



The EU Beet and Sugar Sector:

A MODEL OF ENVIRONMENTAL SUSTAINABILITY



Growers' and Industry's Joint Commitments to:

- Respecting biodiversity
- Soil conservation
- Water management
- Climate change:
adaptation and mitigation

This brochure is published as part of the joint CIBE-CEFS effort to assess and improve the environmental sustainability of the EU beet and sugar sector, with the aim of sharing their results. A shorter leaflet, providing the key findings of this publication, is available from CIBE's and CEFS' websites, from which you can also download this brochure.

www.cibe-europe.eu and www.cefs.org

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FOREWORD

For over 200 years, the cultivation of sugar beet has formed the basis of sugar production in Europe. Today beet farmers and sugar producers ensure that EU consumers are reliably supplied with this natural product. At the same time, they jointly bear the responsibility for providing the high quality product demanded by sugar users and consumers and for complying with the increasingly strict environmental standards expected by society. These high standards apply not only to growing sugar beet, but also to the sugar extraction operation and more recently, to the production of bioethanol and biogas from sugar beet which is developing significantly in the EU.

The International Confederation of European Beet Growers (CIBE) and the European Committee of Sugar Manufacturers (CEFS) had already documented their environmental objectives and achievements in a joint report in 2003. Since then, the context and the achievements have evolved to such an extent that an update of this joint publication was necessary. This new brochure explains the steps that have been taken in recent years in both the growing and processing of sugar beet, and provides a detailed analysis of the environmental practices and standards implemented at each stage of the beet lifecycle.

Firstly, this publication should be seen in the light of recent policy developments. Since the 2006 reform, the EU sugar beet sector has undergone a painful and drastic restructuring process, cutting and concentrating its production consecutively in response to an opening up of the EU sugar market, in particular

in favour of the African, Caribbean and Pacific Group of States (ACP) and Least Developed Countries group (LDCs). Within 3 years, the cut in production of approximately 6 million tonnes of quota sugar (from around 20 million to 14 million tonnes) led to the closure of 83 factories out of 189 in the EU-27, the loss of over 16 500 direct jobs in rural areas, the end of sugar beet cultivation for a total of around 140 000 farmers in all EU producing countries, and a decrease in sugar beet area by 800 000 hectares. The map of EU sugar beet growing and processing has been dramatically reshaped.

The latest developments in the EU Common Agricultural Policy (CAP) have put an even greater emphasis on sustainability: the 2003 CAP reform introduced cross-compliance which has become compulsory and the CAP Health Check seeks to address emerging and interlinked global challenges: climate change, biodiversity, water management and green energy production.

Today, the challenge to find a balance between environmental concerns and agricultural production will have to be tackled by achieving optimal synergy between producing food in order to meet the growth in food demand (food security) and producing feed and energy, while at the same time tackling environmental impacts and the consequences of climate change: this is considered a main goal of EU agricultural policy.

Secondly, the concept of environmental sustainability is at the heart of the sugar industry. Reducing energy use and water demand, re-using resources, valorising all the co-products and

by-products, reaching the 'zero-waste' objective, and cutting its greenhouse gas emissions enables the sugar industry to remain competitive while contributing positively to the preservation of the environment.

CIBE and CEFS share the objective of moving farming and processing towards being 'greener', while at the same time increasing productivity - and hence becoming more competitive. CIBE and CEFS do not consider this a contradiction in terms; on the contrary, the aim of this report is to make a positive contribution towards this objective by demonstrating our sector's achievements and potential.

In documenting the technical progress and achievements made by our sector, CIBE and CEFS have combined the results of their respective beet growing, bioenergy and sugar production sections in a holistic manner. We wish to present our sector as a well-functioning, integrated and sustainable whole rather than as separate beet, bioenergy and sugar entities. Environmental sustainability is the ability to maintain the factors and practices that contribute to the quality of the environment on a long-term basis. Measuring environmental sustainability encompasses a range of issues broad enough to permit a complete appraisal of the state of the environment. Five key issues are of concern in terms of environmental sustainability for our sector: agricultural and industrial practices, soil conservation, water management and quality, biodiversity and energy and greenhouse gas (GHG) emissions. In these 5 sections we wish to illustrate and share our progress.

In virtually no other agro-industrial production sector is the co-operation between farmers and processors as close as in the sugar sector. Thanks to this co-operation, and through a combination of research, development, technology transfer and investment, the EU beet and sugar sector, along with 11 national technical beet institutes, has been able to make progress on these 5 issues. Several EU beet sugar producing countries have developed indicators of this progress and every year they report on the evolution of impacts on these five issues. Despite the wide range in diversity of beet growing and processing conditions in the EU, all the examples in our report illustrate the positive effects which these measures have had over many years. They also demonstrate the substantial and increasing investment being made to continuously improve environmental performance across the sector. While further environmental progress is, despite constant technical progress, increasingly difficult and sometimes costly to achieve, EU beet farmers and the sugar industry remain fully committed to this objective.

Finally, this publication also takes potential future developments into account, including impending EU legislation.

CIBE and CEFS hope this brochure will serve as a valuable reference for all institutions and individuals interested in environmental issues and the beet and sugar sector. We also hope it will provide a useful source of information as well as a constructive basis to be shared and discussed with all stakeholders dealing with these key environmental challenges.

April 2010



Jos van Campen
President of CIBE



Johann Marihart
President of CEFS



INTRODUCTION

WHERE DOES BEET SUGAR COME FROM?

HISTORY

Sweetening foods have always been in great demand, and honey above all was used to provide a sweet taste. Later, during the 14th century, the first cane sugar refineries were built in Europe. For a long time, sugar was a highly coveted and expensive sweetener which was derived exclusively from sugar cane cultivated overseas. Sugar refineries were supplied with imported raw cane sugar which was processed to produce white sugar. Sugar cane thus became the first plant to supply Europe with sugar.

At the beginning of the 17th century Olivier de Serres, a French agronomist, demonstrated the presence of crystallisable sugar in beet, which was being grown as animal fodder. Later, in 1745, the German Andreas Sigismund Marggraf became the first to extract and solidify the juice of this plant. However it took another forty years before his successor, Franz Karl Achard, produced sugar from beet for the first time.

At the end of the 18th century and beginning of the 19th, the uprisings in the overseas territories and the war between France and Great Britain, which resulted in the Continental System blockade, paralysed the cane-sugar trade to the European

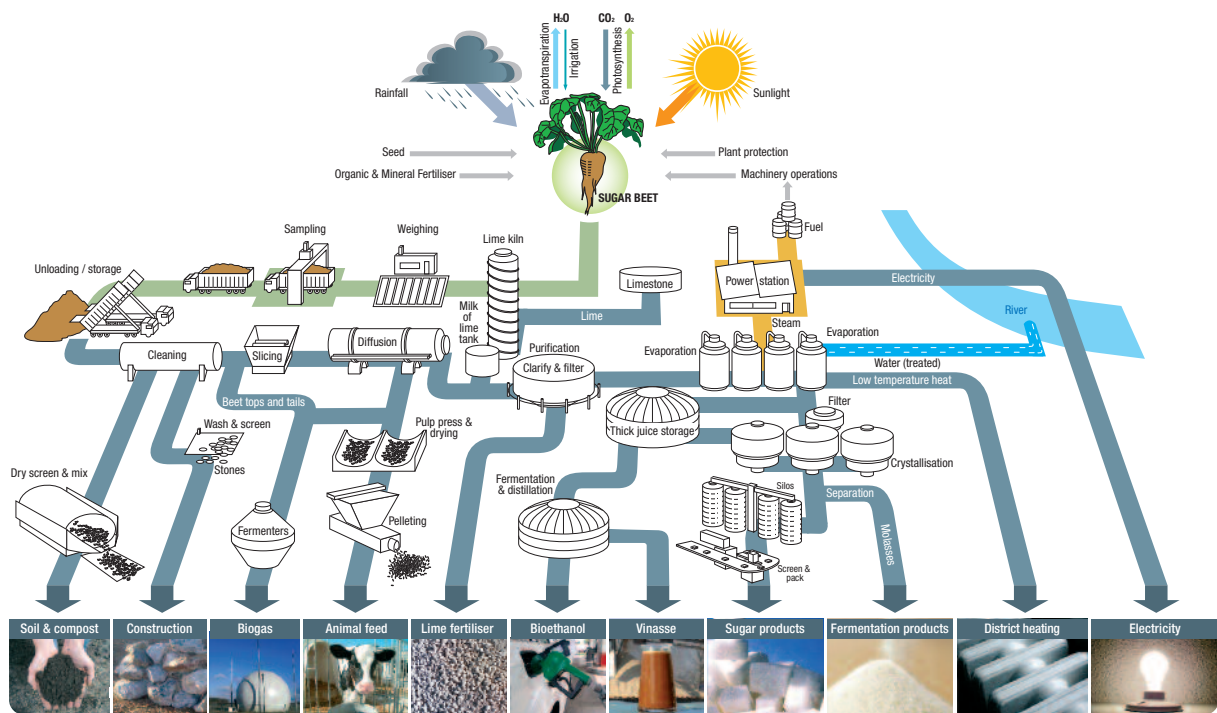
continent. Substitutes were therefore needed and sought. Fruit, honey, grapes and roots were all tried in turn. This was propitious for Franz Karl Achard's work. He improved beet cultivation and opened the world's first experimental beet sugar factory in Silesia in 1801, which produced its first beet sugar the following year.



Following very satisfactory results, several more factories were built in Silesia and Bohemia and the success of beet sugar soon expanded beyond their borders. Europe saw it as the solution to its sugar supply problems. In the years that followed, sugar beet cultivation and processing gradually developed throughout Europe and the basis for European sugar production was created.

Today, the EU beet and sugar sector is a modern, high-performance sector that is essential for EU consumers. Over the last 200 years it has constantly improved its technology and the quality of its products in line with consumer expectations. Together, EU beet farmers and sugar producers ensure that EU consumers receive a high-quality and reasonably-priced foodstuff, which is produced observing strict EU environmental, quality and social standards.

