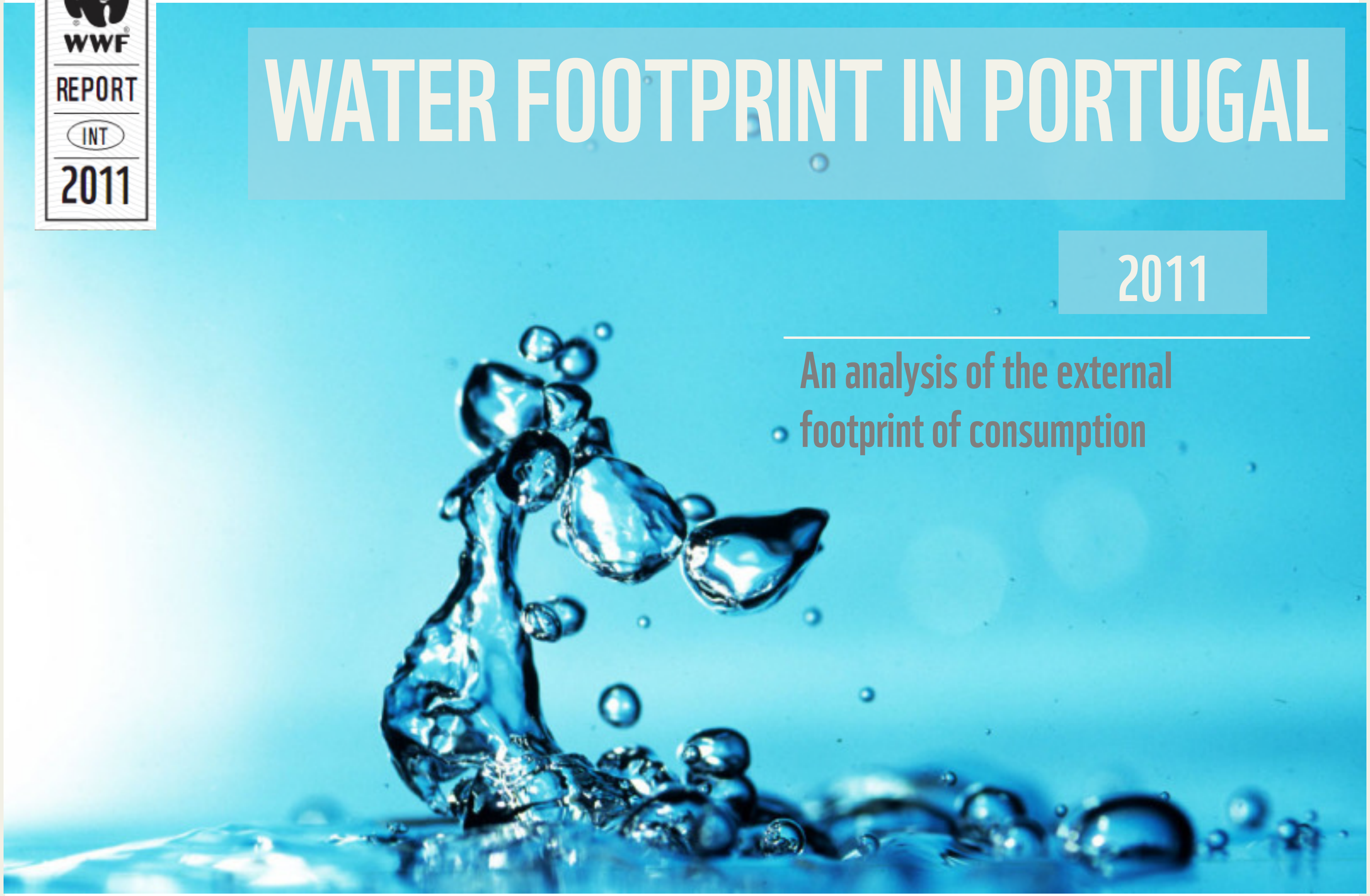
WWF REPORT INT 2011

WATER FOOTPRINT IN PORTUGAL

2011

An analysis of the external footprint of consumption



WATER FOOTPRINT IN PORTUGAL

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1. INTRODUCTION

The first Water Footprint (WF) report for Portugal was published by the WWF Mediterranean Programme Office in February 2010. This first report considered the general values of WF derived from the work of Hoekstra and Chapagain (2004), as presented in Table 1 and Figure 1.

Table 1 shows that the main component of Portugal's WF is green water – in a broad sense, rainfall water embedded in crops.

Blue			Green		Grey
Agriculture	Urban supply	Industry	Internal	External	
6.210	1.090	2.030	8.000	10.550	600

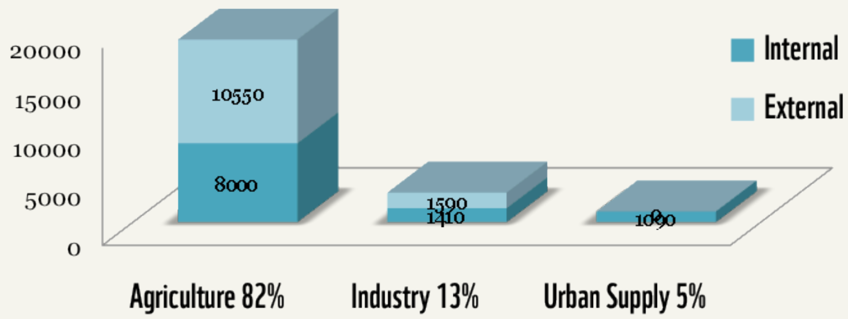
Table 1 - Main components of Portugal's water footprint (hm^3/yr)

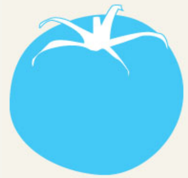
- Blue Water:
Direct abstraction of water from internal surface and groundwater sources (mainly reservoirs and aquifers). It is the volume accounted for in traditional water resources management, and requires technological inputs.

- Green Water:
Rainfall water used for crop evapotranspiration, which is directly dependent on precipitation, potential evaporation, and crop requirements.

- Grey Water:
Clean water needed to dilute or purify polluted and wastewater. Harder to estimate, as it is quite dependent on the numerous chemical parameters of such waters, and its monitoring is poorer.

Figure 1 – External and Internal water footprint of Portugal by sector (hm³ /yr)





Most of Portugal's WF comes from other countries – that is, virtual water needed for the production of goods that are imported to Portugal.

The report also stated that there were important shortages of data for grey water estimations, and similarly important uncertainties for the estimation of virtual water trade.

New data calculated and compiled by Ashok Chapagain, at WWF-UK, have allowed revising and updating these values (average 1996-2005), providing a more in-depth knowledge of Portugal's Water Footprint.

The calculations were based on primary data from the Water Footprint Network (WFN), defining the green/ blue/grey water content of products. The references to compile all data needed were the following:

- Methods - Hoekstra *et al.* (2011), *Water Footprint Manual*, WFN.
- WF of products and top-level WF data - Mekonnen and Hoekstra (2011), *National Water Footprint Accounts*, WFN.
- External WF - Chapagain and Orr (2008), *Water footprint of the UK* (volume 2), WWF-UK.
- Trade data - PC-TAS (2006) SITA system, ITC.
- Food consumption data - FAOSTAT Food Balance Sheets (online).
- Climate and grid level water resources - Mekonnen and Hoekstra (2011), *National Water Footprint Accounts*, WFN.

