (services, including banks, linked to a large extent to productive sectors) and transport. In the figure that follows, it can be seen how a reduction in output will affect the principal associated sectors following a reduction in the demand of the Agri-food sector.

Consequently, the impact of a contraction in European Agri-food demand will not remain limited to the Agri-food sector, a reduction in demand is likely to have repercussions throughout the value chain involving other associated sectors that provide goods and services, generating a negative impact in the overall European economy that is much larger that the original contraction in terms of the effects on output, businesses and related employment.

FIGURE 3 | **ACTIVATION EFFECTS OF AGRI-FOOD ON THE ECONOMY: PRINCIPAL LINKED SECTORS**



Source: Nomisma elaboration on OECD Input-Output Tables (2000).

4 THE ROLE OF PPPs IN THE EUROPEAN SYSTEM

European Agri-food represents one of the main production sectors of the European economic system. It guarantees the security and availability of food for the European consumer, both in terms of quantity and quality. As a highly dynamic element of the production system in terms of businesses and employment, it is linked through a tight network of relationships with other economic sectors (retailing, services, transport, chemicals, etc.) and generates a strong flow of exports that over the next several years will be consolidated, due to the growing extra-EU demand for quality food products.

The key to the success of European Agrifood is represented by the close relationship between agricultural production and processing, allowing the assurance of product safety and quality, thus acting as a strong element in the competitiveness of its products in internal and foreign markets. In this context, a deficit in the supply of primary agricultural resources could destabilise and compromise this system, given the lack of guarantees when extra-EU imports are involved. Guaranteed agricultural production (given the finite natural resources – land, water, etc. – available to Europe) is closely linked to the availability of agricultural technologies and their progressive innovative contributions to the agricultural production cycle.

Among the various factors of production used in agriculture, plant protection products (PPPs) represent one of the principal inputs. In 2004 the overall consumption of intermediate inputs was valued at slightly less than € 100 billion. Most of these costs were associated with inputs related to livestock (feed and veterinary expenses represented, respectively, 65% and 5% of the total), whereas costs related to crop production were contributed by fertilisers and soil improvers (12%), plant protection products – PPPs (10%), and seeds and planting stock (9%).

A reduced availability of PPPs could also rapidly translate into yield reductions and a drop in overall agricultural output, thus generating criticalities in the internal supply model of European Agri-food.

These indications, in fact, have emerged from the initial findings of the current study, the final results of which will be presented at the end of the year. Similar results were seen in other studies. For example, Oerke and Dehne (1996) have found that "Crop protection – chemical, mechanical, and biological – based on modern technologies and applied by responsible and well-trained farmers has the potential to increase crop productivity considerably in many regions." Yet the opposite is also true, as yields could decline significantly without crop protection practices, as estimated in the study which showed that in Western Europe 61% of potential crop losses (calculated from yield reductions due to diseases, animal pests and weeds) are prevented by the efficacy of crop protection practices.

The PPP industry also plays an important role in the European economic system, making a substantial contribution to the production of value and employment as well as sustaining R&D investment.

THE CONTRIBUTION OF PLANT PROTECTION PRODUCTS (PPPS) IN AGRICULTURE

Beginning in the 1960s, the Green Revolution introduced new technologies (fertilizers, PPPs, irrigation, mechanisation, etc.) that were able to help farmers increase crop yields. The gains in production were significant: world cereal yields nearly doubled from 1.4 tonnes per hectare in the early 1960s to 2.7 tonnes per hectare in 1989–1991, with an increase in the use of PPPs of 7–8% per year (World Food Summit, 1996). At present, despite the increasingly strict set of regulations that substantially limit the use of PPPs, due to the development of new technologies and substances, PPPs still represent one of the main inputs in farm production.

However, since the 1970s, the extensive use of PPPs began receiving increased attention from consumers and politicians regarding the environmental and health impacts of such products. At the same time, the PPP producers invested substantial resources in R&D in order to discover and develop new active substances and formulation technologies. This improved products would serve the objectives of higher specificity and reduced toxicity versus non-target organisms, minimisation of environmental pollution, and improved safety (also for the operator), as well as easier application.

New production techniques that have a lower impact on health and environment have been introduced into the agronomic management of crops. In particular, Integrated Crop Management (ICM) is an approach that helps to reduce a farmer's dependency on PPPs. ICM "seeks to provide efficient and profitable production which is economically viable and environmentally responsible and delivers safe, wholesome and high quality food through the efficient management of livestock, forage, fresh produce and arable crops whilst conserving and enhancing the environment" (EISA, European Integrated Farming Framework, 2006). The ICM approach to crop protection calls for a well-established and managed crop that is better able to compete with weeds, more resilient to pests and diseases and requires fewer inputs of PPPs. ICM practices include the use of pest-resistant plant varieties, regular monitoring for pests, use of natural predators and appropriate choice and application of PPPs and good crop management practices that may be used singly or in combination to control or prevent particular pests.

At the same time, there has been an increasing use of production techniques that use lower levels of PPPs, especially organic farming. This method of production mainly relies on several techniques (crop selection, crop rotation, encouraging beneficial predatory insects and beneficial microorganisms, natural PPPs, etc.) which allow farmers to control weeds, insects and other pests to some extent without resorting to synthesised PPPs. These systems of production have spread throughout Europe and the world, but do not account for any significant levels of output or affect large areas of cultivated terrain. In fact, these natural chemical methods do not always provide the same level of protection as the conventional systems.

A recent study focusing on a 100% organic farming scenario in Danish agriculture demonstrates that the yield per hectare for all types of fruit and berries grown organically is considerably lower than the yield from conventionally grown fruit and berries. With the existing crop varieties, average yields in organic production have been found to have fallen by 40–85%, but there are large variations between crop types (Bichel Committee, 1999). Another long-term experiment, regarding organic farming carried out in Central Italy, showed that wheat yield was about 50% lower than yield using conventional techniques (Mazzoncini et al., 2007). Finally, a survey on organic potato production in the EU shows that compared to conventional production yields, organic production yields are estimated to be 30–40% lower (Leifert, 2003).

The use of PPPs also ensures healthy production through the reduction of natural contaminants (i.e. mycotoxins, fungi in wine, insect residues, etc.). In this context, one of the main roles played by crop protection practices is the control of toxigenic fungi and the minimisation of plant infestation.

BOX 8 | **PPPS AND MYCOTOXINS**

Recently, new fungi species, which in the past were considered to be of minor importance due to their limited damage to crops, have become critical, especially in wheat, maize and grape production and their derived products like pasta, milk and wine. This is due to the fungal ability to produce mycotoxins, secondary metabolites with negative chronic toxic properties for livestock and humans. Due to the toxicity of such natural contaminants, the European Authorities have set limits in different food and feed matrices which have to be respected to ensure food and feed safety. An integrated crop management approach, including crop protection measures, is widely recognised as effective in minimising the risk of micotoxins in food and feed.