FROM BEET FIELD TO SUGAR FACTORY



Source: CIBE and CEFS (after British Sugar)

Sugar beet is currently grown and processed in 18 EU countries and is especially significant for many rural areas. This is due not only to the indispensable contribution of beet growing to the economic welfare of 170 000 farms, but also to the importance of the sugar industry in creating jobs in those regions.

Containing about 75% water, sugar beet is perishable. During the campaign, large quantities of beet (about 100 million tonnes in 2008/09) are transported in order to be processed. Therefore, to reduce the economic and environmental impact of sugar beet transport, sugar factories are traditionally located near the beet fields, in most cases in rural areas.

The EU sugar industry has a long tradition of maximising the use of co-products arising from the beet processing operation, all of which are used in productive applications. In fact, sugar factories are not only suppliers of sugar, but also produce other products, such as animal feed. All parts of the beet are used and converted into valuable products, without waste. These products are for the most part marketed in the region, and thus help bolster the economic strength of EU rural areas.

The following steps take place during sugar beet cultivation and beet sugar production:

ROTATION CHOICE – Beet growers usually choose the frequency of beet in their farm’s rotation system according to farm-specific conditions (e.g. soil status, pest and disease prevalence). While growing beet on the same field every four years is a good rule of thumb, most soils are able to sustain one in three year rotations over time without soil quality deterioration and consequent yield loss. One in five and even one in six year rotations also exist.



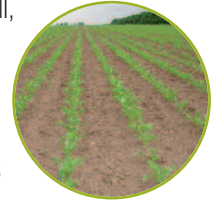
VARIETY CHOICE – Beet growers choose the varieties they wish to grow from a list of approved varieties (i.e. varieties which have passed the required trials). In many cases, this list in turn highlights recommended varieties. These are usually established on a joint basis between growers and processors through the activities of the beet research institutes and seed breeding companies. Apart from the essential criteria for beet variety recommendation, such as root yield and sugar content, other criteria such as early or late maturing, resistance/tolerance to specific pests and/or diseases, nutrient conversion efficiency and internal quality are also evaluated.



SEED ACQUISITION – In general, beet growers order and obtain seed from the sugar factory or other distributors approved by both growers and processors. Most beet seed sown in the EU is pelleted, i.e. the seed is enveloped so as to make it heavier, rounder, smoother and more uniformly-sized, thus facilitating precise mechanical sowing. However, the pellet also contains a small amount of plant protection products (PPPs) which protect the germinating seed and young seedling against early attacks from pests such as pygmy mangold beetles, springtails, symphylids, aphids, millipedes and wireworms, as well as from diseases such as damping off caused by a fungus (Aphanomyces). Such seed treatment is standard procedure for most seed and eliminates the need for pesticide use straight after emergence.



weight (or 7 667-fold increase in dry matter weight), the plant requires sufficiently high temperatures, water and nutrients. Water is principally supplied by rainfall, supplemented by irrigation only when required. Nutrients are provided as much as possible by the soil. They are appropriately supplemented by optimal application of fertiliser according to the nutrients available in the soil and the crop's nutrient requirements.



PLANT HEALTH – The young plant can be threatened in the first instance by competition from weeds for light, water and nutrients. Furthermore, pests and diseases can severely hamper plant growth and even lead to crop failure. Therefore, apart from selecting appropriately resistant/tolerant varieties and opting for appropriate seed treatments, farmers continuously monitor the crop for signs of stress and are regularly informed about weather conditions likely to favour the development of specific pests and diseases.



SEEDBED PREPARATION – This can begin as soon as possible after the harvest of the preceding crop in the rotation. In general, the objectives are to loosen the soil if required, to enhance the breakdown of residues from the previous crop and to avoid proliferation of weeds.

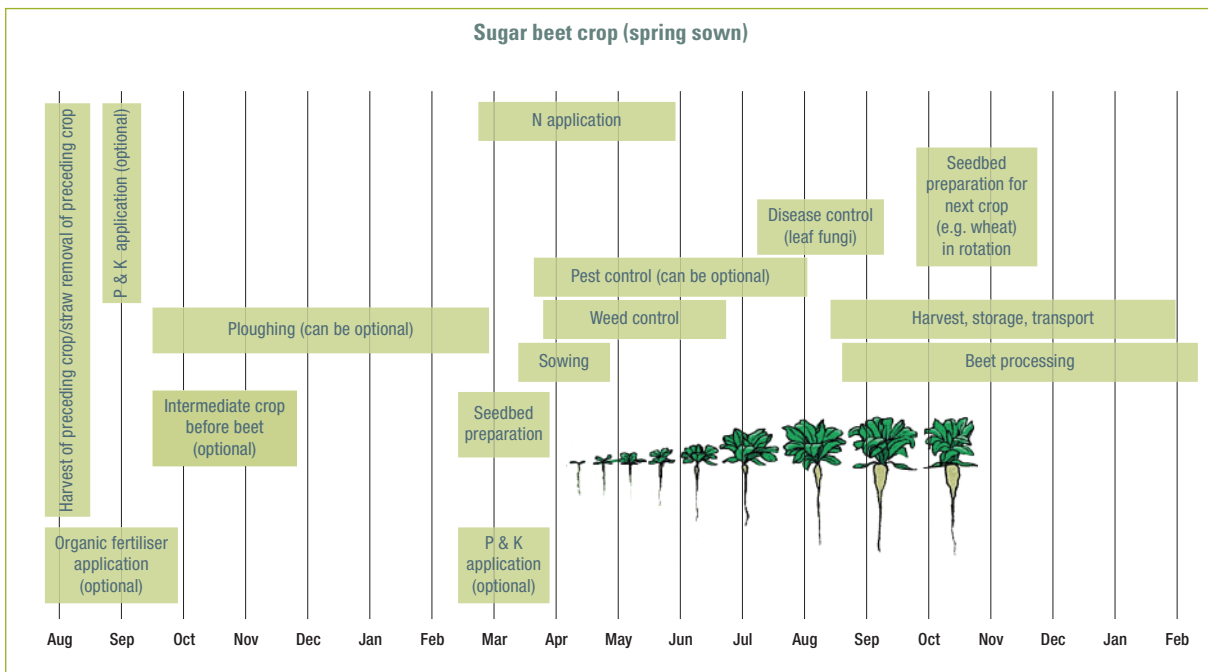
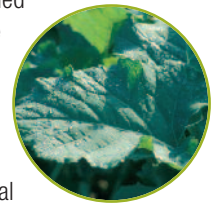


SOWING – Sugar beet is generally sown in spring (mid-March to late April), although there is some autumn-sown (October/November) beet in Spain and Italy. Ideally, beet is sown as early as possible so that the limited growing season can be fully utilised.



PLANT GROWTH AND NUTRITION – From germination of the seed right to the end of its vegetative phase, the plant grows from a 0.03 gram seed to a sugar beet plant with a 1kg root. In order to achieve this 33 000-fold increase in

PHOTOSYNTHESIS – The plant grows by absorbing the sun's energy and using it to convert water and carbon dioxide to sucrose. The biochemical process is called photosynthesis, and it uses carbon dioxide which is absorbed from the air. The sucrose is used in the plant to provide the energy for chemical reactions, but in the case of beet, some of it is stored in the root. Thus, the sugar that is extracted in the sugar factory is the natural product of photosynthesis.



Source: CIBE (after IIZ, IRS and ITB)

BEET HARVEST, STORAGE & TRANSPORT – Seven to eight months after sowing, sugar beet contains around 17% sugar, and is ready to be harvested and processed in sugar factories. Spring-sown beet are generally harvested in autumn and early winter (mid-September to December), although slightly earlier in for example Italy. The period of beet harvesting and processing (campaign) is increasingly extended well into January and even beyond in some cases. Beet harvesting can be round-the-clock work while harvesting conditions are good, particularly if the weather threatens to break and conditions look likely to deteriorate as autumn turns to winter. The beet leaves, which are usually left in the field after harvesting, contain various nutrients which are gradually released into the soil. While some beet is transported directly to the sugar factories, the remainder is stored (for several weeks) in clamps (i.e. heaps) and then transported to the factories to ensure that the raw material is continuously supplied throughout the campaign. Before the factories' optimum campaign start date can be established, beet yields have to be carefully estimated, and the logistics of the harvesting and beet deliveries to the factory thoroughly planned in order to maximize efficiency. During harvesting, when loading and unloading the beet, care is taken to remove as much soil from the beet as possible using appropriate cleaning machinery - while keeping damage to the beet to a minimum.



BEET PREPARATION – After delivery, the sugar beet (which for the most part are pre-cleaned in the field) are either stored temporarily in the sugar factory's beet yard or directly transported via conveyor belts or water channels into the beet washing unit. The cleaned beet is cut into strips, known as cossettes.



SUGAR EXTRACTION – The sugar in the cossettes is then extracted. It is diffused out of the cossettes with warm water to form a solution with a sugar concentration of about 15% – the so-called diffusion juice. The exhausted beet cossettes are then pressed and generally dried to produce **beet pulp** pellets.

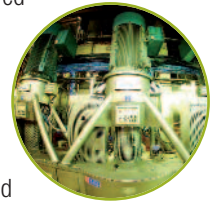
JUICE PURIFICATION – Apart from sugar, diffusion juice contains other components (impurities e.g. organic acids, proteins, ...) derived from the crop. These are removed in a purification process involving the use of lime and carbon dioxide. The resultant lime sugar precipitate is filtered. The filtrate is a clear solution of sugar called **'thin juice'**, while the sludge remaining in the filter is pressed to obtain so-called **sugar factory lime**.



JUICE CONCENTRATION AND EVAPORATION – In the evaporation station, water is removed from the **'thin juice'** in a series of successive evaporating vessels under vacuum until a syrup with around 70% dry matter is obtained. This so-called **'thick juice'** is viscous, golden yellow and clear.