2. EXTERNAL FOOTPRINT

The thorough compilation, combination and assessment of the previous datasets allows us to provide a much more detailed analysis of Portugal's WF, as shown in Tables 2 and 3.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Sector	Internal				External			
	Green	Blue	Grey	Total	Green	Blue	Grey	Total
Agriculture	7.157	1.513	627	9.298	11.901	2.024	982	14.908
Industry	-	43	264	307	-	45	476	522
Urban	-	108	610	718	-	-	-	-
Total	7.157	1.664	1.501	10.323	11.901	2.069	1.458	15.430

Table 2 – External and internal water footprint of consumption in Portugal (hm³/yr)

As already pointed out in the previous report, **the external dependence of Portugal on imported virtual water is quite high** (as shown in Table 3), but now seems to have increased substantially, as shown by comparing the current external footprint (Table 2 - 15.430 hm³/yr) with the previous available value (Figure 1- 12.140 hm³/yr).

Such increase is due to a much higher value of virtual water content in imported agricultural products (+41%). This is not just explained by an increase in consumption and water intensity in agriculture, but also by a refinement of base data, calculations and estimations. Still, a major driver has been the increased external food dependency of the country (+24% between 1999 and 2009).

Virtual water import is more significant from rainfed agrarian systems, mostly in developing countries, than from irrigated crops in industrialised countries. But in all sectors and water components, most of the virtual water consumed in Portugal is imported.

Sector	Total				% of External			
	Green	Blue	Grey	Total	Green	Blue	Grey	Total
Agricult	19.058	3.537	1.609	24.204	62,4	57,2	61,0	61,6
Industry	-	88	740	829	-	51,1	64,3	63,0
Urban	-	108	610	718	-	-	-	-
Total	19.058	3.733	2.959	25.751	62,4	55,4	49,3	59,9

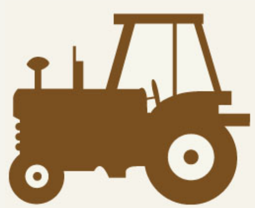
Table 3 – Weight of the external water footprint of consumption in Portugal (hm³/yr)

In the industrial and urban supply sectors, it is the grey component that demands more water, because of the high level of depuration and treatment needs – unfortunately, and particularly in the case of the external footprint, this means mostly sewage and wastewater that is released untreated in the environment, requiring large amounts of diluting freshwater. That is why the ratio of blue and grey water in the industrial sector is quite higher externally (1 to 10) than internally (1 to 6) – Portugal imports industrial products that are more polluting and water demanding than those produced internally.

But it is the agricultural sector that concentrates most of the virtual water consumed in Portugal, as detailed over the following case studies. Table 4 presents the virtual water trade for the most significant crops.

The main causes of unsustainable water use in agricultural production are:

- **leaky irrigation systems**
- **wasteful field application methods**
- **cultivation of thirsty crops not suited to the environment**
- **overexploitation of available resources**



The problem is made worse by misdirected subsidies, low public and political awareness, and weak environmental legislation and/or legal enforcement.

Product	Import	Export	Net
Cotton	6.290	4.342	**-1.948**
Livestock	2.726	799	**-1.927**
Soybeans	2.183	510	**-1.673**
Maize	1.048	44	-1.004
Coffee	964	94	-870
Wheat	1.199	626	-573
Sunflower	992	527	-465
Sugar cane	542	85	-457
Grapes	111	273	+162
Olives	683	892	+209

Table 4 – Virtual water trade of main crop and livestock products for Portugal (hm³/yr)

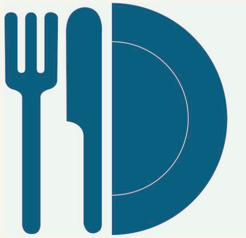
In this context, it is crucial to understand which countries are the source of virtual water export to Portugal, what systems they use for the production of the main agricultural commodities, what impacts affect these exporting regions, and what risks are to be expected "at home".

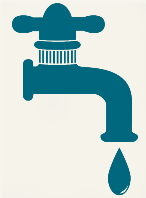
Unsustainable water use harms the environment by changing the water table and/or depleting ground water supplies. Excessive irrigation can also increase soil salinity and wash pollutants and sediment into rivers – causing damage to freshwater ecosystems and species as well as those further downstream, including coastal fish breeding grounds.

3. CASE STUDIES

For the products that represent a higher value of virtual water import to Portugal, its production origins are traced in terms of exporting countries in the following **Sections 3.1 (seed cotton), 3.2 (soybeans), and 3.3 (livestock)**. **Olives** are the subject of another case study analysed separately **(Section 3.4)**, being the second crop exporting more virtual water from Portugal, and having the largest national positive net result.

A final case study on a partner country is provided for virtual water trade with **Spain (Section 3.5)** – by far the largest commercial partner and virtual water exporter to Portugal, thus increasing the already strong natural dependence of the country on its neighbours' water resources.

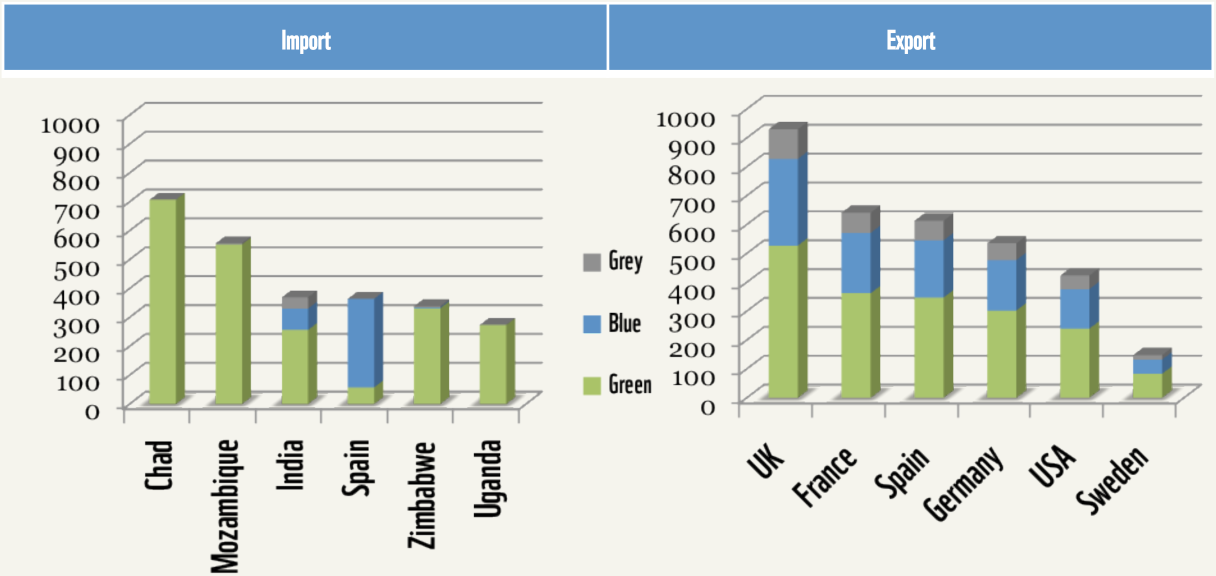




The report closes with a final Section (4) with recommendations for businesses, governments and citizens to reduce its water footprint, particularly when it affects countries that are water-scarce, affected by poor water quality and pollution, or possess crucial freshwater environmental values.