The biological efficiency and selectivity of PPPs have consistently improved over time. The introduction to the market of selective PPPs has allowed farmers to target certain pests very specifically, without harming non-target organisms such as ladybirds, bees, etc. These products also have improved environmental and human health properties compared to the older broad-spectrum PPPs. In fact, the EU has already established strict regulations that protect the environment and human health. Moreover, selective PPPs can be well integrated into ICM, as their activity spectrum is very specific. A typical example is the use in greenhouse applications of bumble bees or other pollinators that are not harmed by selective PPPs.

The availability of a large number of Active Substances (AS) is a key factor in maintaining a satisfactory choice of products to address various pest pressures in changing contexts. One of the most important research activities relating to PPPs (and also ICM) has been to address the phenomena of resistance and adaptive pests. In order to achieve this objective, first of all there is need for rational use of PPPs through practices like ICM, low-dosage products and economic thresholds (pest density that causes damage equivalent in value to the cost of the treatment). Second, there is a need for a large variety of active substances to offer farmers a wider range of solutions, with which to control the rapidly evolving pest challenge.

Another significant aspect that has to be taken into account is the protection and conservation of the universally accepted world germplasm (the genetic material that comprises the physical basis of the inherited qualities of an organism). Having an extensive variety of diversified germplasm available is as important as having a large range of AS. An eventual loss of the world germplasm can generate many problems when new pests or old pests that have developed resistance hit vulnerable or non resistance-selected crops. Such an event could generate a phytosanitary crisis which would be difficult and costly to resolve. Some surveys have demonstrated that "old" germplasm has turned out to be very useful, because it introduced new and useful features that allowed farmers to resolve modern intensive-farming phytosanitary emergencies. Whenever phytosanitary emergencies occur, genetic improvement is an effective but long process. PPPs indeed could be used over a shorter time period; but this is only possible as long as the authorisation system operates smoothly and quickly.

BOX 9 | **BIODIVERSITY AND PPPS**

One of the main contributions of PPP use to biodiversity conservation relates the fact that agricultural productivity per land unit is improved using these products. This generally reduces the need to convert more natural habitats to farmland.

Among the biggest economic threats to biodiversity is the spread of Invasive Alien Species (IAS) as they often outcompete native species and hence threaten the conservation of local, national, regional or global biodiversity. The management of invasive plant species is key to the health of many ecosystems, and the use of PPPs is an important tool in this context.

To protect biodiversity, research and development (R&D) activities of the PPP Industry need to integrate biodiversity conservation aspects before a product enters the marketplace. The EU directive 91/414 EEC, aims at protecting the environment and requires very sophisticated holistic evaluations to mitigate any potential unwanted effects.

ICM is an important tool for biodiversity conservation; it encourages the establishment of both temporary (i.e. rotating) and permanent areas of natural habitats within the farmed landscape. In fact, strategies for simultaneously increasing agricultural productivity and conserving biodiversity range from encouraging wildlife habitats to establishing conservation areas on farms and in surrounding landscapes. Consequently, networks of production systems and wild biodiversity areas form part of an integrated landscape management approach. A challenge for European agriculture in the future will be to embed biodiversity conservation objectives in crop management practices, supported by enabling technologies such as PPPs, in order to enhance productivity and profitability, while being tailored to local conditions and needs

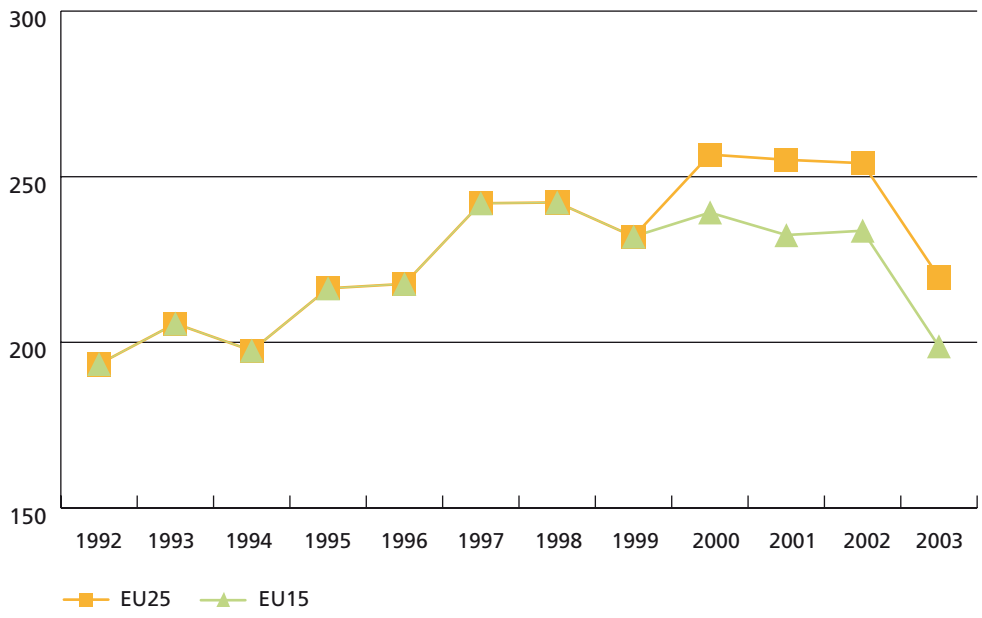
USE OF PPPS IN EUROPEAN AGRICULTURE

The total amount of PPPs used in the EU increased steadily in the 1990s, stabilising by the end of the decade and then declining continuously from 1999 onwards (in 2003 it fell 15%). This decrease is accounted for by the EU-15, since the consumption of PPPs in the 10 New Member States slightly increased during this period.

An analysis of only the quantities of PPPs used in agriculture does not provide a relevant picture of the dynamics in the use of these products. In fact, in order to have a more precise understanding of the situation, it is necessary to evaluate the change in the use of these products with regard to climate conditions and evolution of crop protection techniques, the number of products available and their characteristics (very different in their functions, application techniques, and impact on environment and human health). Only by evaluating all of these different aspects in conjunction is it possible to understand the fluctuations and identify the trends.

The susceptibility of crops to pests and diseases is highly dependent on the weather. Consequently the type, quantity and application methods of PPPs used in cultivated areas depend heavily on weather conditions and temperature. Generally warm weather favours the growth and development of the insect population, while abundant rainfall increases the level of moisture – hence the intensification of the presence of fungi and of weeds – thus pointing towards an increase in the need for PPPs. A change in climate from one year to the next could lead to significant differences in the quantity of PPPs used (in terms of quantity per application and frequency of application). It should be taken into account that the succession of dry springs and summers in Central and Northern Europe since 2000 have restrained pest development (especially fungi), hence the reduction in Active Substance usage in those areas.

TABLE 10 | **USE OF PPPS TOTAL EU-15 AND EU-25 (1992–2003, IN TONNES OF AS)**



Source: Nomisma elaborations on EU (Eurostat).