CRYSTALLISATION – The **'thick juice'** is further evaporated and crystallised in specially designed vacuum pans until sugar crystals form (the **'thick juice'** can also be stored and used for the production of sugar after the beet processing campaign). Sugar crystals are then separated from the accompanying final syrup by centrifugation. This process is carried out two or three times. The centrifuged **sugar** is dried and stored in silos, before being sieved and packaged according to the highest quality customer standards. The final syrup, which still contains 50% sugar, is known as **molasses**.



ZERO WASTE: MANY OTHER VALUABLE PRODUCTS AND CO-PRODUCTS

During the washing process, the remaining **adhering soil** (known as soil tare) is removed, any remaining **leaves** and **stones** are separated out and **beet tails and roots** accumulate. All these co-products are reclaimed for use in many productive applications.



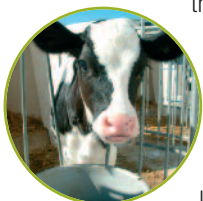
The **soil** contained in the washing water can be directly returned to the fields or can be stored in settling ponds so that it becomes concentrated to form high quality soil. This is then used for a wide range of applications, including agricultural land improvement, in the sports amenity industry, civil engineering and housing construction, garden centres (horticulture), land reclamation and landfill site restoration.



Stones are used in road building and in the construction industry.

Beet leaves, tails, and roots are re-used as energy-rich and easily-digestible feed for ruminants, or as compost which makes a useful soil conditioner. In certain countries tails and beet parts are also used in rural biogas plants as biomass for co-fermentation.

On average, 50kg (dry matter) of **beet pulp** are produced per tonne of beet. Beet pulp is a high energy and top quality **animal feed**, which is used in compound feed products or fed directly. Pulp is generally dried to produce beet pulp pellets. In some cases, notably when there is local demand for fresh animal feed, the factory can provide the more perishable 'fresh' pressed pulp. The latter is, most often, the result of pressing the cossettes in order to obtain a product with up to 25% dry matter to be ensiled (stored) by the farmer or to be consumed directly by the animals. In many countries, beet pulp is highly valued by the beet growers, who take it back to their farms during the processing season. In many cases, beet pulp is transported in the otherwise empty beet lorries returning from the factory thus avoiding unnecessary transport. The processing and use of animal feed is subject to strict EU and national feed regulations. Moreover, beet pulp is a raw material with interesting potential for use in applications other than simply animal feed.

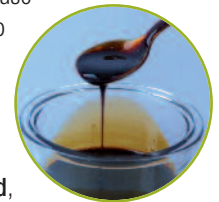


For example, beet fibre can also be used for **food applications** and beet pulp's biomass can be a substrate for **biogas**.

Sugar factory lime from the juice purification process is used as a **soil conditioning product (fertiliser)** for agricultural land. It is marketed in a range of forms to suit various spreading techniques.



Molasses, the remaining syrup from the crystallisation stage of the process (around 50kg per tonne of beet), is used in a wide variety of market applications. These include use as a feedstock by fermentation industries to produce high value **pharmaceuticals, citric acid, yeast, ethanol (for various uses, such as fuel and beverages)** and specialist **bio-chemicals**. However, the largest single application is as a supplement for **animal feed**, where it can either be sold to feed manufacturers or farmers (e.g. to add to grass or maize silage to improve product quality), or can be added directly to animal feed at the sugar factory. The sweet taste and relatively high energy content make molasses a highly appreciated raw material for the producers of mixed feeds. Molasses is used in both energy feed and mineral feed for virtually all types of farm animals. Of particular importance is the high digestibility of its organic ingredients.



BIOGAS: The production of biogas by fermenting the **waste water** during the anaerobic water treatment process in the sugar factory makes an environmentally-friendly and sustainable contribution to reducing fossil fuel. This biogas, which has a methane content of around 75%, helps reduce fossil fuel demand (to produce heat and electricity). Biogas is increasingly used in the sugar industry as a valuable substitute for fossil fuels, for example, as a source of energy in the boiler house (the factory's power station) or for drying the pulp. In some countries, **beet tails** and other parts are used in rural biogas plants as biomass for co-fermentation. In other cases, where **pulp** is not used as cattle feed, it can be used to produce biogas.



HEAT AND ELECTRICITY: The **surplus heat** generated from the sugar factories' combined heat and power systems can be re-used in the evaporation stages and also to heat the sugar juice throughout the process. The remaining heat can be exported and sold to neighbouring consumers in the form of hot water or steam. In the same manner, where more **electricity** is generated than required, it is exported to the grid or sold to the electricity supply companies.



BIOETHANOL: The **raw juice**, the **‘thin juice’** and the **‘thick juice’** correspond to different processing steps which correlate to an increase in the concentration of sugar content.

These intermediate products can be used directly to manufacture bioethanol through a fermentation process. Molasses resulting from sugar beet processing can also be used to produce bioethanol. Sugar companies in many EU countries have invested in the production of

bioethanol, which can then be used for various purposes, mainly for fuel and for beverages. **Vinasse**, a co-product resulting from the production of bioethanol or yeast from beet (around 40kg of dry matter per tonne of beet), can be used as **animal feed** or as a **fertiliser** due to its high mineral and high organic matter content, which is ideally suited for soil conservation. Vinasse can also be returned to the distillation and fermentation processes as a raw material.



The impact of REACH on the sugar industry’s zero-waste objective

REACH is a new European Community Regulation on chemicals and their safe use (EC 1907/2006). It deals with the Registration, Evaluation, Authorisation and Restriction of Chemical substances. The new law entered into force on 1 June 2007.

The aim of REACH is to improve the protection of human health and the environment through better and earlier identification of the intrinsic properties of chemical substances. At the same time, the innovative capability and competitiveness of the EU chemical industry should be enhanced. One of the fundamental changes brought about by REACH was the change of responsibility from public authorities to industry in demonstrating the safe manufacture and use of chemicals.

REACH legislation is mainly directed at the chemical industry. However, its far-reaching scope means that many substances used or produced by non-chemical sectors such as the food and drink sector are also affected. These include a number of co-products necessary to or derived from sugar production. The European sugar industry aims to be a zero-waste industry by maximising the value of all its products and co-products. It is therefore important that the application of the new REACH rules takes due account of the sugar industry’s specific situation so as not to jeopardise the achievement of the zero-waste objective.

The financial aspects of REACH are not to be neglected either. The costs related to the registration of substances, including all the costs associated with the setting up of a

Consortium to deal with the necessary tests of a substance under REACH can often exceed € 1 million per substance. In some cases, it is only the amount of the substance which is marketed for non-food and non-feed uses that falls under REACH. This may lead some companies to stop marketing that substance for REACH-relevant uses in order to avoid the associated registration costs. This may put pressure on some companies to conclude that it is better for a product to be considered as waste and dealt with under the relevant regulations for the disposal of waste.

REACH will therefore be one of the main focuses among the environmental issues of concern for the sugar industry in the years to come.

STRUCTURAL DATA

The Common Market Organisation in the sugar sector, or CMO Sugar, has stabilised beet and sugar production in the EU since the late 1960s. Within this stable context, the sector has made considerable progress. As a result of increasing yields (by about 33% since 1990), the area devoted to beet growing in the EU-15 steadily decreased (at an annual rate of about 1.7%) by about 25% between 1990/91 and 2004/05. Industrial restructuring also took place: the number of sugar factories in the EU-15 decreased from 194 in 1990 (236 if the 42 factories in former East Germany are included) to 117 in 2004.

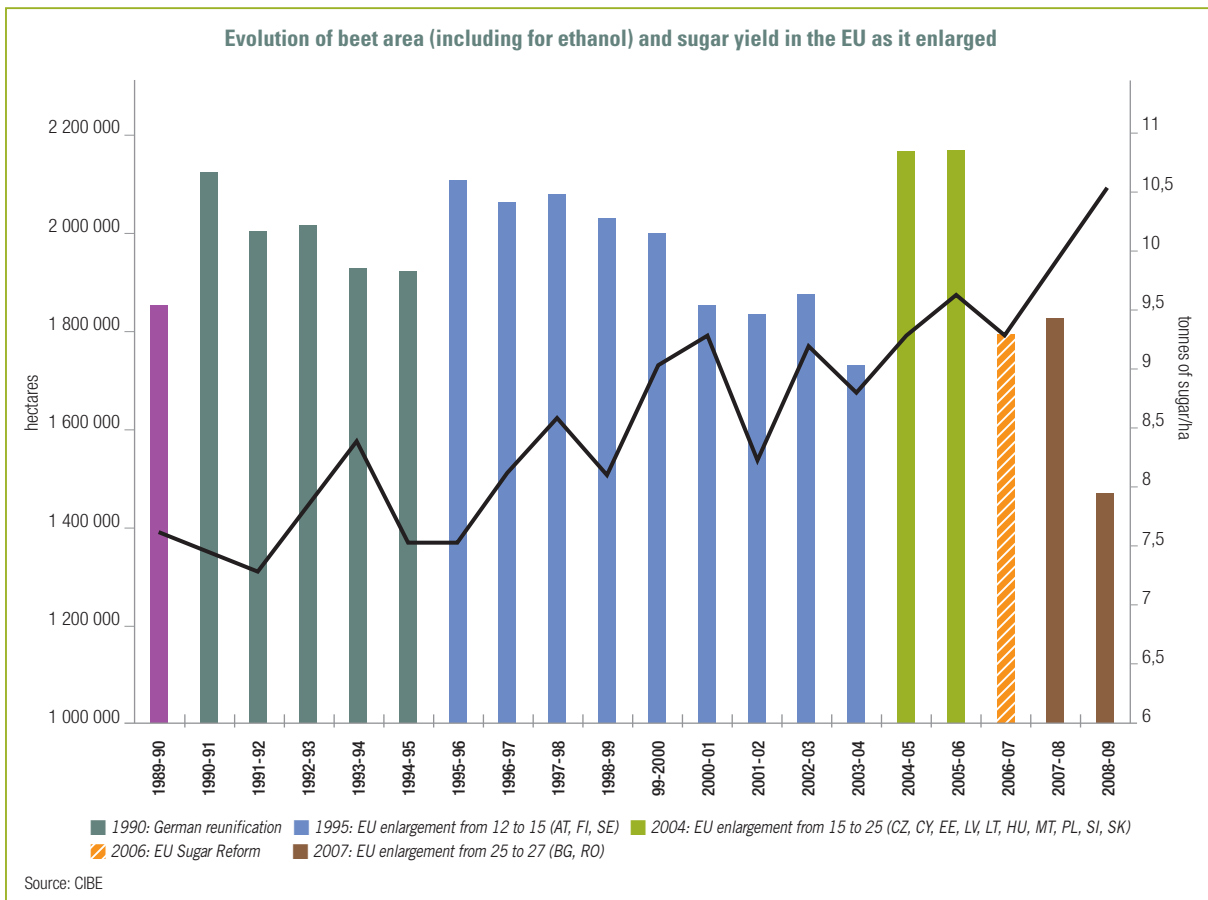
In 2006, the CMO was thoroughly reformed.