3.1 Cotton

Figure 2 – Seed cotton virtual water trade for Portugal (hm^3/yr)



Portugal imports large quantities of seed cotton, mainly from developing countries based on dry-farming (mostly green water), plus Spain, where cotton is an irrigated crop (mostly blue water). It is transformed in the **large national textile industry** sector, and manufactured products are then sold mainly in the EU market (plus the USA).

Cotton is the **largest money-making non-food crop produced in the world**. Its production and processing provide some or all of the cash income of over 250 million people worldwide, and employ almost 7% of all labour in developing countries. Nearly all activities associated with cotton production, processing, and manufacturing are becoming more concentrated in the hands of fewer companies and fewer countries. Cotton textiles constitute approximately half of all textiles (Banuri, 1999).

Area under cultivation - 32.7 Million ha
Global Production - 54.6 Million Tons (Seed); 19.1 Million Tons (Lint)
Share of internationally traded production - 26%
Value - $7,818 Million
Principal Producing Countries - China, United States, Pakistan, India, Uzbekistan, Turkey

Environmental Impacts

Major environmental impacts of cotton production include:

- Habitat conversion
- Soil erosion and degradation
- Agrochemical use
- Water use and contamination

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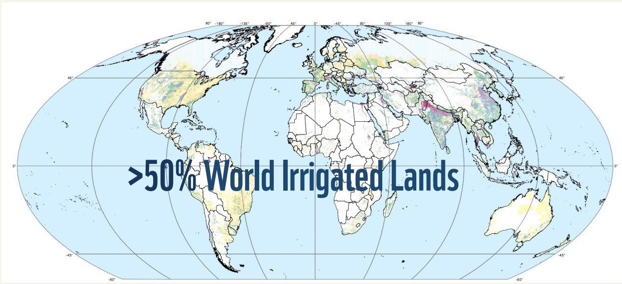
While habitat conversion is a problem associated with cotton production, the most important production impacts are the use of agrochemicals (especially pesticides) and water contamination.

The quality of soil and water and the impact on biodiversity in and downstream from the fields are also major concerns. Finally, because of the high use of pesticides there are a number of human health concerns, both for farm workers and for nearby and downstream populations.

On the processing and manufacturing side, the use of industrial chemicals is of concern, especially those associated with dyeing textiles and finishing clothes. These chemicals affect not only the environment but also workers in the processing and apparel industries.

Water Use

Cotton uses a tremendous amount of water both to produce and process. Cotton production requires 550 to 950 litres per square metre of area planted. Put another way, 7 000 to 29 000 litres of water are required for each kilogram of cotton produced. Some estimates indicate that it is the largest user of water among all agricultural commodities, representing more than half of the irrigated agricultural land in the world (Soth *et al.*, 1999).



1m^2 Plantation = 550 - 950 lt

1kg Cotton = 7 000 - 29 000 lt

In many cotton-producing areas, surface waters are diverted to irrigate cotton. Most cotton irrigation systems rely on traditional flooding techniques. Freshwater is taken from its source (e.g. river, lake, reservoir, or aquifer) and transported via a series of even smaller, open canals to the area to be irrigated.

Freshwater losses occur through evaporation, seepage, and inefficient water management. Globally, irrigation efficiency of all types is lower than 40% (Gleick, 1993). This means that 60% of the water used in irrigation never makes it to the targeted plant.
Even with irrigated cotton, some 60% of water demand is provided by rainfall (Klohn, 1998). The total global freshwater demand for cotton production is between 50 and 210 cubic kilometres per year. This is between 2% and 6% of total global freshwater withdrawal (Soth *et al.*, 1999).

Total water use: 50-210 km^3 (2-6% of global abstracted water)

Promoting Sustainable Production

In general, **improved irrigation systems and water management could reduce water losses to 15% or less** from current levels of 60% on average (Ait Kadi, 1993, as cited in Kirda *et al.*, 1999). In drip irrigation systems, the total water used is far less than the 7 000 to 29 000 litres of water required to produce a kilogram of cotton with conventional means. Furthermore, drip irrigation systems produce the highest cotton yields of any cotton production systems in the world. Today, however, only 0.7% of irrigated areas globally use drip technology because of its high costs (Soth *et al.*, 1999).

Improved cultivation techniques also reduce water use. For example, conservation tillage reduces overall water use because crop residues are left on top of the soil, allowing them to act as water-conserving mulch.
Nevertheless, a tremendous amount of work will be required to bring cotton production into line with even minimally acceptable environmental standards. The strategy must focus on reducing the most significant impacts. Toward this end, **the overall goal of a conservation strategy for cotton should be to promote the sustainable production and use of cotton by minimising the impacts of overall water withdrawal as well as pollution of freshwater ecosystems from cotton production** (Soth *et al.*, 1999).

For farmers, the interest in sustainable cotton is direct. They stand to save water resources, maintain soil quality, maintain present and future incomes, and reduce health problems. It is also quite likely that they will actually save money by reducing expenditures for pesticides and other inputs.
For the rest of the cotton market chain, there is also direct interest in sustainable cotton production. Every business that buys and uses cotton - from yarn makers to weavers, textile manufactures, and retail clothing stores - has an interest in a stable, sustainable supply of cotton.

In Brazil, a number of producers report that corn is grown in rotation with cotton and other crops because it provides more mulch. Similarly, pasture grasses are planted at the same time as corn, between the rows, to provide more biomass that will act as mulch and through their root systems help to build up the organic matter in the soil. Careful crop rotations reduce the need for pesticides and fungicides in addition to reducing water use.

WWF Proposals

WWF's Better Cotton Initiative aims to reduce the amount of water and chemicals used to grow cotton so that ecosystem health is sustained by adequate flows. Achieving this, would represent an important step towards making cotton production more sustainable.

WWF is working with farmers, government agencies, buyers and investors at key stages of the market chain - from the field to the clothes shop - in a joint endeavour to promote cotton that has less impact on the environment and which is ethically sound.

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Links to WWF Reports

"Cleaner, greener cotton"
http://assets.panda.org/downloads/cotton_for_printing_long_report.pdf
"Thirsty crops"
http://wwf.panda.org/about_our_earth/about_freshwater/freshwater_problems/thirsty_crops/cotton/
"The impact of cotton on freshwater resources and ecosystems"
http://assets.panda.org/downloads/impact_long.pdf