TABLE 11 I **RANKING OF 8 MOST COMMONLY USED CHEMICAL CLASSES (IN TERMS OF QUANTITY USED, 1992–2003)**

	CHEMICAL CLASSES 1992		CHEMICAL CLASSES 2003	
1	Inorganic sulphur	F	Inorganic sulphur	F
2	Dithiocarbamate	F	Organophosphorus	H
3	Urea	H	Dithiocarbamate	F
4	Copper compounds	F	Urea	H
5	Triazine	H	Phenoxy	H
6	Phenoxy	H	Soil sterilants	H, I, N
7	Organophosphorus	H	Plant Growth regulators	
8	Thiocarbamate	H	Chloroacetanilide	H

F: fungicides; H: herbicides; I: insecticides; N: nematocides. Source: Nomisma elaborations on EU (Eurostat).

Thanks to significant investments in R&D, innovative technologies have been developed and new types of products were phased into the agrochemicals market. Since 1992 a change in the ranking of the chemical classes reflecting the replacement/substitution effect, therefore also the fluctuation of the overall PPP consumption, has occurred.

Due to the introduction of new products and the progressive substitution of those previously utilised, a classification based solely on the volumes of active substances is not sufficient to illustrate the important changes that have occurred in the use of PPPs over the last decades, especially for products used in small quantities. As a matter of fact, these technological developments have allowed farmers to limit pest resistance phenomena and thus help protect biodiversity. Products used at high dosage rates have been replaced by substances active at very low dosages; at present, in order to control different pests, farmers use a higher number of products (less toxic and with narrow-spectrum skills), but that need to be applied at lower dosages and with a different and more intense frequency. They also have the possibility to rotate them (this was not possible in the past since there was only one broad-spectrum product), so that pest-resistance phenomena are not induced. This also could explain a possible increase in overall AS consumption. In addition, the growing role of prognosis systems in the decisions to treat important crops, such as potatoes, cereals or grapes, could also be considered a possible reason for the decrease in PPP use.

Most of the EU's PPP consumption is concentrated in three main crop categories: fruit (especially grapes), cereals and potatoes. In particular grapes and potatoes require fungicides, which are usually applied at high dosages (grapes need between 20 kg and 30 kg of AS/ha, depending on weather conditions), and insecticides. In the cultivation of grapes, sulphur is used both in conventional and in organic production (at a rate of 20 to 30 kg/ha). Although cereals require herbicides at lower dosages (between 1 kg and 2 kg of AS/ha), the high levels of total consumption of this type of PPP is a function of the extensive land area planted in Europe.

These consumption levels also provide indications of the distribution of PPP use in the EU-25 Member States. In 2003, five countries (France, Spain, Italy, Germany and the United Kingdom) together accounted for nearly 75% of the total quantity of PPPs used in the EU-25. These same countries are also the main European agricultural producers (66% of EU-25 agricultural production in 2005), accounting for the largest shares of cultivated area in the EU (63% of EU-25 utilised agricultural area).

France, Italy and Spain were the main users of fungicides. This situation is explained by the predominance of these three countries in grape production (83% of the total EU-25 area cultivated with grapes). In 2003, sulphur still accounted for 76% of all fungicides used on this crop. With regard to herbicides, France, Germany, Spain and the United Kingdom together accounted for 63% of the total consumption of these PPPs. Cereals and maize are the main consumers of herbicides. The insecticide market is dominated by Italy and Spain; together with France, they account for 80% of the total EU-25 insecticide consumption. The geographic location of Southern Europe, in fact, leads to a far greater vulnerability to the attack of insects. Finally, the use of plant growth regulators is almost exclusively associated with cereal crops. Data show that 71% of the total volume of these products is used in France, Germany and in the United Kingdom (Eurostat).

PPP INDUSTRY AND RESEARCH

Companies producing plant protection products (PPPs) contributed significantly to the sharp increases in agricultural productivity in the 1970s and 1980s, a period of significant growth for the industry. Yet in the 1990s, the world market for plant protection products (PPPs) was faced with several new challenges: crops that were more resistant to disease and pests and changing regulatory requirements. The latter were motivated by increasing social and government concerns about health and environmental effects of PPPs. These developments were accompanied by changes in cultivation practices and support measures due to CAP reforms as well as fluctuations in world commodity markets. Thus, PPP companies made significant investments in order to address the changes in the market conditions for PPPs, both in adapting products to the modified plant characteristics of some cultivars and developing products that will continue to be approved by relevant registration bodies. As a result, since the 1990s the world agrochemicals industry has undergone a significant restructuring and consolidation, via a series of mergers and acquisitions, leading the seven largest companies to account for around 85% of the world market, with the 30 largest companies responsible for 98% of sales.

Another challenge for the major agrochemicals companies is the protection of intellectual property and competition from generic agrochemical companies. Sales of generic and post-patent products have increased substantially, while in many cases R&D costs were originally sustained by the major R&D-driven companies. Particularly India and China are now playing major roles in the generic market. Generic PPP sales are estimated to account for around 19% of the European agrochemicals market (Brookes, 2006); at the global level some sources estimated this share to be as high as 30% (Jarvis, 2005). This is supported by data for 2005, showing that the patented share of the market was only 29.9%, whereas 70.1% of PPPs are off-patent (32.9% proprietary-off patent and 37.2% generic) (Phillips McDougall, 2007). Competition by generic producers is increasingly facilitated by free access to regulatory data generated by the R&D-based industry, thus creating unbalanced competitive conditions.

In 2005, the global PPP market was valued at US$ 31.19 billion or € 25.11 billion, with the value of the European PPP market (EU-25 and EFTA) T € 6.69 billion (ECPA, 2006). Europe represented 29.2% of the global market in dollar terms in 2005, ahead of NAFTA (24.9%) and Asian (24.8%) regions. In 2006, the overall value of the PPP market in dollar terms declined by 2.5% from 2005, with Europe's share expanding somewhat to 30.3% of the total (Phillips McDougall, 2007). Europe and North America will remain the largest markets for PPPs, since these economies apply effective agriculture practices, which require high-technology inputs (seeds, fertilizers, PPPs, irrigation and mechanisation), but most growth is now expected in developing and emerging countries, where registration procedures are less well implemented and more innovative agricultural management approaches are being adopted.

TABLE 12 | **GLOBAL ACTIVE INGREDIENT INTRODUCTIONS AND RESEARCH/DEVELOPMENT (1980–2005)**

PRODUCTS	1980–1989	1990–1999	2000–2005	IN RESEARCH & DEVELOPMENT
Herbicides	51	57	21	18
Insecticide	29	37	16	15
Fungicides	36	29	24	16
Others	7	3	4	0
TOTAL	**123**	**126**	**57**	**45**
Ave. annual rate of introduction	**12.3**	**12.6**	**10.8**	**9.8**

Source: Phillips McDougall (2007).