Before the reform, over 300 000 farmers in the EU grew beet with an average beet area per farm of about 7 hectares. Today, around 170 000 farmers grow sugar beet in the EU, with an average beet area per farm of about 9 hectares. The area devoted to beet cultivation in the EU-27 has decreased from over 2 million

hectares before the reform to the present level of about 1.5 million hectares.

Virtually every country and region of the EU has been affected: in 5 countries (Bulgaria, Ireland, Latvia, Portugal and Slovenia), beet sugar production ceased. Today, sugar production is distributed among 18 EU countries out of 27 (as opposed to 23 before the restructuring) with 70% of the production concentrated in 7 countries.

The EU sugar industry has been restructuring for years, well before the 2006 reform of the sugar CMO. In the period 2000-2005, 68 factories (i.e. 11 per year) were closed in the EU-25. The CMO reform has accelerated the pace of factory closures: 83 factories (i.e. almost 28 per year!) were closed between 2006 and 2008 in the EU-27. Overall, the number of beet sugar factories in the EU-27 has been reduced by 44% since the CMO Reform was adopted in 2006 (from 189 factories in 2005/06 to 106 in 2009/10).



At the same time, the average size of sugar beet factories has continued to increase, in particular in Western European Countries (EU-15) where the bulk of EU beet sugar production (85% of production in 2009) is concentrated.

The number of employees in the sector has followed suit. During the 2008/09 processing season, they numbered 31 280, a fall of 41% since 2004/05 (EU-25: 52 960). Despite the fact that the number of direct employees has decreased during recent years, the sugar beet processing industry retains an important economic function in rural areas, where it guarantees jobs and training positions. As well as being the processor of sugar beet, the sugar factories are also a partner for numerous small businesses and ancillary suppliers. Taking into account direct and indirect employment, the beet sugar factories in the EU support about 180 000 jobs.

In 2003 the European social partners of the sugar industry (CEFS for the employers and EFFAT, the European Federation of Food, Agriculture and Tourism Trade Unions, for the employees) signed a CSR (Corporate Social Responsibility) Code of Conduct aimed at developing the sustainability of the sugar industry at a social level. In the context of the sugar reform, this Code of Conduct has proved an efficient tool for proactively managing the restructuring process and the associated factory closures and staff reductions. A report on the implementation of the Code of Conduct is presented each year at the plenary session of the Social Dialogue Committee for Sugar (www.eurosugar.org)

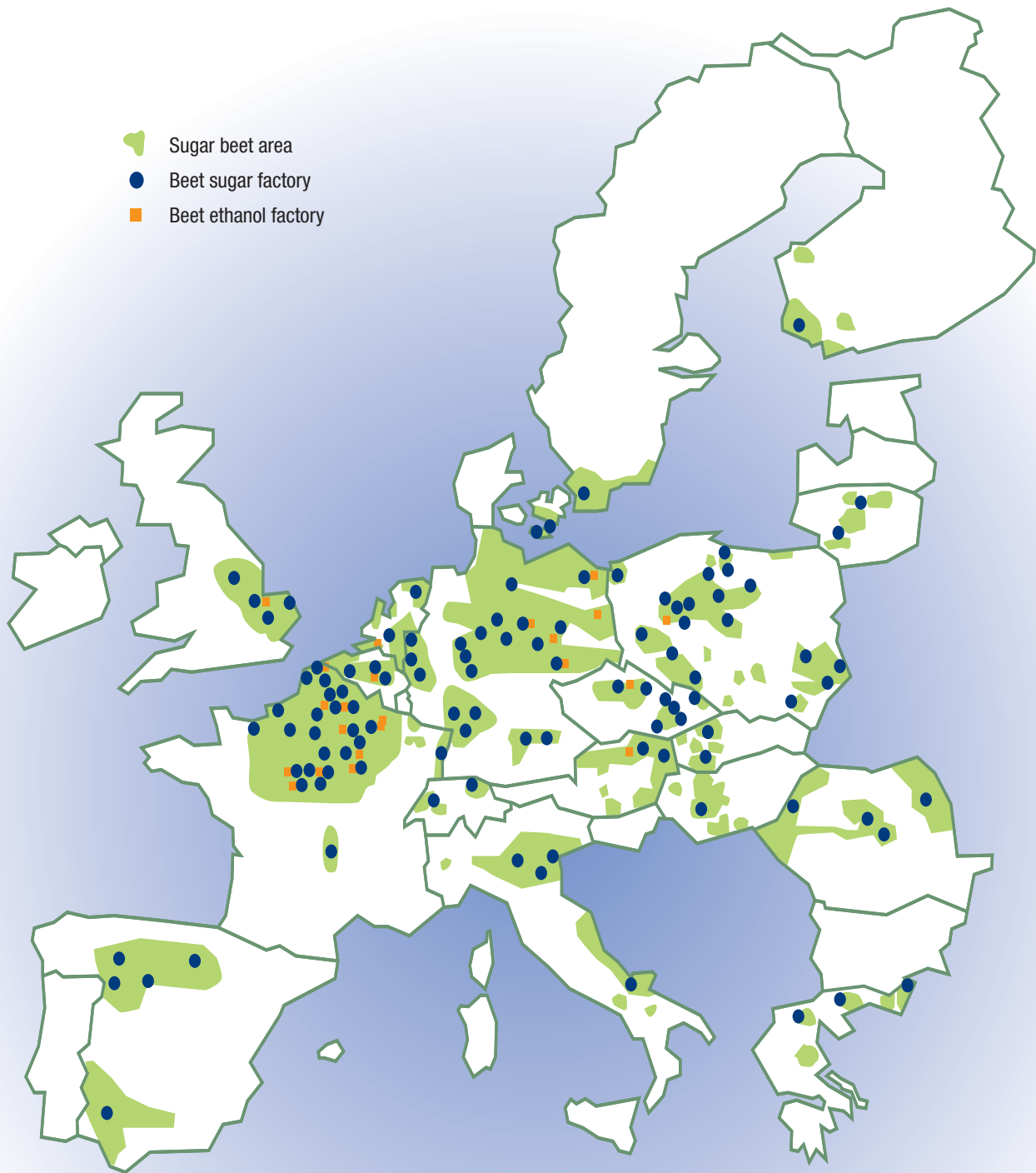
Sugar beet is one of the main raw materials for the production of bioethanol in the EU. Currently 21 bioethanol plants can process sugar beet and/or molasses in the EU. In 2008, around 1.35 billion litres of bioethanol were produced from sugar beet, half of which was used as fuel and half for traditional uses (e.g. the drinks, chemical and pharmaceutical industries). This represents around one third of total EU bioethanol production.

EU countries	Number of beet sugar factories in 2009-10	Sugar production quota in 2009-10 (in tonnes)
Austria	2	351 027.4
Belgium	3	676 235.0
Czech Republic	7	372 459.3
Denmark	2	372 383.0
Finland	1	80 999.0
France (excl. DOM)	25	2 956 786.7
Germany	20	2 898 255.7
Greece	3	158 702.0
Hungary	1	105 420.0
Italy	4	508 379.0
Lithuania	2	90 252.0
Netherlands	2	804 888.0
Poland	18	1 405 608.1
Romania	4	104 688.8
Slovakia	2	112 319.5
Spain	5	498 480.2
Sweden	1	293 186.0
United Kingdom	4	1 056 474.0
Total (Excl. Azores)	106	12 846 543.7

Source: CIBE, CEFS and European Commission

Biogas production from sugar beet is developing rapidly across the EU. Thanks to a very high yield per hectare and a sustainable production pathway, biogas from sugar beet constitutes an excellent contribution from EU farmers to the development of decentralised energy production in the EU, which can provide electricity, heating and transport fuel to farms and sugar factories, as well as to rural communities and the general public.





Source: CIBE / CEFS 2009



IMPROVING AGRICULTURAL AND INDUSTRIAL PRACTICES

SUGAR BEET CULTIVATION AND ENVIRONMENTAL REQUIREMENTS

The recent reforms of the Common Agricultural Policy (CAP) ensure that its rules are compatible with environmental requirements and that CAP measures promote the development of agricultural practices preserving the environment and safeguarding the countryside. Since 2003, CAP aid has been decoupled from production and farmers are required to meet a minimum set of environmental standards (cross-compliance). Farmers are encouraged to continue playing a positive role in the maintenance of the countryside and the environment.

This is achieved by:

- targeting aid at rural development, promoting environmentally sustainable farming practices, like agri-environmental schemes
- sanctioning non-compliance with environmental laws through a reduction in support payments from the CAP.

Beyond these cross-compliance standards, almost all EU countries have developed their own code of good or best agricultural practices and adapted their practices regarding some specific targets (soil, water) in specific regions: nitrate vulnerable zones, zones prone to soil erosion or pesticide resistance, etc.

What is cross-compliance?

Since 2005, all EU farmers receiving direct payments have been subjected to clearer obligations to manage their farms in sustainable ways. 'Cross-compliance' links direct payments to farmers to their respect for the environment and other requirements set at EU and national levels. Cross-compliance is compulsory and has been extended beyond compliance with environmental rules to include new requirements regarding public, animal and plant health, animal welfare and the maintenance of all agricultural land by 'good agricultural and environmental conditions'.