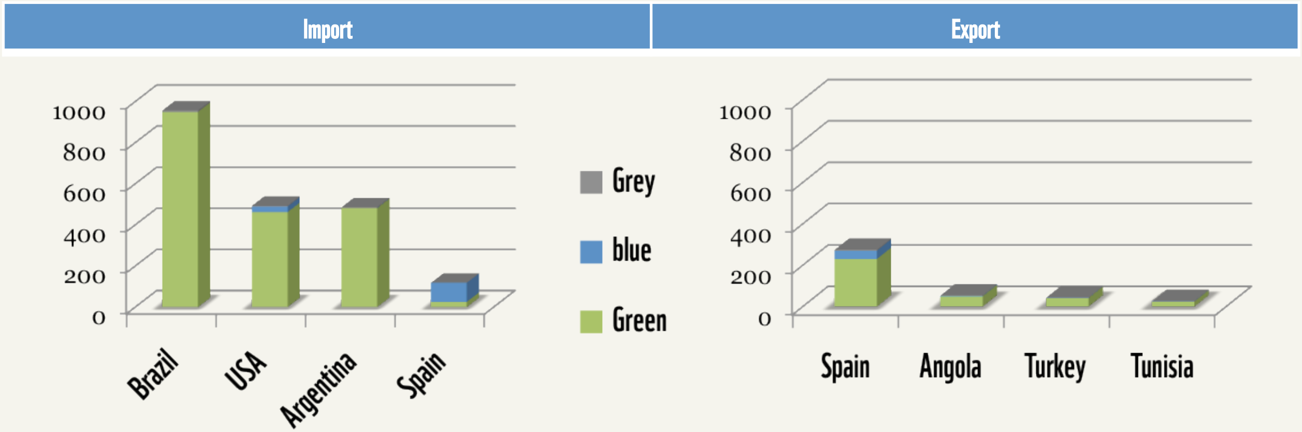
Better Cotton Initiative

http://www.bettercotton.org/

3.2 Soybeans

Soybeans are grown primarily to provide cheap edible oil and high-protein animal feed. Soybean oil is currently the most consumed oil in the world, and soybean-based fodder, a relatively cheap, nutritious feed source for animals, allowed the development of confined poultry and pork operations.
Portugal is a net importer from the world's largest producers (Brazil, USA, Argentina), based on dry-farming (i.e. using mainly green water). Most of this import is consumed internally, but a significant part is re-exported, mainly to Spain and secondly to several Mediterranean and African countries (Figure 3).

Figure 3 – Soybeans virtual water trade for Portugal (hm³/yr)



Through the development of different seed varieties, improved nutrient input packages, and mechanised planting and cultivation, a monocrop soybean production system was developed in the United States, and adapted to local conditions and spread throughout the world, including some of the world's most biodiverse ecoregions.

Of particular concern from an environmental point of view is the rapid expansion of soybean cultivation into the natural habitat of the Brazilian *cerrado* (a relatively flat, mixed woodland and savannah area of central Brazil), where most of the soybeans exported to Portugal are produced.

Area under cultivation - 74.1 Million ha
Global production - 161.2 Million Tons
Share of internationally traded production - 57%
Value - $18,728 Million
Principal Producing Countries/Blocs - United States, Brazil, Argentina, China, India

Environmental Impacts

Major environmental impacts of soy production include:

- Conversion of natural habitat
- Soil erosion and degradation
- Agrochemical use
- Genetically modified seeds

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In the United States and the European Union, the production of soybeans poses a few rather distinct environmental problems. These have to do with the use of agrochemicals in production and the degradation of soil through the use of chemicals, erosion, or compaction. Runoff resulting from soybean production can include high levels of agrochemicals, suspended soil, and organic matter. This can be a major source of freshwater and groundwater contamination.

Elsewhere in the world the major environmental problems associated with soybean production include the conversion of natural habitat, soil erosion, and the ever increasing use of pesticides. This is not the case in many tropical countries, however, where the cultivation of soybeans often is part of the process of converting extensive areas of natural habitat to agriculture for the first time. This is true of Brazil, Argentina, Bolivia, Paraguay, and Cambodia. In these instances, producing soybeans destroys natural habitat and nearly all the flora and fauna found there. In Latin America, soybean cultivation has taken place at the expense of natural savanas and tropical forests.

Damages Done in Brazil

Brazil is by far the largest soybean virtual water exporter to Portugal. In Brazil some soybean producers clear forests themselves. Others buy the land from small producers, often colonists, who have already cleared it. These same small producers then move further into the frontier and clear more land. In the 1970's, 2.5 million people were displaced by soybean production in Paraná state alone. Many of these people moved to the Amazon where they cleared pristine forests (Fearnside, 2000).

More recently, the expansion has been concentrated in the central areas of *cerrado*. **The savannas and *cerrados* habitats are the most at risk**. These areas have biodiversity that rivals equivalent areas of Amazonian forests, but only 1.5% of such lands are in federal reserves. Unfortunately, they can be easily converted into vast expanses of soybean fields.

Even during the first year, however, agrochemicals must be provided for the crop to be financially viable. The soils are often so poor that within two years, virtually all nutrients are provided through applied lime and fertilisers. The soil is stripped of virtually all fertility and only serves to hold up the plants.

Soybeans Massive Share in Chemical Usage

The FAO and others estimate that 25% of all pesticides used in Brazil are used in soybean cultivation, and that in 2002 an estimated 50,000 tons of pesticides were used by Brazilians on soybeans (World Bank, 2002). Because of the rapid expansion or area planted to soybeans, pesticide use is increasing at a rate of 21.7% per year.

25% of Brasil's pesticide use (50.000 tons)

22% increase per year

However, the growth in pesticide use is increasing even faster than the growth in either cultivated area or overall soybean production. While part of this can be explained by the lack of frost and pests developing resistance to pesticides due to increased use, other factors include increasing mechanisation and reduction of labour costs.

Lime requirements of growing soybeans in the Amazon alone could lead to considerable destruction of natural resources. Lime (a source of calcium) is applied to soils to counteract acidity, because neutralising soil acidity makes existing nutrients more available to plants such as soybeans. The mining of limestone requires the removal of considerable overburden (natural cover, soil, etc.) to gain access to limestone deposits. In addition, large amounts of energy are used to cook the limestone and make it into agricultural lime.

Better Management Practices

There are a number of conservation strategies that can reduce the impact of soybean production. These include **creating protected areas** in areas of soybean expansion and **using zoning to restrict expansion** to degraded or abandoned agricultural areas.

The identification and adoption of no-till practices can reduce the soil erosion caused by soybean production, as can linking the adoption of such practices to government subsidy programs. A related policy initiative to reduce the harmful impacts of the industry is to remove subsidies that encourage soybean expansion for artificial markets.

Clearly, one conservation strategy should be to identify and analyse the implications of soybean expansion for natural habitat. Finally, strengthening command-and-control regulatory systems can reduce the environmental problems associated with soybean cultivation. Each of these strategies may be addressed separately, however, their cumulative impacts are greater than their individual ones.

Links to WWF Reports

"Managing the soy boom"
http://assets.panda.org/downloads/managingthesoyboomenglish_nbvt.pdf
"Soy expansion – loosing forests to fields"
http://assets.panda.org/downloads/wwfsoyexpansion.pdf
"Facts about soy production and the Basel criteria"
http://assets.panda.org/downloads/factsheet_soy_eng.pdf

Roundtable on Responsible Soy

http://www.responsiblesoy.org/

WWF Proposals

Because of the threats of soy plantations to the environment, WWF helped establish the **Round Table on Responsible Soy (RTRS)** in 2005 as a forum for all parties affected by, and involved with, soy cultivation.

The RTRS is a platform to develop solutions for responsible soy production, including the development of criteria for responsible production and sourcing of soy. In 2009, preliminary **voluntary production standards** were adopted by the RTRS, requiring producers to take measures to protect the environment, including prohibition on the conversion of areas with high conservation value, and eliminating hazardous pesticides in soy farming.