The industry reported a total of 26,400 employees in the EU-15 and Switzerland in 2004. Of these, over 12,000 were involved in production and logistics, 5,800 in sales & marketing and 5,200 in technical support, including R&D on the plant protection products in use (Phillips McDougall, 2005). These figures are down from those reported by the same source for 2003, when employment in R&D and technical services totalled 6,344.

While agrochemical companies are increasingly under pressure from stagnating market demand and stricter regulatory requirements, particularly in Europe, they have also been faced with rising costs of R&D and product registration procedures. It is estimated that most large R&D-driven crop protection companies invest 8–12% of turnover in R&D (Bijman, 2001). In comparison, R&D spending by generic companies is only about 1–2% of sales (Brookes 2006). One of the factors in the high cost of R&D is that, according to industry sources, only one out of 200,000 compounds eventually becomes a new plant protection compound (Bijman, 2001). While in the 1980s and 1990s, an average of more than 12 new active ingredients per year were introduced, in the most recent period (2000-2005) this has declined to less than 11 per year, reflecting lengthier and more costly R&D and registration phases.

The cumulative total of R&D spending by the agrochemical industry in 2004 was valued at US$ 2.25 billion, including US$ 705.2 million for discovery, US$ 506.8 million for new product development and US$ 397.2 million for re-registration (Phillips McDougall, 2005). In 2004, the R&D expenditures of the three largest European producers of PPPs totalled nearly US$ 1.57 billion, rising slightly to nearly US$ 1.58 billion in 2005. This represents a 42.7% increase in R&D investment from US$ 1.1 billion in 2000 (Phillips McDougall, 2007). In comparison, R&D spending in PPPs by the leading US agrochemical companies was only about a third of the European level in 2005 (US$ 557 million). Some of the spending on R&D by European companies takes place outside of Europe, whereas companies from the USA, Japan and other countries also engage in some R&D activities in Europe: recent industry estimates suggest that total spending on R&D for PPPs conducted in Europe is at least US$ 1 billion.

TABLE 13 | **AGROCHEMICAL INDUSTRY R&D EXPENDITURE SPLIT BY R&D PHASE (2004)**

R&D Activity	Expenditure (US$ M)	% of Total
Discovery	705.2	31.3
New Product Development	506.8	22.5
Costs of managing existing business, excluding re-registration	558.7	24.8
Re-registration	397.2	17.7
Patents	82.1	3.7
Total	2,250.0	100.0

Source: Phillips McDougall (2005).

According to industry sources, it can cost up to US$ 280 million and take up to 10 years to bring a product to market. An earlier Phillips McDougall study showed that

costs of bringing new PPPs to market have increased steadily over the years: in 1975–1980 this averaged US$ 23.1 million and has risen to US$ 152 million in 1995 and US$ 184 million in 2000. During 1995–2000, total research costs increased 30.6%, while total product development costs of the 10 largest agrochemical companies increased by 17.9% (at nominal value), driven mainly by rising costs in field trials (38.9%) and environmental chemistry (23.1%) (Phillips McDougall, 2003).

Developing new active substances generally takes 8–10 years (ECPA, 2006). Thus, not only must cost be considered in investment decisions, but also the time to market – a critical factor in maintaining competitiveness. During 1995–2000, the lead time between the first synthesis and first sale of a PPP increased from an average of 8.3 to 9.1 years (Phillips McDougall, 2003). Lengthier and more rigid registration requirements have also increased the cost of development and testing.

The crop protection industry is an important contributor to the European capacity for innovation and research and development. Risk of public under-spending for such research could lead to an erosion of the EU's current capacity for plant science R&D, coupled with the unpredictability of the EU regulatory framework (Schenkelaars Biotechnology Consultancy, 2005). High cost of compliance with the regulations has created difficult conditions for the field which is not the case in the USA and other countries. There has been a lower number of new substances registered in Europe than in the US. Future development is also constrained by the low number of students taking up chemistry and plant sciences in Europe.

The attention focused on R&D activities has always been high within the European Union. The key role which it plays in facilitating economic growth has recently been further emphasised in the mid-term review of the Lisbon Strategy.

The EU is currently spending an average of around 2% of GDP on R&D (ranging from below 0.5% to above 4% of GDP in different Member States), barely up from the level at the time of the launch of the Lisbon strategy. Moreover, only around 55% of research spending in the EU is financed by the private sector. Low levels of private R&D investments are identified as one of the main explanations for the EU/US innovation gap. More rapid progress towards meeting the collective EU target of raising research investment to 3% of GDP is needed. The main challenge is to put in place framework conditions, instruments and incentives for companies to invest in research.

Conversely, the PPP industry is characterised by high levels of investment in R&D (8–12% of turnover). Yet over the last few years, research activity has slowed down, with a lower capacity in Europe to bring new active substances to the market compared to that in the United States, and a significant rise in the cost of registration. In a phase in which a large share of the products subject to review are being withdrawn from the market, due to the application of Directive 91/414/ECC, research activity is essential in guaranteeing an adequate modernisation of the European PPP portfolio and in ensuring that farmers will have appropriate tools to control plant pests and weeds. In

BOX 10 | **THE LISBON STRATEGY**

The "Lisbon Strategy", launched during the European Council meeting in Lisbon (March 2000), aims to make the European Union the most competitive economy in the world and achieve full employment by 2010. This strategy rests on three pillars:

1. An economic pillar preparing the ground for the transition to a competitive, dynamic, knowledge-based economy. Emphasis is placed on the need to adapt constantly to changes in the information society and to boost research and development.
2. A social pillar designed to modernise the European social model by investing in human resources and combating social exclusion. The Member States are expected to invest in education and training, and to conduct an active policy for employment, making it easier to move toward a knowledge economy.
3. An environmental pillar, which was added during the Göteborg European Council meeting in June 2001, drawing attention to the fact that economic growth must be decoupled from the use of natural resources.

The mid-term review held in 2005 showed that the results achieved had been unconvincing, so the Lisbon Strategy was re-launched, placing jobs and growth at the top of European political priorities. Knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. Increasing and improving investment in R&D, with a view to establishing the European knowledge area is a key objective.

fact, agriculture is and will continue to be a strategic sector in the European socio-economic framework, but in order to ensure the same levels of productivity and competitiveness, it is necessary for agriculture to continue to have access to a range of production-enhancing inputs, including PPPs.

THE REGULATION ON PPP PLACEMENT IN THE MARKET: TOWARDS THE NEW PROPOSAL

Developed countries have dedicated many resources to their administrative and R&D sectors in order to improve safety of PPP use (developing more selective products, safeguarding the environment and human health, organic farming, fostering ICM, improving local assistance in PPP management). However, developing and least developed countries are not able to guarantee the same level of protection due to a lack of resources and less effective implementation of regulations. There is thus an important imbalance between the guarantees offered in the use of PPPs by the two groups of countries.