The two strands to cross-compliance are:

1. Farmers no longer have to produce in order to receive the SPS (Single Payment Scheme) and/or other direct payments. However, they must respect cross-compliance standards in two ways:
 - Good agricultural and environmental conditions: All farmers claiming direct payments, whether or not they actually produce from their land, must abide by standards established by the Member States. This new requirement is a consequence of the introduction of the SPS and its aim is to avoid the abandonment of agricultural land (and the environmental consequences of this)
 - Statutory management requirements: Farmers must respect other cross-compliance standards, called statutory management requirements, set up in accordance with 19 EU Directives and Regulations relating to the protection of the environment (including standards related to soil protection, the maintenance of soil organic matter and soil structure, the maintenance of habitats and landscape, and the protection of permanent pasture); public, animal and plant health; and animal welfare.
2. Failure by farmers to respect these conditions can result in deductions from, or complete cancellation of, direct payments.

The EU CAP reform post-2013 may also include new developments in cross-compliance with the aim of improving its efficiency, adapting it to new challenges, and harmonising and simplifying its implementation.

Source: European Commission

11 NATIONAL INSTITUTES DEDICATED TO BEET CULTIVATION AND SUGAR PRODUCTION

Over many years the EU sugar beet sector has developed and improved its actions, tools, measures and follow-up of impacts and recommendations to contribute to an increased consideration of the environment through improved growers' practices. In no other agro-industrial production sector is the engagement and co-operation between farmers and processors as intense and close as in our sector. Thanks to this, and to the financing and participation of all the stakeholders in the sector in the work of professional technical institutes dedicated to sugar beet cultivation and production, constant research is carried out to improve the sustainability of beet growing.

In the EU, no fewer than 11 technical institutes currently place a high value on and promote good agricultural practices:

- ZFI (Sugar Research Tulln, Austria)
- IRBAB (Belgian Royal Institute for Beet Research)
- Řepečský Beet Institute Semčice (Czech Republic)
- NBR (Nordic Beet Research, Denmark and Sweden)
- SJT (Sugar Beet Research Centre, Finland)
- ITB (French Technical Institute for Beet)
- IfZ (Institute for Sugar Beet Research Göttingen, Germany)
- Beta Italia (Italian Sugar Beet Research Institute)
- IRS (Dutch Institute for Sugar Beet Research)
- AIMCRA (Spanish Sugar Beet Research Institute)
- BBRO (British Beet Research Organisation).

These institutes systematically work together and have regular exchanges under the auspices of the IIRB (International Institute of Beet Research), which also includes representatives from non-EU countries (e.g. Switzerland, Turkey, Morocco, Japan, China and USA). The efficient operation of technical networks has been successful in achieving progress, not only in the beet sector but also in agriculture in general. Research priorities include the use of intercrop and soil conservation techniques; the question of nitrogen and plant protection product residues; and the role of sugar beet in crop rotation.

SUGAR BEET: A KEY ROTATIONAL CROP

The production methods used in sugar beet farming, particularly the principle of growing sugar beet in rotation, are characterised by environmental sustainability.

Sugar beet is a rotational crop, generally grown in the same field only every three to five years, over 8 months from mid-March to mid-November. It is practically never grown in consecutive years. As a root crop it has become a very valuable part of arable farming because sugar beet has the important effect of breaking up the mainly cereal-based crop rotations (as demonstrated in some EU countries, the cereal yield after beet can be 10-20% higher compared to the cereal yield after two years of successive cereals). Because sugar beet is seldom a host to pests and diseases which affect combinable crops, the cultivation of sugar beet reduces the level of diseases and pests and therefore reduces the amount of pesticides applied.

Once emerged, sugar beet is less vulnerable to environmental, especially climatic variations and, in addition, does not go through a potentially stressful reproductive phase during its first year of growth. There is thus no relationship between yield performance and cultivation intensity, like there is in many other crops.

What is crop rotation?

Crop rotation is a planned order of specific dissimilar types of crops planted in the same field. Crop rotation has several agronomic objectives including: maintaining or increasing yields by helping to control weeds, pests and crop diseases and increasing plant resilience to adverse weather effects; improving soil fertility and structure and ensuring nutrient management by balancing the fertiliser requirements of different crops.

SPECIFIC COMMITMENTS TOWARDS SUSTAINABILITY

In the sugar beet sector specific voluntary commitments and registered practices have improved performance vis-à-vis the environment. There are numerous examples among EU countries.

The Sugar Beet Assurance Scheme in the United Kingdom was piloted in 2003 and became a contractual requirement for the 2008 crop onwards. In the light of recent EU legislative changes regarding food safety and traceability, the National Farmers Union (NFU) and British Sugar have agreed that an assurance scheme for the sugar beet crop encompassing all growers is the best way forward. This includes a rigorous programme of raw material testing (carried out at British Sugar's expense), so that the integrity of sugar processing from a food safety perspective is assured.

The Integrated Food Safety Management System in the Netherlands or Integrated Chain Quality Management (ICQM) in Belgium are other good examples. The ICQM Standard describes all statutory and supplementary standards relating to basic quality and traceability of fruit and vegetable production, including sugar beet. The ICQM Standard thus describes the minimum requirements which agricultural producers and workers have to meet to have access to the market.

In the Netherlands, the new projects SUSY (Speeding Up Sugar Yield) and LISSY (Low Input Sustainable Sugar Yield) implemented in 2006 facilitate technology transfer and exchange in order to improve sustainability and competitiveness. These projects are part of a private-public partnership programme ('Koda') and thus benefit from financing for this co-innovation programme.

In addition, in most EU beet-producing countries growers can access online documents and software programs designed to assist decision-making regarding crop management. This includes the choice of variety and seed treatment, soil and seedbed preparation, sowing dates, the timing and choice of inputs (fertiliser, mechanical intervention, plant protection products) during the crop cycle, harvesting and storage.

Examples of online tools available to growers include:

- variety choice: Base Variétés (France); BISZ-Sorten and LIZ-Sorteninfo (Germany); Betakwik Variety Choice (the Netherlands)
- weed control: online diagnosis program (serving Belgium, Denmark, Finland, France, Germany, Italy, Lithuania, the Netherlands, Spain, Sweden and the UK); FAR-Consult (Belgium); HerbInfo and LIZ-Herbizid (Germany); BETSY (France); Betakwik Weed Control (the Netherlands)
- irrigation management: IRRIBET (France); Balance Hidrico (Spain); Acqua Facile (Italy)
- fertiliser management: Fert-Consult (Belgium); Fertibet and Azofert (France); LIZ-Dungpro and BISZ Düngung (Germany); Integrated Beet Nutrition - N.I.B. (Italy); Betakwik N-P-K (the Netherlands)
- pest and disease control: online diagnosis program (serving Belgium, Denmark, Finland, France, Germany, Lithuania, the Netherlands and Sweden); BISZ Warning Service and LIZ-monitoring (Germany); Cercostop (Italy); Betakwik Pests and Diseases (the Netherlands).

Voluntary standards and certification

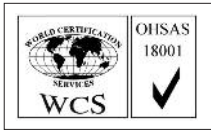
Voluntary standards and certification are used either in order to encourage management improvements above the minimum level required by law; or to support legislation implementation. These initiatives play a complementary role alongside the regulatory frameworks. Most of the codes and standards in agriculture are process standards (criteria for the way the products are made) rather than product

standards (specifications and criteria for the final characteristics of products).

Many national agricultural research systems, extension services and international institutions have recently developed standards related to sustainable agricultural production practices for specific commodities. Objectives include the maximisation of yield, the optimum use of production factors and available

resources, limiting negative externalities or maximising positive externalities on soil and water, and others. Recommendations focus on reducing the use of off-farm, external, non-renewable inputs; improving the match between cropping patterns and productive potential; working to value and conserve biological diversity; and taking full advantage of local knowledge and practices.

INTEGRATED MANAGEMENT SYSTEMS



The EU sugar industry is committed to Integrated Management Systems combining environmental protection, occupational safety and quality assurance. Many of the systems also cover the production of the raw material on the farms, from seed to harvest. All sugar companies operate with specific management systems in close co-operation with different players, from farmers to sugar factories and distributors, ensuring effective application of these measures throughout the food chain. In many cases these conform to EMAS the (Eco-Management and Audit Scheme), ISO 14001 (environment), ISO 9001:2000 (quality), ISO 22000 (food safety), GMP+ (Good Manufacturing Practice) (feed quality), IFS (International Food Standard) and OHSAS 18001 (Occupational Health and Safety Advisory Services).

All EU sugar companies are committed to environmental protection as a key parameter for their operations. A healthy environment is crucial for growing sugar beet and producing sugar. For environmental protection measures to be effectively devised and implemented, companies need the right organisational structure. Their management systems therefore provide an ideal basis for ongoing environmental improvements. The effectiveness of these systems is verified by internal and external audits. Annual internal company audits monitor their compliance with the relevant environmental regulations. Companies' environmental impacts are also analysed to identify potential improvements. This leads to the definition of new environmental targets and concrete measures to be implemented by companies in their environmental programmes.

RESPONSIBLE PLANT CLOSURES

In partnership with local communities and environmental conservation organisations, sugar companies make considerable investments in applying the strictest environmental criteria to guarantee that biodiversity is respected when renovating facilities or in the case of factory dismantling. For example, in Germany, such investments are made in partnership with the Paul Feindt Foundation in Hildesheim, the Foundation for Land Conservation in Hanover, the Natural Landscape Foundation in Hanover, and the Schleswig- Holstein Foundation for Nature Conservation in Kiel.