Furthermore, over the long term, criteria adopted through the RTRS toward responsible soy production should include requirements to:

- Promote best management practices;
- Ensure fair working conditions and respect land tenure claims;
- Reduce the amount of greenhouse gas emissions from soy cultivation and production.

3.3 Livestock

For aggregated livestock products, Portugal virtual water trade is extremely concentrated with Spain: 61% of total virtual water imports, and 56% of its exports. Blue and grey water weight significantly in the total amount of virtual water exported to Portugal, which reflects intensive breeding systems. On the contrary, for the second exporter, Brazil, livestock (mainly cattle) production relies fundamentally on extensive rainfed systems, as indicated by the very high proportion of green water.

Principal Exporters:
Boneless - Australia, United States, New Zealand, Ireland, Canada
Bone in - Germany, France, United States, Netherlands, Ukraine
Principal Importers:
Boneless - United States, Japan, Mexico, Canada, Egypt
Bone in - Italy, Russia, France, South Korea, United States

Figure 4 – Beef & Dairy Production/Top Ten Countries

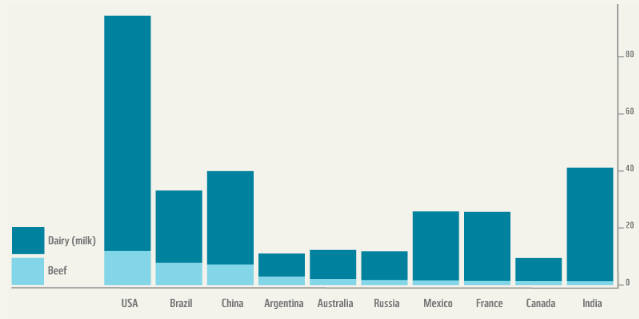
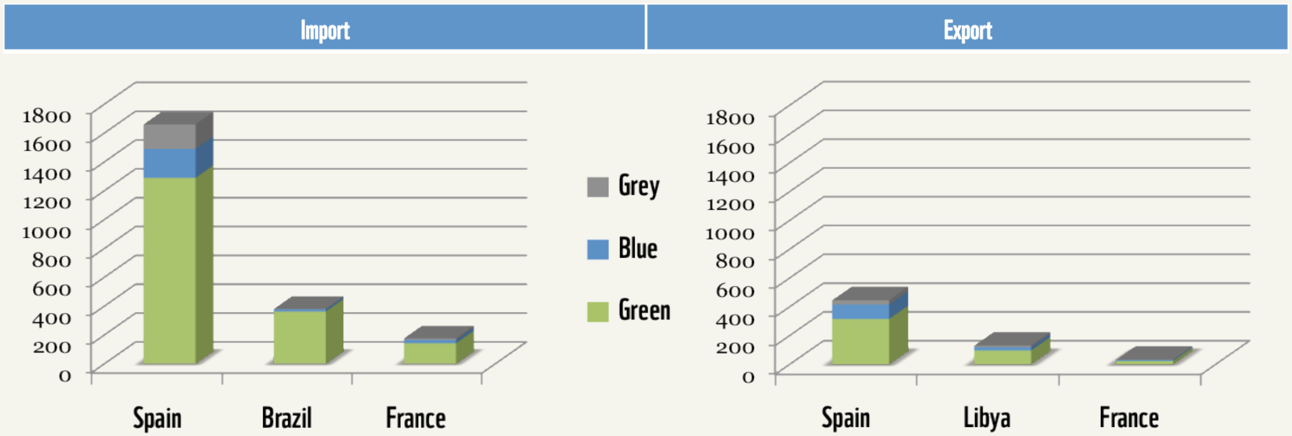


Figure 5 – Livestock (aggregated) virtual water trade for Portugal (hm³/yr)



Environmental Impacts

Major environmental impacts of livestock production include:

- Habitat conversion
- Overgrazing
- Feedlot pollution
- Production of feed grains

Pasture area - 3,459.8 Million ha
Herd - 1,346,400,000 animals
Meat - 56.5 Million Tons
Slaughter - 277,800,000 animals
Milk - 488.2 Million Tons
Producer value at slaughter - $73,958 million (meat)
International trade production :
Meat - 13.1 Million Tons, $30,434 million
Hides - 2.0 Million Tons, $3,325 million

Unlike many other agricultural commodities, cattle have significant impacts on a wide range of ecosystems because they can be produced under such a variety of conditions and are literally capable of walking themselves to market.

Globally, the largest environmental impact of agriculture in general is the conversion of natural habitats to farming land. But within the sector, **more pasture is used for cattle than all other domesticated animals and crops combined**. In addition, cattle eat an increasing proportion of grain produced from agriculture, are one of the most significant contributors to water pollution and soil degradation, and are a major source of greenhouse gas emissions. Finally, processing cattle into meat, meat by-products, and leather is a major source of pollution in many countries.

Water Use

Including direct consumption by cattle, irrigation of pastures and crops, and carcass processing, it can take as much as 3 682 litres of water to produce one kilogram of boneless beef in the United States.

In addition to total water use, there is increasing concern about water pollution, especially the harmful effects of pesticides – used to maintain or improve pasture areas or to increase feed grain production – on surface water and groundwater quality. Besides contaminating waterways, groundwater, and even marine environments, those who use pesticides and live in rural areas tend to contaminate not only the water supplies of their own livestock operations and those of their neighbours, but also their own water supplies.

Reducing Impacts

There are a number of ways to reduce the environmental impacts of beef production. As with most operations, perhaps **the key to reducing subsequent impacts is to site and construct operations well**. Once built, however, there are still a number of management practices that can reduce environmental damage. These include maintaining vegetative cover, avoiding overgrazing, protecting riparian areas, reducing waste and disposing of waste in the least harmful ways, reducing the use of chemicals and antibiotics, reducing wastewater and improving water effluent quality, and reducing soil compaction.
Improved control of input use and efficiency can minimise off-site discharge of pollutants and therefore improve water quality. Pollutants come from manure, organic matter, fertilisers, sludge application, pesticides, chemicals, and fuels. If these materials are properly stored, applied, and disposed of, there is less chance that they will become part of runoff.

The **development of nutrient management plans** can reduce the nutrient loading in runoff. Nutrient tests that allow producers to determine the most appropriate timing and rates for application of fertilisers can reduce use of these inputs, which can reduce expenditures for inputs in addition to reducing the nutrient content of runoff. Fertilisers and pesticides should not be applied near water bodies and drainage ditches or prior to forecasted heavy rainfall.

WWF Proposals

The potential to improve the sustainability of livestock production and reduce its impacts is quite good, based on existing **organic production guidelines, natural beef certification, grass-fed beef replacing grain-fed beef, and best practices** examples from some parts of the world.