In the EU-27 these guarantees are even more comprehensive due to the effect of strict regulations covering the placement of PPPs on the market and maximum residue levels in food. PPPs used to protect plants or plant products are mainly regulated by Directive 91/414/EEC on the placing of plant protection products on the market. The Directive states that Active Substances cannot be used in plant protection products unless they are included in an EU positive list. An EU programme of evaluation to revise this list is under way (chemical substances or micro-organisms, including viruses, in PPPs are only approved for use if they have undergone a risk assessment, and safe use has been demonstrated through a peer-reviewed safety assessment). Most of the AS currently under evaluation are those used in PPPs (including PPPs for organic agriculture), but others are not. All AS uses are covered, not just those applicable to agriculture. Once a substance is included in the positive list, Member States may authorise the use of products containing them.

Over the last several years, as required by Directive 91/414/EEC, the market availability of various AS was progressively subject to revision. The effect of the Directive since 1993 is that 55.4% of the AS can no longer be authorised for use in the EU. With the application of these norms, over the next several years there will be a consistent reduction in the availability of PPPs for European agricultural production that cannot always be promptly substituted by new products because of the time required for research, development and registration. A review of this Directive has been carried out over the last few years, suggesting amendments on parallel trade of PPPs, the exclusion or substi-

TABLE 14 | **STATUS OF AS UNDER EU REVIEW (DOC. 3010)**

STATUS	NUMBER	SHARE
Included in annex I*	165	15.1%
Not included in annex I**	604	55.4%
Pending or notified***	321	29.4%
TOTAL AS	**1,090**	**100.0%**

* Substances included in annex I to Directive 91/414/EEC, and that therefore can be authorised in the EU.
** Substances not included in annex I to Directive 91/414/EEC, and that therefore cannot be authorised in the EU.
*** Substances for which the evaluation is still ongoing. Pending any decision, they can be authorised in the EU.
Source: Nomisma elaboration on EU – DG Health and consumer protection (Update 28/06/2007).

TABLE 15 | **PREDICTED IMPACT OF CRITERIA IN THE NEW PROPOSAL: SHARE OF PPPS AFFECTED**

	COMMISSION EVALUATION	ECPA EVALUATION
Trigger non-approval criteria	5%	30%
Candidates for substitution	15%	Up to 50%
TOTAL AFFECTED	**20%**	**60%**

Source: Nomisma elaboration of European Commission and ECPA data.

tution of many AS, cut-off criteria, procedures for the introduction of new substances and products, data protection, transparency, Mutual Recognition and Zonal Authorisation and Integrated Pest Management.

The proposal for a new Regulation replacing Directive 91/414/EEC is now also under discussion in the European Parliament. This proposal was analysed in order to understand the likely number of active substances affected by non-approval ("cut-off") criteria and criteria to identify "candidates for substitution". The respective conclusions of the European Commission and the European Crop Protection Association (ECPA) varied greatly, as seen below.

The Commission's data provides a summary of the present situation, including the current classification of substances. The Commission considers that some substances, for which the 91/414 review has yet to be completed, would not be withdrawn from the market for reasons other than the exclusion criteria. ECPA, however, believes that a more holistic approach must be taken, given the impact on the market as it now exists, plus substances at risk of being classified in the future, using the criteria that have been identified in the proposal.

The current legislation on PPPs regulates their placement on the market, but at present there are not actually any specific regulations to monitor the correct use of these products by farmers. Following clear label instructions and best agricultural practices, farmers should make every effort to avoid unacceptable damage to the environment and risks to human health. Sustainable Use legislation was recently proposed in order to incorporate rules on PPP use into the existing legislative framework. This proposal is a part of the package of measures (including Dir. 91/414/EEC) which will make up the European Commission's strategy for PPPs. The purpose of the new Sustainable Use Directive is to create a legislative framework establishing a set of guidelines that must be observed to allow profitable integrated farming following the best agriculture practices over a long term perspective. However, the present draft also contains a set of short-term measures that will reduce the use of PPPs.

Yet the trend in the legislation and regulation of active substances used in agriculture, such as PPPs, is toward use reduction and potential prohibition. This becomes evident in the current revision to Directive 91/414/EEC, which governs the placing of plant protection products on the market, and in the proposed Directive on the Sustainable Use of Pesticides. Denying farmers the use of such important tools, while at the same time restricting use of GMOs, will result in inevitable difficulties in controlling plant pests (insect, fungi, virus, etc.) and weeds. This will generate unavoidable impacts on the overall agricultural production of the EU-27, which would experience a contraction in yield and will consequently lead to negative repercussions for the Agri-food industry. Also there will be particular impacts on European farmers, whose production systems are already today characterised by higher costs than in countries with less restrictive regulatory systems. Thus, in this manner, farmers are in danger of losing an important technological tool in their production processes, with negative effects on income.

A possible solution could be offered by the further expansion of R&D activities to develop innovative products that are more effective with lower impacts on health and the environment, even though the current proposal does not offer sufficient elements to stimulate further research, especially in terms of the uncertainties in the time to market required and the return on significant investment.

5 CONCLUSIONS

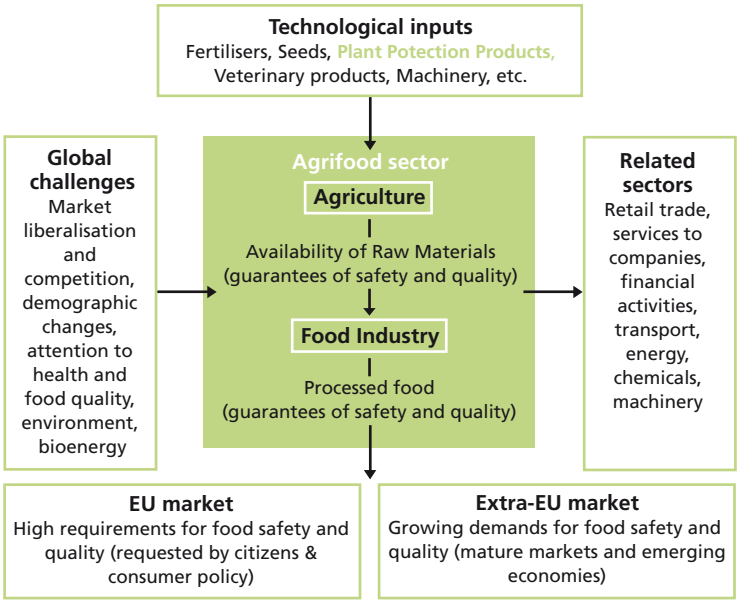
At present, the European Agri-food sector is faced with a rapidly evolving global scenario. Increases in population and income, economic growth of emerging countries and the progressive liberalisation of markets have changed the competitive environment and require a strong commitment by the European Agri-food sector to adapt to the new conditions. In addition to the socio-economic aspects of the global economy, increasing attention must also now be devoted to health and environmental issues, which in turn shape the dynamics of the sector.