CORPORATE SOCIAL RESPONSIBILITY

The EU sugar industry is also committed to creating added human and social value by incorporating Corporate Social Responsibility (CSR) into all its activities. Established in 1969, just after the creation of the sugar CMO, the social dialogue in the European sugar industry has brought together CEFS and EFFAT (the European Federation of Food, Agriculture and Tourism Trade Unions) for over 40 years. Official recognition of the social partners by the European Commission was formalised in 1999 with the creation of the social dialogue committee for the sugar industry. In 2003, CEFS and EFFAT voluntarily became engaged in CSR and agreed on a Code of Conduct which sets compulsory minimum social standards and basic rights. CSR reflects the commitment of the social partners to progressively develop and demonstrate the overall sustainability of the sugar industry. Collected examples of best practices are regularly updated and serve as an inspiration for sugar companies. Every year, a report is submitted to the European Commission concerning the implementation and updating of examples of good practice (these reports can be consulted at www.eurosugar.org).

SUSTAINABLE TRANSPORT AND LOGISTICS

The EU sugar industry constantly works with local partners (e.g. local authorities, rural communities, transport companies) to optimise transport and logistics, with the aim of reducing environmental impacts (e.g. searching for the best combination of transport distance, lorry weight and loads, use of rail transport).

Sugar beet are perishable and progressively lose sugar content from the moment they are harvested. Moreover, sugar beet contain around 75% water, which represents a very big and non-productive part of the roughly 100 million tonnes of beet transported and processed by the EU beet sugar industry every year during the processing campaign. Therefore, to reduce the economic and environmental impact of sugar beet transport, beet sugar factories in Europe have, for more than 200 years, been located close to the beet fields, mostly in rural areas. Despite the restructuring of the industry and the associated factory closures, the local processing of the raw material remains a characteristic and, from an environmental perspective, significant feature of the EU sugar industry. Hence, in 2009, the average distance between the beet field and the sugar factory was just 44 kilometres in the EU-27.

Moreover, the EU sugar industry ensures that more than 14 million tonnes of sugar do not have to be transported over long distances to supply the EU market, but can be produced locally. EU sugar thus ranks amongst those food materials which are not only produced in an environmentally sound manner but are also – from the point of view of avoiding unnecessary transport – produced and marketed close to the consumer.

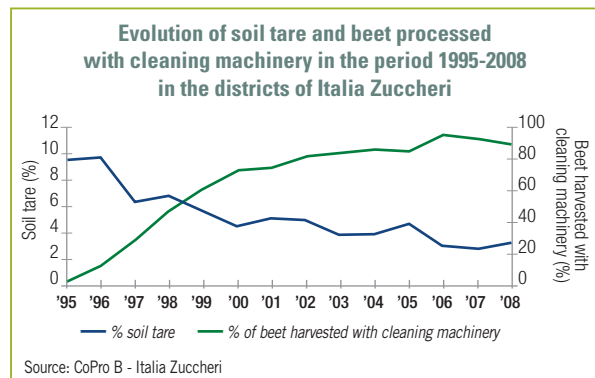
Efficient beet processing requires accurate control of enormous commodity flows, and continuous beet delivery to the factory. The objective is to assure the factory's supply of raw materials without costly temporary storage of beet on the factory site, and especially without loss of sugar in the beet. Harvesting sugar beet from the field and their delivery to sugar factories therefore takes place according to a precise schedule, avoiding long waiting times for the deliverers. To reduce the traffic burden on the roads surrounding the factories, several measures have been introduced. These include the establishment of washing installations for the beet vehicles at the factory site, and the creation of special access routes to the factory.

In recent years, rationalisation pressures within the sugar industry have led to the closure of many factories in the EU. This has meant that in some regions sugar beet tend to be transported over longer distances. However, this has been partially compensated by the fact that those beet growers located furthest from sugar factories have often been encouraged to cease growing beet. At the same time, the sugar industry has pursued a policy of transport rationalisation to reduce the environmental effects of beet transport. Among other initiatives, beet farmers are encouraged, through targeted information and various handling improvements made in the factories, to deliver in larger vehicles and to deliver cleaner beet. The amount of soil adhering to the beet (soil tare) is dependent on soil type and is strongly influenced by the weather conditions during harvesting.

The use of cleaning machinery contributes considerably to the reduction of soil tare. This in turn reduces the number of lorry trips, resulting in lower fuel consumption and less noise.

The objective of continuously decreasing the distance travelled is of key importance to ensure an efficient supply of beet to the factories. The reduced beet areas and the ever higher sugar content in beet play a positive role in ensuring transport rationalisation. Both for financial and environmental reasons, the EU sugar industry is striving to minimise transport. The examples below illustrate how the sugar industry has managed to rationalise it:

- Over the last 25 years factories in the UK have decreased from 17 to 4 consequently increasing the average transport distance from 29 to 45km. But the average vehicle distance travelled has been reduced by 50% because the size of vehicles has doubled, the sugar content and crop quality have increased and the soil tare has decreased.
- In Italy, the introduction of new equipment (harvesters and others) covering 60% of the total beet area) has led to a reduction in soil tare by roughly 50% in 10 years. The graph below clearly shows the relationship between the use of beet cleaning machinery and soil tare.
- In Austria, approximately 50% of the beet is delivered from the beet reception centres to the sugar factories by train, thereby saving a significant amount of emissions.
- In the Slovak Republic, all beet is pre-cleaned, which saves transport volume and reduces emissions. Transport efficiency is optimised by the use of a special railcar-container system to transport beet by rail. Improved beet clamp management by the grower, which reduces the risk of beet losses, is another example.
- In Germany, the systematic pre-cleaning of beet in the fields has contributed to a drastic reduction in the amount of soil transported to the sugar factories.
- The same applies in Denmark and Sweden, where the improved cleaning of the beet in the fields has also substantially reduced transport and the costs related to the handling of the soil at the factories.





Loading sugar beet onto train in Austria

New lorry weight and load regulations across the EU beet processing countries have limited the number of journeys, meaning less environmental impact per tonne of transported beet. Notably, the higher permitted tonnage of lorries, 29 tonnes on average in the EU, greatly contributes to less carbon emissions. In some countries, such as the Netherlands, the trucks are allowed to carry up to 35 tonnes of sugar beet on each journey thus maximising the reduction in fuel consumption and the associated environmental impact.



Railcar-container system from the sugar factory 'Sered' in Slovakia

EU sugar companies also take into account environmental aspects when packaging their products. Approximately 75-80% of the sugar produced in the EU is delivered to large-scale buyers for further industrial processing. Only around 20-25% is directly consumed. Most deliveries to large-scale buyers use silo trains or trucks and barges, so that almost no packaging is required. A further and essential saving in packaging results from the increasing delivery of sugar in reusable containers. Furthermore, where packaging material is used, savings have been realised during recent years with both large-scale buyers and private households. The other products related to sugar production (e.g. animal feed and molasses) are mostly transported in bulk.

Logistics' cycle – a success story in Central and Eastern Europe

The German sugar company Nordzucker has introduced a logistics concept for raw material procurement to conserve resources at Eastern European companies in which they hold an interest. It focuses on harvesting sugar beet with a low soil tare using integrated pre-cleaning and harvesting systems and/or compulsory pre-cleaning of all beet at the edge of the field. By introducing these stages, the company has virtually halved the soil tare. This has the positive effect of leaving fertile soil in the fields instead of it being transported to the sugar factory unnecessarily only to be taken back to the fields after the campaign. Another element of the logistics concept is organised beet transportation using high-capacity HGVs (Heavy Goods Vehicles). This reduces the load frequency and traffic to the sugar factories. The logistics concept is completed by the carefully coordinated transportation of the company's other products: the pressed pulp and the sugar factory lime. These are transported from the sugar factory to the beet growers by the transporters, which delivered the beet, thus eliminating additional haulage and empty trips. The transport service therefore is part of a cycle between the beet growers and the sugar factory with benefits all round.

Source: Nordzucker Sustainability Report 2008

PRESERVING THE ENVIRONMENT FOR WORKERS AND LOCAL RESIDENTS

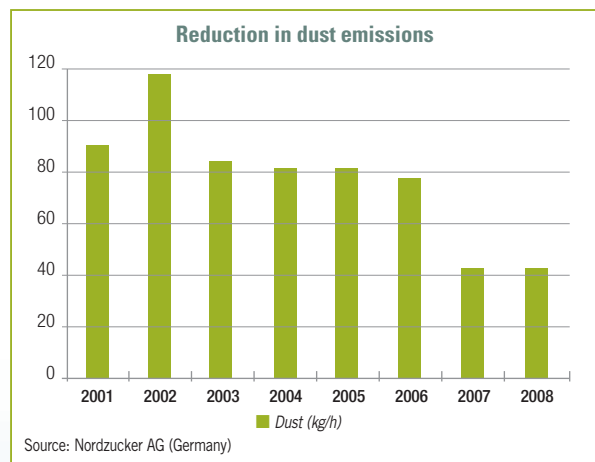
Most sugar factories were originally set up in rural and sparsely populated areas close to the fields that provide the main raw material, sugar beet. Due to the urbanisation of many rural communities and the expansion of residential areas however, sugar factories today are often located closer to populated areas. Sugar companies are committed to maintaining good relations with their staff and residents near their factories, by complying with strict environmental protection requirements. This necessitates investment, mainly to reduce noise, odour and dust emissions.

To protect both employees and the residents in the surroundings of the sugar factory from noise, a variety of noise reduction measures specific to the conditions of each site have been adopted. Examples of these measures are on the one hand, different types of physical noise barriers (e.g. use of silencers, absorption materials, sound barriers) and on the other hand, good logistical practices (e.g. slow approach of trucks in the factory yard). Finally, when new machines or equipment are acquired, noise prevention is one of the leading considerations.

Odour emissions are largely associated with pulp drying and water treatment. By improving drying technologies, optimising measurement and control technology and improving ventilation systems and water treatment systems, odour emissions have been reduced. This is a field of research for further improvement.

Dust mainly originates from the drying of pulp and from drying/cooling sugar. Through the optimisation of dust extraction systems, sugar companies are reducing dust emissions from these sources to comply with strict environmental limits.

Emissions into water are dealt with in a separate section of this report. Suffice to say here that sugar factories in the EU have invested in enhanced water treatment plants to reduce the organic load of waste water to very low levels, well beyond legal requirements.