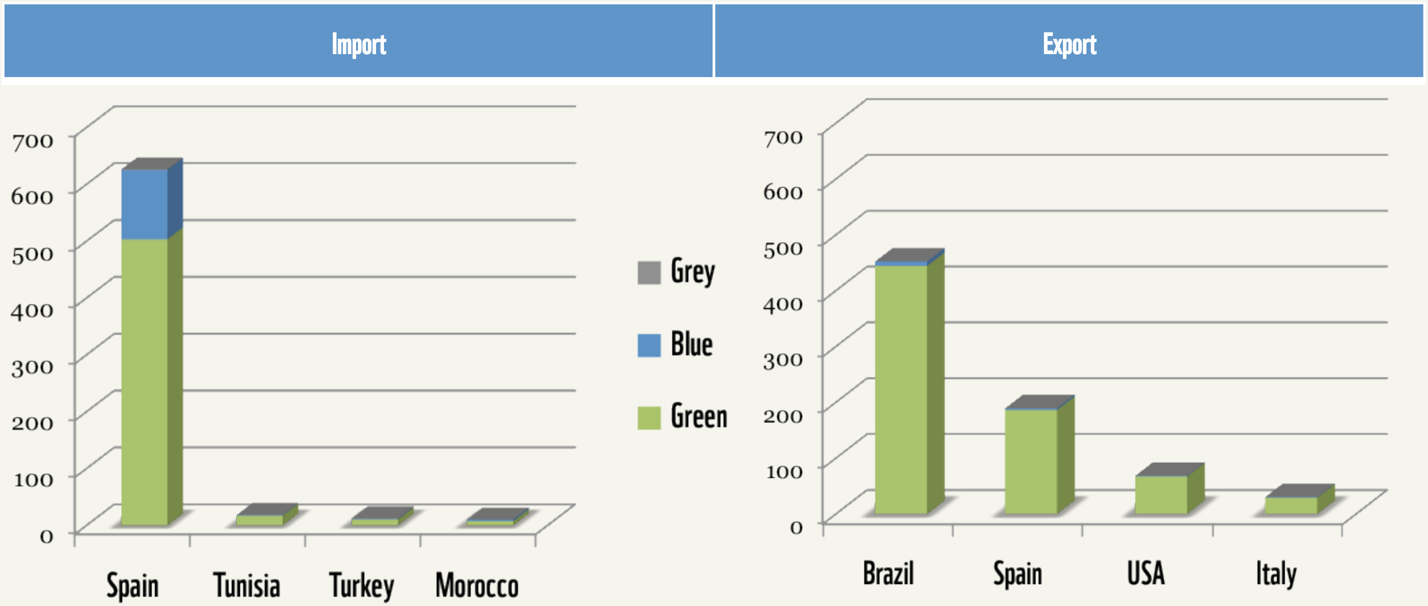
WWF envisions a global marketplace in which all beef is sustainable. Stakeholders across the beef industry – such as retailers, restaurants, traders, processors, ranchers, farmers, scientists, government officials, investors and NGO's – all play a critical role in making this happen. WWF is working with these stakeholders to ensure that beef is produced and processed in a way that is socially responsible, economically viable and environmentally sustainable —preserving and restoring critical habitats, helping to protect watersheds, and improving soil health and water quality.

Our first major initiative related to this work was the **Global Conference on Sustainable Beef**, held in November 2010 in Denver, Colorado. Approximately 300 stakeholders from across the beef system met to address the environmental, economic and social impacts of beef production. The goal of this forum was to develop and promote greater adoption of sustainable beef practices that lead to science-based, measurable outcomes through a global multi-stakeholder initiative. For more information on the forum, please visit www.sustainablelivestock.com.

3.4 Olives

Olive groves have been one of the oldest oil and fruit sources for some of the oldest civilizations of the world. For Phoenicians, Greeks, Romans, Moors and others across the Mediterranean, olive production has always been a key for their economic and social welfare, as well as a part of a sustainable environment. Furthermore, the olive tree has been used for ages as a symbol and an indicator of the Mediterranean region itself.
Nowadays, **over 95% of the world's olive groves are situated in the Mediterranean region**, with the European Union countries Spain, Italy, Greece and Portugal producing 76% of global production.
The virtual water market for olives is one of the few (as for grapes) where Portugal is a net exporter. Imports are mainly from Spain (Figure 6), mostly raw olives transformed internally into olive oil, and sold mainly to Brazil (olive oil is Portugal's biggest agricultural export to Brazil, in total value) and the USA. Virtual water export to other Mediterranean countries is mainly raw olives too, supplying major global producers that need to overcome eventual internal shortages.

Figure 6 – Olives virtual water trade for Portugal (hm³/yr)



Environmental Impacts

Although traditionally a dry-farming crop, olive groves have increasingly been expanded and transformed into an intensive, mechanised and drip irrigated crop. In the Iberian Peninsula, the exponential growth of blue water demand for olive production has occurred mainly in the Guadalquivir and Guadiana river basins, which already present **serious problems of water scarcity and overexploitation**. In the case of the Guadiana, this trend is not only happening in Spain but in Portugal as well, particularly within the new Alqueva irrigation scheme, where recent estimations point to 30.000 hectares of new, intensive, irrigated olive groves.

Although most of these recent plantations use an efficient drip irrigation system, its scale and intensity not only account for a significant blue water demand, but also cause **other major environmental problems**, such as:

- **soil erosion, due to heavy mechanisation and intense land use**
- **water and soil contamination, through intense pesticide and other agrochemicals use**
- **habitat destruction, namely riparian galleries, and fragmentation**

Recently, increased demand for olive oil across the world has been supported by the knowledge of its nutritional and organoleptic value. Nevertheless, the increase in supply has been based on a strong intensification of production: mechanisation, increased tree density, agrochemicals (pesticides and fertilizers), varietal selection, and irrigation, among other factors.

Most of the new plantations contribute to a huge increase in blue and grey water demand – the former due to the need to abstract water for irrigation, the latter because of the increased water pollution in runoff and groundwater from intensive use of agrochemicals, and olive oil plant transformation.

WWF Proposals

A recent work published by WWF Spain (2009) has proposed several techniques of **controlled deficit irrigation** as a way to reduce water use on irrigated olive groves, while improving the ability to extract olive oil, increase its content of unsaturated fat acids, and some of its organoleptic features.

One of the major solutions for olive oil production has been **organic farming**. Olive trees are extremely well adapted to Mediterranean conditions and barely need any support to grow and produce olives. Together with a growing market demand for quality olive oils, it is understandable that olive groves have the highest rate of expansion among organic farming cultures in Portugal, and represent its largest share (in area).

Organically farmed olive oils are from olive orchards which adhere to organic production rules, as laid out in the European Regulations. This method of production requires several specific conditions to be met: maintenance of soil fertilisation, use of adequate rotations, dry-farming or restricted drip irrigation, and the respect of strict fitosanitary and fertilisation norms. The use of practically all synthetic chemical products is banned.

Similar trends have been observed in other EU Mediterranean countries, and particularly in Spain, the world's largest olive oil producer. Nevertheless, organic production accounts only for a small and particular portion of the global market, and **a global initiative is still needed to promote sustainable olive production** in general.

The importance of olive trade with Spain is part of Portugal's great dependency on its neighbour's water resources, which is the subject of the following national case study.

Weblinks

Casa do Azeite ("Olive Oil House", Portugal)

http://www.casadoazeite.pt/Default.aspx?alias=www.casadoazeite.pt/en

International Olive Oil Council

http://www.internationaloliveoil.org/

3.5 Spain

Spain and Portugal share five major river basins, with two-thirds of their borders established by these rivers or their tributaries (Figure 7). The three main watersheds (Douro, Tejo, and Guadiana) are also the **largest shared rivers fully within European Union borders**. In general, Spanish territory is upstream and about 70% of the mean yearly water resources of these rivers is generated in Spain. The areas of shared river basins total 46% of the surface area of the Iberian Peninsula, accounting for 64% of Portugal's mainland territory, and 42% of Spain's.