Whereas the European Agri-food sector must respond to the different external challenges, within the EU there are profound changes occurring in the regulatory framework that affect the production processes of European businesses. In particular, in this study the focus is on the evolution of the regulatory framework for plant protection products (PPPs). The purpose of this study is to provide a better understanding of the relationship between the competitiveness of the European Agri-food sector and the evolution of the regulatory framework for the placing of plant protection products on the market.

The research is being carried out in two phases. The first phase, which is the subject of this report, examines the role of the Agri-food sector in the European economic system, the evolution of global trends and dynamics, and the challenges that these present for the sector. While recognising the contribution of different technologies that support agricultural activity, the focus in this study is on the role of Plant Protection Products (PPPs), which are an important factor in productivity of agriculture and thus the competitiveness of Agri-food.

The second phase of the study, which will be available at the end of 2007, will analyse the evolution of EU legislation regarding PPPs and the quantification of effects on the productivity of European agriculture due to a reduction in PPP availability. Implementation of current and new regulations will limit the number of available products and create conditions that do not stimulate research activities aimed at introducing new active substances. Finally, the research will also demonstrate how agricultural technologies play a vital role in maintaining long-term productivity, profitability and competitiveness of the European Agri-food sector, with all of its attendant societal benefits.

FIGURE 4 I **STUDY APPROACH: MAIN RELATIONSHIP AND INDUCED EFFECTS OF AGRI-FOOD**



The approach followed in outlining these concluding considerations begins with the assumption of reduced PPP availability, which could result in a significant contraction of EU-27 agricultural output. These indications, in fact, have emerged from the initial findings of the ongoing study. This development affects various important aspects that are addressed in the following section.

Agri-food represents a key sector in the European economic panorama. A decline in the capacity for self-sufficiency in primary agricultural products will create inevitable negative repercussions. Not only would it create greater pressures on global supply chains, but it would also impact on other parts of the economic system that are associated with the Agri-food sector, thus moving against the objectives of the Lisbon Strategy aimed at promoting greater competitiveness, productivity, growth and full employment.

The economic dimensions of the Agri-food sector demonstrate that it is of primary global importance (leader in agricultural production, food production and trade flows) and strategic for the European economic system (4% of GDP, more than 18 million persons employed, equivalent to 8.4% of total employment).

Agricultural and food demand are satisfied by 7.4% of total European output. Agri-food, in fact, is closely linked with other sectors (wholesale and retail trade, services to companies, financial activities and transport, etc.). Due to its extensive linkages, growth in the Agri-food sector also has important positive effects on associated sectors, unleashing a virtuous process of value creation that benefits the entire economy. Conversely, the impact of a contraction in Agri-food demand will not remain limited to the sector, but is likely to have repercussions throughout the value chain involving other associated sectors, generating a negative impact that is much larger in terms of its effects on output, businesses and related employment.

The European Union represents an important basin of world production of agricultural commodities and has historically had problems of over-production. In recent years, however, there has been evidence of a reversal of this trend, which could further be aggravated over the next few years. In this scenario, the EU-27 needs to resort to increased supplies of agricultural products from international markets at a time that is particularly sensitive in terms of heightened demand and consequent escalation of prices.

The EU is the leading global producer of Agri-food products. Despite this leadership role, Europe's agricultural trade balance is afflicted by a structural deficit, which has been steadily growing from the beginning of 2000. If this trend continues, the EU-27 risks losing its self-sufficiency in several important agricultural products over the medium term.

A lower level of self-sufficiency of the EU-27 could be compensated to some extent by a further increase in imports, but in the last few months there have emerged numerous signals of possible tensions on international markets regarding the supply of primary agricultural resources (increased demand of the emerging economies, production of biofuels, etc.). Besides these structural dynamics that affect the EU-27 Agri-food sector, it is also possible that there will be a drop in agricultural productivity associated with a reduced availability of PPPs. In such a case, further negative impacts on the level of European self-sufficiency are inevitable.

Quality represents the main competitive advantage of the EU in succeeding in international markets. In certain production branches, this is intrinsically linked to the internal production of primary agricultural resources. The high level of European attention to quality associated with specific territories is seen in the success of the Protected Domination of Origin (PDO) and Protected Geographical Indication (PGI) products. In the global market there is progressively increasing demand for quality and healthy products. A decline in European production could

thus lead to a dual loss: on the one hand, the EU-27 could not take advantage of new market segments that are currently developing, and, on the other hand, would even lose part of its current export share with important impacts on the entire economic system.

In an international context which is moving toward progressive liberalisation, extra-EU commodities will be more competitive than those from the EU, due to lower labour costs and economies of scale. EU-27 competitiveness relies on the high quality level of its processed food products, which emerging economies, thanks to progressive population and income growth, will demand in increasing quantities.

The key to the success of European Agri-food in international markets is quality, which is ensured by various approaches, such as quality assurance systems, quality labels and designations of origin associated with specific territories (like PDO and PGI, etc.). Such products represent important elements of European culture and lifestyle. However, an essential precondition guaranteeing the model of European quality production is to have access to primary agricultural resources produced according to European standards. The current progressive decline in European self-sufficiency could be further aggravated by a decline in agricultural productivity associated with a reduced availability of PPPs. A drop in agricultural production would translate into a potential fall in food manufacturing output (in terms of both quantity and quality), which would undermine, first of all, the competitiveness of the EU-27 exports and secondly, the overall trade balance of the Agri-food sector.

Food safety is a major requirement that European citizens seek to have satisfied by the agricultural sector. Various EU policies (Consumer protection, CAP, Rural Development) are implemented in a coherent manner to defend one of the principal values of European food production. In pursuing this objective, the best guarantees are offered by the European production model. A decline in internal production would expose European consumers to increased food risks.

Besides quality, another element characterising the European Agri-food sector is the high level of hygienic and health guarantees that are offered by the European production system. This is the result of growing attention to food safety within European institutions that are involved in specific policies to protect consumer health. In addition, a number of different quality assurance schemes (QAS) are applied throughout the EU, some mainly meant to provide guarantees on the producing firm and/or its organisation.

For the European Union, the strong link between the different parts of the food chain represents an important factor in guaranteeing the safety of final products, since they are controlled by shared production standards. A decline in agricultural productivity could compromise this system of quality and safety guarantees in the sense that it would make Europe more dependent on supplies of primary resources from extra-EU sources, which are not able to offer the same hygiene and health guarantees.

A robust agricultural sector will allow strengthening the positive impacts associated with the multifunctionality of the European agricultural model, which, besides the production of agricultural goods, contributes to the preservation and protection of the environment, the territory and the landscape as well as animal welfare, the development of integrated economic activities and countering the phenomenon of depopulation of rural areas.

Over the years, the European Union has paid significant attention to maintaining agricultural multifunctionality and has launched numerous initiatives that are coherent with this objective. This model of multifunctional agriculture, which has been adopted extensively only in Europe, represents a privileged instrument in ensuring, on the one hand, adequate development of rural

areas (92.7% of EU-27 territory and 58.3% of population) and, on the other hand, protecting the environment and its precious resources.