RESPECTING BIODIVERSITY

AGRICULTURE AND BIODIVERSITY

The specialisation, concentration and intensification of agricultural production over recent decades in the EU are generally recognised as potentially threatening to biodiversity. Many species and agriculture are interdependent (i.e. many bird species nest and feed on farmland) and inevitably, agriculture has influenced the original diversity of our countries.

However, agriculture and nature must not be considered as antagonists: sound agricultural management practices can have a substantially positive impact on the conservation of the EU's wild flora and fauna, as well as on the socio-economic situation of rural areas, by safeguarding certain existing natural or semi-natural habitats, or by preventing land abandonment.

In addition to the implementation of cross-compliance with the 2003 CAP reform, most Member States have implemented agri-environmental measures to preserve biodiversity, for example, by reducing or phasing out the use of fertilisers and pesticides and by maintaining crop rotation. Examples include integrated crop management, set-aside of field margins and specific measures, tested through LIFE nature programmes, aimed at particular habitats. Measures are also in place to manage farm woodlands, wetlands and hedgerows to benefit flora and fauna; and the protection of endangered crop varieties and animal breeds.

The EU policy framework

The EU policy framework was first put in place to implement the UN Convention on Biological Diversity adopted at the Rio Earth Summit in 1992. In 1998 the EU communicated a European Biodiversity Strategy, consisting of four action plans for the conservation of natural resources, agriculture, fisheries and for economic and development cooperation.

In 2001 EU Heads of State and Government committed themselves to halting the decline in biodiversity in the EU by 2010 and to restore habitats and natural systems. In 2002, they also joined some 130 world leaders in agreeing to significantly reduce the rate of biodiversity loss globally by 2010.

In May 2006, the European Commission adopted a communication on 'Halting Biodiversity Loss by 2010 – and Beyond: Sustaining ecosystem services for human well-being'. The Communication underlined the importance of biodiversity protection as a pre-requisite for

sustainable development, as well as setting out a detailed EU Biodiversity Action Plan to achieve this.

The key element in the conservation of natural resources is the creation of Natura 2000. Natura 2000 is the centrepiece of EU nature and biodiversity policy. It is an EU-wide network of nature protection areas established under the 1992 Habitats Directive. The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats. It is comprised of Special Areas of Conservation (SAC) designated by Member States under the Habitats Directive, and also incorporates Special Protection Areas (SPAs) which they designate under the 1979 Birds Directive.

The Biodiversity Action Plan for Agriculture was adopted in 2001, it defines priorities in terms of the implementation of agri-environmental measures, the promotion of good farming practices, the support of less favoured areas, and the support of specific

measures related to the use of genetic resources.

It should be noted that in its recent communication of June 2009, the Commission came to the worrying conclusion that, despite the Biodiversity Action Plan presented in 2006 and the 160 measures which it envisaged, "it is highly unlikely ... that the overall goal of halting biodiversity loss in the EU by 2010 will be achieved. This will require significant additional commitment by the European Community and the EU Member States over the next two years, if we are even to come close to our objective". Since then, the European Commissioner for the Environment has indeed admitted that the goal of halting biodiversity loss by 2010 will not be achieved. One decisive factor in the sobering picture painted by the mid-term review is that no real progress had been achieved over the past few years on mainstreaming biodiversity concerns into other policy areas.

Biodiversity is now a key consideration when dealing, in particular, with the development of biofuels and the implementation of sustainable criteria. The Renewable Energy Directive contains environmental sustainability criteria for biofuels, including the protection of biodiversity (see page 48). The introduction of standards at EU level, used as a basis for certification schemes, is under consideration. Cross-compliance is already in place for

EU farmers. However, discussions are ongoing to define certain details of the biofuels sustainability criteria aimed at protecting specific areas (grasslands, peatlands, undrained soils) in the EU as well as in third countries. Additional provisions are also under discussion, requiring economic operators to give evidence that the harvesting of raw material does not interfere with nature protection, preservation of grasslands, etc.

The LIFE programme

LIFE is the EU's financial instrument supporting environmental and nature conservation projects throughout the EU, as well as in some candidate, acceding and neighbouring countries. Since 1992, LIFE has co-financed some 3 104 projects, contributing approximately € 2.2 billion to the protection of the environment.

The third LIFE+ call for proposals was published on 15 May 2009, with up to € 250 million available for the co-financing

of projects under three headings: nature and biodiversity; environmental policy and governance; and information and communication.

The LIFE + components consist of:

- The LIFE+ Nature and Biodiversity projects, which support projects that contribute to the implementation of the EU's Birds and Habitats Directives, and contribute to the EU's goal of halting the loss of biodiversity.

- The LIFE+ Environment policy and governance which supports technological projects that offer significant environmental benefits.

- LIFE+ Information and Communication which co-finances up to 50% of projects that spread information about environmental issues.

Source: European Commission

INCREASED GENETIC DIVERSITY

The conservation of biological diversity is a decisive factor in agricultural activities: at the core of the various biological processes utilised by agriculture, biodiversity allows farmers to produce foodstuff and non-food products as well as be a service to their community. Besides environmental effects, the aim of biodiversity in agriculture thus allows for the creation of new varieties and breeds in order to achieve economic, health, technical and ecological objectives.

Sugar beet originates from a variety of fodder beet chosen in 1786 for its naturally high sugar content. For 220 years progress in research to improve beet seed and breeding techniques, including pest and disease resistance, has greatly contributed to the improvement in sugar beet productivity and to the turnover of a great pool of varieties, without compromising the genetic diversity of the original wild beet species; the average commercial lifetime of a new beet variety is about 5 years.

Threats from diseases such as rhizomania, cercospora and rhizoctonia must be avoided in combination with the objective of a reduction in plant protection products (fungicides for example). Resistance improvement is therefore a critical area of focus for all breeders. These efforts prioritise resistance breeding for rhizomania, rhizoctonia, cercospora, mildew, aphanomyces, virus yellows and nematodes. Multiple resistances within one variety must be able to withstand the rapid spread of pests and diseases. Moreover yield and quality differences between, for instance, rhizomania-resistant varieties and varieties without a specific resistance are now minimal. Resistance to rhizomania is now standard in many countries – indeed, in several countries susceptible varieties are no longer on offer. Now research and selection are focused on nematodes or rhizoctonia and increasingly on varieties with double and even triple resistance.

SUGAR BEET'S BENEFITS TO BIODIVERSITY AND WILDLIFE

Agricultural activity can contribute to enriching biodiversity. It creates and maintains special ecosystems and habitats which would disappear if farming activities were abandoned, such as the mosaic of cultivated fields and field boundaries demarcated by hedges and ditches providing refuge and sources of food for certain flora and fauna and micro-fauna.

Agricultural biodiversity - a subset of biodiversity, is essential for satisfying basic human needs for food security. It is actively managed by farmers; many components of agricultural biodiversity would not survive without this human intervention; indigenous knowledge and culture are integral parts of the management of agricultural biodiversity.



Birds, being near the top of the food chain, are an excellent indicator of the impact of sugar beet (and other crops) on species at the lower end of this chain. In the UK a range of scientific studies on bird numbers and behaviour as an indicator of biodiversity have been undertaken.

From these studies, it has been stated that while farmland birds have continued to decline over recent decades, sugar beet continues to provide important food and habitat resources for certain species, whose decline otherwise would likely have been greater.



Sugar beet, apart from being an important element of diversity in crop rotation, also has a positive effect on the biodiversity of both flora and fauna.

Birds are especially attracted to lagoons used for water storage and treatment in sugar factories, which are located in rural areas. At some factory sites in Spain, the water resulting from biological and extensive water treatment processes is used to create wetlands.



Sugar beet growing and impacts on birdlife

The stone-curlew is just one of a number of farmland bird species (including some which appear on the Quality of Life Indicator for Farmland Birds) which uses sugar beet crops more than other crops, attracted by (a) the winter stubble left in the ground until the spring sowing, (b) the open vegetation structure in late spring and (c) the post-harvest sugar beet stubble. These advantages can however be reduced if crop protection is too intensive during establishment.

Stubble from the previous crop provides an important resource for wildlife, in particular for wintering farmland and other migrant birds. Stubble fields can, for example, be an excellent winter feeding habitat for seed-eating species such as finches and buntings. Over time, the area of winter stubble in the UK has decreased as autumn-sown crops have become more popular, so sugar beet is an important crop in this respect. However, the value of the preceding stubble will depend on the management of the previous crop and the extent to which the stubble is treated with herbicides in the autumn.

The nature of the sugar beet crop means that fields retain an open vegetation structure and areas of bare soil until late spring, which is conducive to many ground-nesting birds whose breeding

season begins at the same time, such as the stone-curlew, lapwing and skylark. The stone-curlew is a UK Biodiversity Action Plan priority species as its numbers are threatened in Western Europe. The sparse vegetation of sugar beet after mid-May, in contrast to the density of other arable crops at that time, means that stone-curlews can have second breeding attempts, a factor which is important to their overall breeding success. Sugar beet is also a good nesting habitat for skylarks and lapwings and likely to support these species in higher numbers than winter cereals.

Since control of broadleaved weeds is usually more difficult with sugar beet than, for example, with cereals, it can act as an important feed source for birds. These weeds are associated with a higher number of invertebrates than grass weeds and also tend to produce seeds more readily used by birds.

Both invertebrate and weed seed availability are likely to be relatively high in sugar beet stubble. After beet is harvested in the autumn and winter many bird species (pink-footed geese, swans, skylarks, golden plover, lapwing, pied wagtail, and meadow pipit) use the stubble and remaining beet tops for food and also forage for invertebrates. A good deal of the

sugar beet crop remains in the ground until January, providing food and habitat for a wide range of species long after other crops have been harvested. Between a quarter and a third of the world's pink-footed geese use sugar beet land after harvest close to their roosting areas in North and West Norfolk. Sugar beet tops are also fed to cattle and sheep during winter and are ploughed back into the land to provide valuable organic matter and to increase soil biodiversity.