Transboundary river basins are of particularly high significance to Portugal, due to its downstream geographic position, and to the fact that 67% of its surface water resources come from such basins, while that value in Spain is only about 39%.

Furthermore, being Spain the major commercial partner of Portugal, both in terms of exports and imports, such **dependency increases exponentially due to virtual water embedded in agricultural products**, as shown in previous case studies presented in this report (Sections 3.1 for cotton, 3.3 for livestock, and 3.4 for olives).

Considering the virtual water trade of major crops between Portugal and Spain, the results presented in Figure 7 provide an insight.

Figure 7 – Location of transboundary river basins shared between Portugal and Spain

Source – http://www.cadc-albufeira.org/pt/cuencas.html

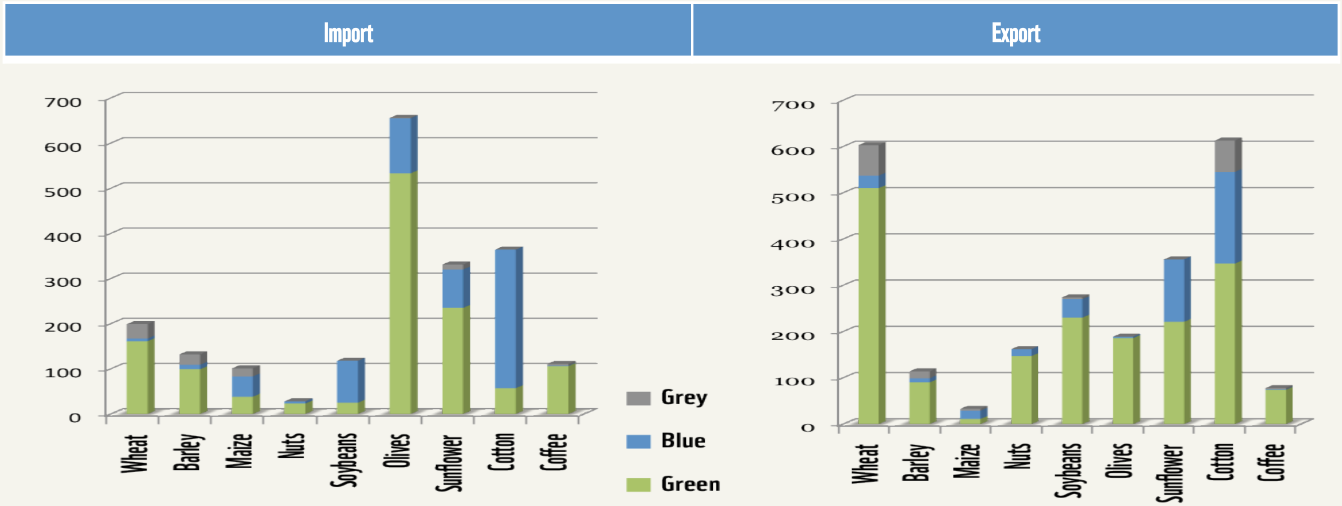
Virtual water trade with Spain for selected crops represents 86% of total water import and 96% of total water export – meaning that Portugal still has other significant imports in terms of water content (like cocoa beans, fresh fruits, palm oil, potatoes, oats, rye and other cereals), but also that the above list is quite representative of virtual water trade between the two countries.

Contrary to what happens for livestock products, crops virtual water trade is quite balanced, although crucial differences arise between particular crops (Figure 8):

- **Olives are clearly the most significant import**, with an important proportion of blue water embedded (from irrigation) and a strong imbalance in relation to Portugal's export;
- **Cotton is the 2nd import and 1st export** from Portugal: imports from Spain are almost exclusively raw product from irrigation systems, then transformed in textiles that are exported, with an higher proportion of green water embedded (imported cotton from rainfed systems in developing countries, as shown previously in Figure 2);
- **Portugal is a massive exporter of virtual water embedded on wheat** products (2nd in ranking) to Spain, with a little irrigation component (mainly dry-farming);
- **Soybeans and maize are other major imports from Spain** with significant proportion of blue water embedded; for Portugal only sunflower has such a significant component, but still lower than that of green water (from rainfall).

A final reference to nuts, a significant virtual water export from Portugal (mainly rainfed), which includes almonds, peanuts, chestnuts and others.

Figure 8 – Major crops virtual water trade with Spain (hm³/yr)



Livestock virtual water import from Spain is also quite substantial, as pointed out previously in Section 3.3. If the analysis of livestock virtual water trade with Spain is run by livestock sub-products, the following results (Table 5) can be found.

Import					Export				
Product	live	meat	other	total	Product	live	meat	other*	total
Bovine	12	294	155	461	Bovine	14	13	38	65
Swine	320	433	50	803	Swine	41	21	2	64
Dairy	-	-	-	353	Dairy	-	-	-	299

Table 5 – Livestock virtual water trade with Spain by sub-products (hm^3/yr)

Table 5 shows how bovine (17% imports, 8% exports), swine (29-8%) and dairy (13-37%) virtual water trade with Spain concentrate most of Portugal's total livestock virtual water imports.
The imbalance is particularly significant for swine products, which in general terms (there is a strong variability within sub-products), have a larger relative weight of blue and grey water components. The same occurs with dairy products, where Portugal almost balances its imports from Spain (being a net exporter of milk).

These facts point to a **large dependency of Portugal on irrigated crops (olives, cotton, soybeans, maize), mostly grown in river basins that have significant water scarcity problems**, due to excessive regulation and overexploitation of available water resources – that is particularly the case of Guadiana, Guadalquivir, Ebro and Jucar river basins.

This fact is quite meaningful: products incorporating a higher proportion of blue and grey water reflect the need for irrigation and sewage treatment – i.e. infrastructures, economic investment and costs. In short, **this water is more expensive and has much larger environmental impacts**.

As a consequence, **virtual water trade between the two Iberian countries further increases the Portuguese dependency on Spanish water resources**, and contributes significantly to the excessive demand and pressure on it, due to over abstraction and water pollution.

4. RECOMMENDATIONS

4.1 Governments

Water sustainability is fundamentally about effective collective action by all of those who use and depend on water supply. Ultimately, therefore, water sustainability is a task for governments.

The interdependence of EU countries, both in terms of monetary value and virtual water trade, is quite high. In neighbouring cases such as Portugal and Spain, such dependency is even higher – but fortunately there is a legal, social and cultural framework that binds both countries. In this context, governments and public authorities should assume the water footprint reduction as a common goal, enabling to reduce impacts and improve agricultural sustainability across the whole EU territory.

Governments can assume a key role in defining water policies that include water footprint analysis, and respond to its environmental, social and economic impacts. While the assessments can be done at the river basin scale, the response actions ought to be based in EU legislation and international trade policie

A first step should be to incorporate water footprint analysis in transboundary River Basin Management Plans, and include results on its Programme of Measures.

Supporting the modernisation of irrigation schemes and farmers decision-making is another crucial role for governments to help reduce the internal water footprint, as well as enforcing the vast and thorough environmental legal framework in place across the EU.