Ensuring the competitiveness of European agriculture thus also means supporting the other functions it plays and providing them with a future.

The European agricultural model is subject to a system of strict regulations on placing PPPs in the market and their use which offers a series of high-level measures to protect human health and the environment. This is a further reason to support the preference for European Agri-food products as opposed to those from outside the EU. Maintaining this system of guarantees and assurances has a cost for European agricultural enterprises, and it contributes to the gap in competitiveness compared to developing countries.

Developed countries have dedicated many resources to their administrative and R&D sectors in order to improve safety of PPP use (developing more selective products, safeguarding the environment and human health, organic farming, fostering ICM, improving local assistance in PPP management). In contrast, most developing and emerging countries' regulations often are not effectively implemented, hence the standards are lower.

This generates an imbalance between the conditions for competitiveness and productivity affecting the production systems of the two groups of countries. On the one hand, the guarantee of food safety and quality offered by the use of PPPs is higher in developed countries and particularly in the EU. On the other hand, the gap in competitiveness of European agriculture associated with the application of a system with very rigid regulations should not be ignored.

A change in the system regulating the market placement of PPPs will generate negative direct impacts on the agrochemicals industry, which plays an important role in the R&D and innovation capacity as well as the competitiveness of the EU as a whole in the context of the Lisbon Strategy.

The EU is currently spending around 2% of GDP on R&D; only around 55% of this is financed by the private sector. Low levels of private R&D investments are identified as one of the main explanations for the EU/US innovation gap. In contrast, the PPP industry is characterised by high levels of investment in R&D (8–12% of turnover) and has an important employment impact, particularly for high-technology driven jobs. The PPP industry is an important actor in the growth of the European economy, and its contribution is essential in the pursuit of the objectives defined by the Lisbon Strategy.

Yet over the last few years, while expenditure on R&D by European companies has risen, the rate of introduction of new active substances to the market has been slowed by a significant rise in the cost of registration and time to market. In a phase in which a large share of the products subject to review are being withdrawn from the market, due to the application of Directive 91/414/EEC, research activity is essential in guaranteeing an adequate modernisation of the European PPP portfolio and in ensuring that farmers will have appropriate tools to control pests and weeds. A legislative and regulatory framework must be developed for agricultural technologies such as PPPs which stimulates the research and development of ever-improving solutions for farmers, enabling them to secure the supply of high quality, safe, and affordable raw materials for the Agri-food industry.

BIBLIOGRAPHY

ACNielsen (2005); "Global Consumer Confidence & Opinions Survey".

Banks J., Long A., Van der Ploeg J. D. (2002); "Living Countryside: Rural Development Processes in Europe – The State of the Art", Elsevier, Doetinchem.

Bijman J. (2001); "Restructuring the life science companies", Biotechnology and Development Monitor, No.44/45.

Brookes G. (2006); "Impact assessment of the EU Commission's proposal to change the way in which plant protection products are approved in the EU", Briefing paper study developed for ECPA.

Chataway J., Tait J., Wield D. (2003); "Understanding company R&D strategies in agro-biotechnology: Trajectories and Blindspots", Innogen Working Paper 2.

CIIA, 2005, Annual Report.

CIIA, 2006, Annual Report.

CIIA, 2006, Data & trends of the European and food drink industry.

Cockburn I.M. (2007); "Global Innovation in the Pharmaceutical Industry", Incomplete Draft Prepared for the National Academies STEP Board Conference on Globalization of Innovation: Emerging Trends in IT, Biopharma and Financial Services.

Commission of the European Communities (2001); "Biodiversity Action Plan for Agriculture", COM(2001)162 final, volume III.

Commission of the European Communities (2005); "A quality environment: How the EU is contributing".

Commission of the European Communities (2006); "An EU Strategy for Biofuels, impact Assessment", Commission staff working Annex to the Communication from the Commission, COM(2006)34 final.

Commission of the European Communities (2006); "Food: From farm to fork statistics".

Commission of the European Communities (2006); "Proposal for a Regulation of the European Parliament and of the Council Concerning the Placing of Plant Protection Products on the Market", Com(2006) 388 final.

Commission of the European Communities (2006); "Report on the impact assessment for a regulation replacing directive 91/414/EEC on plant protection products".

Commission of the European Communities (2006); "The EU rural development policy 2007-2013".

Commission of the European Communities (2007); "2006 Environment Policy Review", Communication from the Commission to the Council and the European Parliament, COM(2007)195.

Commission of the European Communities (2007); "Adapting to climate change in Europe – options for EU actions", Green Paper from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions, COM(2007) 354 final.

Commission of the European Communities (2007); "Europeans, Agriculture and the Common Agricultural Policy" Special Eurobarometer 276.

Commission of the European Communities (2007); "General budget of the European Union for the financial year 2007".

Commission of the European Communities (2007); "Green Paper on market-based instruments for environment and related policy purposes", COM(2007)140 final.

Commission of the European Communities DG Agriculture – DG Economic analysis (2007); "Scenar 2020 – Scenario study on agriculture and the rural world".

Commission of the European Communities DG Agriculture (1997); "Towards a common agricultural and rural policy for Europe".

Commission of the European Communities DG Agriculture (2006); "Development in the European Union – Statistical and Economic Information".

Commission of the European Communities DG Agriculture (2006); "Rural development in the European Union: statistical and economic information".

Commission of the European Communities DG Agriculture (2007); "Note to the file: The impact of a minimum 10% obligation for biofuels use in the EU-27 in 2020 on agricultural markets", AGRI G-2/WM D(2007).

Commission of the European Communities DG Agriculture (2007); "Prospects For Agricultural Markets And Income In The European Union 2007–2014".

Commission of the European Communities DG Employment (2007); "The social situation in the European Union 2005-2006 – The Balance between Generations in an Ageing Europe".

Convention on Biological Diversity, http://www.cbd.int/default.shtml.

CropLife International (2005); "New Study Shows Agrochemicals Among World's Most Research-Intensive Industries", Press Release.

Department Of Agricultural Economics And Engineering – University of Bologna (2006); "Study on Implementing the Energy Crops CAP Measures and Bio-Energy Market", commissioned and funded by the EU Commission – DG Agriculture.

ECPA (2006); "ECPA Annual Review 2005–2006".

ECPA (2006); "Proposal for a Regulation concerning the placing on the market of plant protection products – Impact of the criteria for 'non-approval' and 'candidates for substitution'".

EEA (2006); "How Much bioenergy can Europe Produce without harming the environment?", EEA Report No 7/2006.

EISA (2006); "European Integrated Farming Framework – A European Definition and Characterisation of Integrated Farming as Guideline for Sustainable Development of Agriculture".

ERS/USDA (1996); "Agricultural Adaptation to Climate Change: Issues of Long run Sustainability" Agricultural Economic Report No. AER740.

ERS/USDA (2001); "Agriculture in Brazil and Argentina: Developments and Prospects for Major Field Crops", Agriculture and Trade Report No. WRS013.