As for the external water footprint, national authorities should:

- **Incorporate sound water management as a key plank of Portugal and EU aid strategy** with a much higher priority and funding allocation;
- **Measure the water needed to meet national food security**, and assess its implications in terms of sources sustainability;
- **Facilitate dialogue and links (at national and EU levels) between business and government** with regard to impacts on water sources at production sites;
- **Undertake sample water audits of government programmes** to ensure that they do not have adverse unintended consequences on water, or promote misallocation of water resources (Chapagain & Orr, 2008).

4.2 Businesses

In both Portugal and Spain, irrigation accounts for about 80% of total blue water use. If green and grey water is taken into account, then the agricultural footprint rises to over 90%. More than a third of all irrigated area still uses the "flooding" method, about one third of all water abstracted is lost in leakages, and many farmers lack the technical support and knowledge needed to decide properly when and how much to water.

In this context, **it is crucial for existing irrigation schemes and infrastructures to be modernised, adopting drip systems, replacing old pipelines, installing universal metering devices, and respecting the environmental legislation in all fields of action.** Furthermore, it is crucial that the water saved is not used for the expansion of irrigation, but mostly seized for environmental and domestic uses.

But water footprint is far from being a farmers' issue: all water users have their share, and large businesses have the largest stake. High water impacts in production locations can compromise the long-term security of the supply chain, the livelihoods of the people in those locations, and the long-term functioning of local ecosystems. **Businesses may be directly affected by water shortages either in terms of running out of water for factories and production, or from the price of raw materials. They may also be affected indirectly through higher insurance costs, lending risk and the stability of nations where water is scarce.**

There is also a reputational risk associated with the manner in which companies exploit natural resources, due to increasing public scrutiny (Friends of the Earth, 2005). Where this scrutiny translates into public 'outrage', companies face dramatically amplified risks, especially those judged to be profligate or irresponsible (JP Morgan, 2008).

Therefore, businesses that import and/or use high water-value commodities should publicly assume their water sources, as well as a risk-reduction policy based on the replacement of those sources that are not environmentally sound, that are based in water-scarce areas, or that contribute to the contamination of existing freshwater resources.

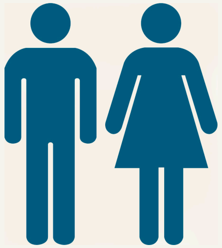
Furthermore, in order to reduce their exposure **companies should:**

- **ensure that their own operations make efficient use of water;**
- **address the issue of water use throughout the supply chain, making good water management a standard part of supplier contracts;**
- **inform business development and growth by considering the impact of operations on local water systems** (Chapagain & Orr, 2008).

This risk-based approach should be clearly assumed by every business in the form of a Water Disclosure Strategy, aimed at reducing water footprint and compensating impacts.

4.3 Citizens

Reducing the impacts of water use arising from the consumption of food and fibre is not solely the responsibility of the consumer / citizen, however **each one of us can play a positive role in lobbying Government, and demanding better performance from businesses** in terms of its impact on water sources. Of course this only addresses indirect impacts of water use through virtual water, but there are also many things we can do as individuals to address our own direct water footprint, starting with reducing the amount of water we use and the amount of food we waste at home (Chapagain & Orr, 2008).



We can also evaluate our own water footprint to become more aware of the role of water in our daily lives (using online calculators such as the one available at: http://www.waterfootprint.org/?page=cal/WaterFootprintCalculator

People may, as a consequence, choose to:

- **reduce the consumption of highly water-intensive commodities**, adopting a more sustainable diet (generally healthier too), and a more sustainable wardrobe;
- **waste less food and recycle products**, therefore wasting less water;
- **pressure retailers and food manufacturers** to deliver water sustainability through their stores and supply chains;
- **support and pressure the Government** to fully implement policies relating to the sustainable use of Portugal's water resources (Habitats Directive, Water Framework Directive) and external water resources (UN and UNECE Conventions).

5. WWF WORK

WWF is encouraging and helping governments and businesses to better manage water resources, in order to reduce water footprint impacts.

The concept of "water footprint" has rapidly emerged as a major concern for companies, finance institutions, insurers and government agencies. WWF's Global Freshwater Programme is at the forefront of developing this concept to measure both water use and the impacts of this use, and from this defining public and private sector actions that support better water management in specific river basins. We are engaging with companies, NGOs and governments to find, promote, and implement specific solutions.

Examples of this work include:

- **Promoting private sector water stewardship at the global level**

This includes ensuring that water footprint tools and measurements are broadly accepted and reviewed through stakeholder for a (such as the Better Cotton Initiative and water roundtables convened by WWF through the Market Transformation Initiative), and that public policy for water is broadly supported by the private sector.

- **Engaging with individual businesses to reduce the impacts of their water use**

This includes calculating the water footprint of business operations and supply chains in key commodities, river basins and countries, identifying credible measures to address water issues and impacts, and supporting appropriate policy changes in water management.

- **Promoting public sector water stewardship at the river basin level**

This includes measuring water use and impacts at the river basin level, demonstrating solutions for reducing these impacts, and promoting national and international policies (such as for agriculture and irrigation) that encourage good water stewardship and ensure environmental flows.

In terms of WWF's work, the *impact* of water use is more important than the *amount* of water used. These impacts can include habitat loss, reduced water flow and/or reduced water quality – and must be addressed to achieve our twin goals of **saving biodiversity and reducing humanity's impact on natural habitats.**

6. CONCLUSIONS

Portugal has one of the largest Water Footprint (WF) of consumption *per capita* of the world (ranking 6th as of 2008). Most of this WF is external – that is, based on productions from other countries.

This report shows that the **agricultural commodities account for over 96% of Portugal's external WF, and that cotton, soybeans and livestock products alone represent ¾ of such value**. The virtual water trade path for these products is depicted and analysed, showing that Portugal is quite dependent on green water from developing countries, mostly for cotton that is used in the national textile industry (and re-exported as clothes), and for soybeans that are used industrially as fodder and oil. Furthermore, **Portugal is strongly dependent on Spain's water resources, including a large blue and grey water component. This fact is quite relevant, as this type of water is much more expensive and impacting.**

On the other hand, **Portugal is a net exporter of virtual water embedded in olives and grapes** (mainly through olive oil and wine exported to the EU and Brazil), and of other commodities mainly based on dry-farming: wheat, sunflower, and dairy products.

Therefore, it is acceptable to state that **Portugal puts much more pressure on external water resources (mainly Spain, Brazil and some developing countries) than on its** own. All these countries have significant environmental problems related to the pressure of water use for agricultural production: Spain because of water scarcity, overexploitation and associated infrastructures in exporting basins, Brazil because of the conversion of natural habitats and agrochemicals contamination of soil and water sources, which is also true for most developing countries. Social impacts of cheap labour, poor sanitarian conditions, and external dependence (on large-scale agro-business) should also be taken into account.

It is crucial, within the EU, to take action in order to **incorporate WF assessment into river basin planning, business strategies, and international trade regulations.**

Portugal and Spain, sharing not only their EU neighbourhood and institutional framework, their rich common geography, history and culture, their environmental values and problems, but also most of their natural water resources, should stand as pioneers on this path for a sustainable future.

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conserving the world's biological diversity
ensuring that the use of renewable natural resources is sustainable
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