ERS/USDA (2001); "Changing Structure of Global Food Consumption and Trade", Agriculture and Trade Report No. WRS-01-1 chapter 3.

ERS/USDA (2004); "U.S.-EU Food and Agriculture Comparisons", WRS-04-04.

ERS/USDA Global Climate Change Briefing Room; http://www.ers.usda.gov/Briefing/GlobalClimate/.

Eurostat (2007); "The use of plant protection products in the European Union-Data 1992–2003", Eurostat Statistical Book.

Fapri (2007); "U.S. and World Agricultural Outlook", Food and Agricultural Policy Research Institute.

Fischer Boel M., (2007); "The Future of Rural Regions", Informal Agriculture Council, Mainz, 22 May 2007, Speech/07/322.

Gianessi L.P., Sankula S. (2003); "The Value Of Herbicides In U.S. Crop Production", National Center For Food & Agricultural Policy.

Henson S., Loader R., Swinbank A., Bredhal M. (1999); "The impact of Sanitary and Phytosanitary Measures on Developing Country Exports of Agricultural and Food Products", presented at The Conference on Agriculture and the New Trade Agenda in the WTO 2000 Negotiations, World Bank's Integrated Program of Research and Capacity Building.

Insecticide Resistance Action Committee (IRAC), Southern Region Integrated Pest Management Center; "Insecticide Resistance: Causes and Action", Mode of Action Initiative.

Intergovernmental Panel on Climate Change (1997); "The Regional Impacts of Climate Change: An Assessment of Vulnerability", Working Group II Special Report, Summary for Policymakers.

Intergovernmental Panel on Climate Change (2001); "Climate Change 2001: Impacts, Adaptation and Vulnerability", Working Group II Third Assessment Report, Summary for Policymakers.

Intergovernmental Panel on Climate Change (2002); "Climate Change and Biodiversity".

Intergovernmental Panel on Climate Change (2007); "Climate Change 2007: Impacts, Adaptation and Vulnerability", Contribution of Working Group II to the Intergovernmental Panel on Climate Change Fourth Assessment Report, Summary for Policymakers.

Jarvis P. (2005); "Generic agchem industry moves centre stage," AGROW, No. 485.

Joly P.B. and Lemarié S. (2002); "The technological trajectories of the agrochemical industry: change and continuity", Science and Public Policy, vol. 29, no. 4, pp 259–266.

Knickel K., Renting H. (2000); "Methodological and conceptual issues in the study of multifunctionality and rural development" in Sociologia Ruralis n. 4 Vol. 40.

Leifert C. (2003); "Blight – MOP. Development of a systems approach for the management of late blight in EU organic potato production", EU AgriNet.

LlorensAbando L., Rohnerthielen E. (2007); "Different organic farming patterns within EU-25. An overview of the current situation", Eurostat: Statistics in Focus, Issue number 69/2007.

Mazzoncini M., Belloni P., Risaliti R., Antichi D. (2007); "Organic Vs Conventional Winter Wheat Quality and Organoleptic Bread Test", 3rd QLIF Congress, Hohenheim, Germany, archived at http://orgprints.org/view/projects/int_conf_qlif2007.html.

Mittal S. (2006); "Structural Shift in Demand for Food: Projections for 2020", Indian Council for Research on International Economic Relations, Working Paper No. 184.

OECD - Directorate For Food, Agriculture and Fisheries Committee for Agriculture (2006); "Agricultural Market Impacts of Future Growth in the Production of Biofuels", AGR/CA/APM(2005)24/FINAL.
OECD (2007); "Agricultural Policies in Non-OECD Countries: Monitoring and Evaluation 2007".
OECD-FAO (2007); "OECD-FAO Agricultural Outlook 2007–2016", Oecd publishing.
Oskam A.J., Vijftigschild R.A.N., Graveland C. (1997); "Additional EU policy Instruments for plant protection products. Final report.", Wageningen Agricultural University (Mansholt Institute).
Philips McDougall (2003); "The cost of new agrochemical product discovery, development and registration in 1995 and 2000", Final Report, Study carried out for ECPA and CropLife America.
Phillips McDougall (2005); "Agrochemical Industry Research and Development Expenditure", a Consultancy Study for CropLife International, p. 11.
Phillips McDougall (2005); "Keeping Europe Attractive for Sustained Business Development", ECPA Annual Conference.
Phillips McDougall (2006); "The Global Crop Protection Market – Industry Prospects", Industry Presentation.
Philips McDougall (2007); "The Global Crop Protection Market – Industry Prospects", Industry Presentation.
Schenkelaars Biotechnology Consultancy (2005); "The competitiveness of the agri-business R&D sector in the EU", in commission of the United Kingdom Department of Trade and Industry.
Schmidhuber J. (Global Perspective Studies Unit, FAO) (2003); "The outlook for long-term changes in food consumption patterns: concerns and policy options," paper prepared for the FAO Scientific Workshop on Globalization of the Food System: Impacts on Food Security and Nutrition, FAO, Rome.
Schmitz M. (2001); "Crop Protection: Costs and Benefits to Society and Economy", Agribusiness Institute University of Gieben, Germany.
Silva J. F. (2006); "Brazil Biotechnology Annual Agricultural Biotechnology Report 2006", USDA Global Agriculture Information Network.
Smith A., Watkiss P., Tweddle G., McKinnon A., Browne M., Hunt A., Treleven C., Nash C., Cross S.(2005); "The validity of Food Miles as an Indicator of Sustainable Development", DEFRA, London.
The Bichel Committee (1999); "Report from the Bichel Committee – Organic Scenarios for Denmark", report from the Interdisciplinary Group of the Bichel Committee.
UK Climate Impacts Programme, Defra, Tyndall Centre, Hadley Centre (2002); "Climate Change Scenarios for the United Kingdom", the UKCIP02 Briefing Report.
UK Treasury (2006); "Stern Review on the economics of climate change".
United Nations DESA, Population Division (2001); "World Population Ageing: 1950–2050".
United Nations DESA, Population Division (2007); "World Population Prospects: the 2005 Revision".

WEB

Convention on Biological Diversity: http://www.cbd.int/default.shtml.
ERS/USDA, Global Climate Change Briefing Room: http://www.ers.usda.gov/Briefing/GlobalClimate/.
Eurostat: http://epp.eurostat.ec.europa.eu
Faostat: http://faostat.fao.org
IMF: http://www.imf.org
OECD statistics: http://www.oecd.org
U.S. Department of Labor, Bureau of Labor Statistics: http://www.bls.gov
UN Comtrade: http://comtrade.un.org
USDA Data and statistics: http://www.usda.gov.
World Bank (World Development Indicators): http://ddp-ext.worldbank.org
WTO international trade statistics: http://www.wto.org

ELECTRONIC COPY
If you would like an electronic copy of the full report, or have questions and need further information, please contact **agri-food@nomisma.it**.