These beneficial aspects of the sugar beet cropping cycle are reduced in instances where the timing of some agricultural operations (e.g. mechanical weeding, irrigation) impacts on nesting birds or where intensive crop protection (mechanical and chemical) reduces available food resources for farmland birds and leads to concerns over drift and runoff into adjacent habitats. So the key is to encourage sympathetic farm management decisions, to ensure that the potential gains for biodiversity are maximised.

Biodiversity benefits are at their greatest where the impacts of pesticide use are mitigated and the provision of nesting habitat and winter food resources for birds are maximised.

Source: Defra Environmental Report on Sugar beet 2003



IMPROVING SOIL CONSERVATION

SUGAR BEET AND SOIL CONSERVATION

Soil is defined as the top layer of the earth's crust. It is formed from mineral particles, organic matter, water, air and living organisms. It is an extremely complex, variable and living medium. The interface between earth, air and water, soil is a resource which performs many vital functions: production of food and other biomass, as well as the storage, filtration and transformation of many substances including water, carbon, and nitrogen. Soil has a role as a habitat and gene pool. These functions are worthy of protection because of their socio-economic as well as environmental importance.

Processes like erosion, the decline in organic matter in soil, soil contamination (e.g. by heavy metals) and soil compaction can reduce the productive capacity of soil. Such degradation can result from inappropriate farming practices such as unbalanced fertilisation, the excessive use of groundwater for irrigation, improper use of pesticides, or the use of heavy machinery. Other causes of soil degradation include the abandonment of certain farming practices, (for example greater specialisation towards arable farming has frequently meant an end to traditional crop rotation systems), practices which helped to restore the organic matter content of soil.

Sugar beet is a root crop which requires good soil. It is in the growers' interest to preserve this valuable resource; it is vital to keep soil erosion, soil compaction and soil removal at harvest to a minimum. To achieve this, practices and conservation techniques have been developed. These include intercrop cover, adapted ploughing and tilling with reduced intervention.

The EU policy framework

The Common Agricultural Policy contributes to preventing and mitigating soil degradation processes. The European Commission adopted a Soil Thematic Strategy (COM(2006)231) and a proposal for a Soil Framework Directive (COM(2006)232) on 22 September 2006 that aimed at:

- the preservation of soil functions
- the prevention of soil degradation
- the restoration of degraded soils.

The proposal for a Directive sets out common principles for protecting soil across the EU. Within this common framework, EU Member States will be in a position to decide how best to protect soil and how to use it in a sustainable way on their territory.

Despite the efforts of several presidencies, the Council has had difficulties so far in reaching political agreement on this legislative proposal due to the opposition of a number of Member States considering this issue to be more the competency of a Member State than a competency of the European Commission. Further progress on this issue is needed to resume the discussions.

The EU SoCo project

The question of soil degradation and soil-friendly farming is the subject of recent work by the European Commission's Directorate General for Agriculture and Rural Development and the Joint Research Centre (JRC). The main findings of this two-year project 'Sustainable Agriculture and Soil Conservation (SoCo)' were presented on 28 May 2009. The aim of this work is firstly to improve the understanding of soil conservation practices in Europe, secondly to analyse how policy measures can encourage farmers to adopt such practices, and thirdly, to assess recommendations to be translated into policy.

The SoCo project shows that the existing suite of policy measures including cross-compliance; rural development instruments or mechanisms for advice and support are adequate for addressing soil degradation processes in Europe. However it also shows that their effectiveness concerning soil conservation could be significantly increased if, for example, policy measures were targeted more towards its conservation; if more advice and support were provided to farmers and if a stronger commitment was made to investment in indicators, data and monitoring with a view to strengthening the knowledge base for policy making.

In reviewing farming systems and practices, the following agricultural practices have been highlighted:

- minimal soil disturbance (through reduced or no tillage) in order to preserve soil structure, soil fauna and organic matter;
- permanent soil cover (cover crops, residues and mulches) to protect the soil and contribute to the suppression of weeds;
- diversified crop rotations and crop combinations, which promote soil microorganisms and disrupt plant pests, weeds and diseases.

ENHANCING SOIL STRUCTURE AND SOIL FERTILITY

Growers pay close attention to the structural stability of the soil, to its moisture, to its organic content and to its composition in general. Providing technical advice in this area, which is carried out in several EU countries by competent institutes, is a very important tool in soil protection. For example in Southern Germany, the 'Bodengesundheitsdienst' (Soil-Health-Service) provides individual advice to growers based on the results of soil analysis. These illustrate the balance of different elements (nitrogen, potassium, phosphorus, calcium, magnesium, boron) making a distinction between the 'directly available' nutrients for the plants and the 'potentially available' nutrients, as well as the soil needs for each nutrient. This provides the grower with precise information and ultimately, precise fertiliser recommendations tailored to the crop's requirements depending on climatic conditions, rotation and harvested intercrop products etc.

In France the method used is based on a 'balance method' accessed via software ('Fertibet' and 'Azofert') available online for growers, which calculates the nutrient requirements precisely through an annual measure of nutrients in the soil. The performance of the nitrogen-specific Azofert software is being

further improved by the development of 'Reliquat Azoté Virtuel'. This indicates the virtual mineral nitrogen stock in the soil, using estimates of nitrogen inputs and actual nitrogen consumption - including basal mineralisation and water transfer in the soil. This forms a sound basis for the establishment of the Azofert balance and the corresponding nitrogen requirements.

In addition, the cultivation of 'nitrogen catch crops', such as nematode resistant varieties of mustard and oil radish, is spreading. These intermediate crops have the capacity to prevent nitrogen nutrients from leaching.

In developing an extensive and deep fibrous root system, sugar beet naturally improves soil structure and soil biological status in the lower soil strata. Sugar beet yields a considerable quantity of dry matter, of which about 74% is sugar and roughly 26% is cell wall material (used as pulp) and minerals. The leaves (5-7 tonnes dry material/ha), beet tops and pieces of root and root hairs left in and on the ground after harvesting also play a role in returning nutrients to the soil which are then available for subsequent crops.



AVOIDING SOIL EROSION

Due to its long growing season and its extensive leaf canopy, sugar beet provides better and longer-lasting ground cover than most other rotational crops in Europe. Sugar beet is therefore a good crop for combating soil erosion during summer and autumn.

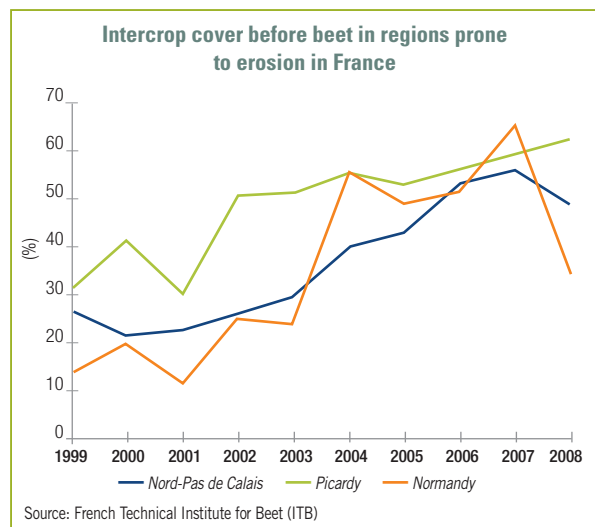
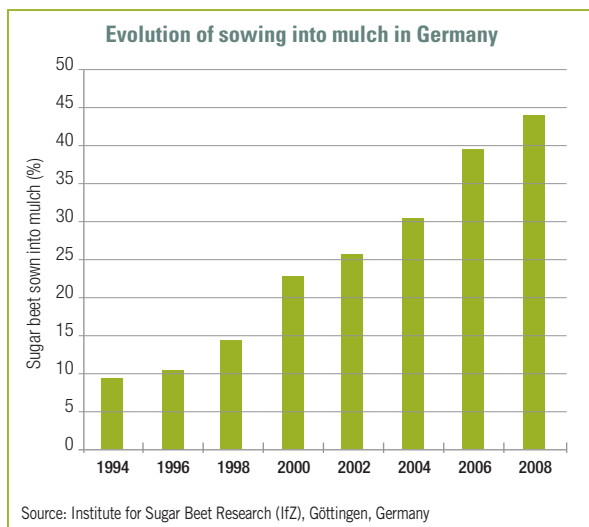
In order to reduce the risk of erosion in the spring before the leaf canopy is fully developed, farmers increasingly use different soil conservation techniques, such as sowing into mulch (i.e. the residue of the preceding crop) and/or minimum cultivation.

In Germany, reduced soil preparation techniques were developed in the early 1980s. Today more than 40% of beet area in Germany and 30% in Austria are sown into mulch. Advantages are:

- less energy (diesel) and time expenditure
- higher water infiltration
- higher level of protection against wind and water erosion
- higher load-bearing capacity of soil (conservation of soil structure).

Recently, tillage techniques have been developed to restrict soil disturbance after the harvest of the preceding crop to a narrow band next to the sugar beet row. Such techniques can be combined with an autumn catch crop and give promising results for improving crop growth and, simultaneously, erosion control.

In France the use of cover crops to minimise erosion is being extended. The graph illustrates the development of cover crops over the last decade in three French regions (Normandy, Picardy and Nord-Pas de Calais). In 2000, cover crops were used on 20-30% of the beet area; now they are used on 40-60%. In addition, the development of beet cultivation without prior ploughing started in France in the late 1990s. Such techniques have been implemented by growers with the aim of protecting the soil against climatic assaults and in particular against erosion, but also to enhance soil biodiversity. In 2006, 'ploughless' techniques were implemented on 13% of French beet area.



REDUCING THE RISK OF SOIL COMPACTION

The risk of soil compaction is frequently reduced by a combination of factors. This includes using the appropriate machinery at each stage of sugar beet cultivation, combined with the proper training of machinery operators.

Passes over fields with high-pressure tyres unnecessarily burden the soil. Less traction and higher slip resistance through tracks costs additional fuel. Modern radial tyres allow for a high load bearing capacity with low tyre pressure and with that, higher tread contact at lower speeds during field work. The most important principle for the protection of the soil's structure is not to work on very damp soil. Therefore, the planned rate of use for agricultural machinery must allow for breaks at times of extremely bad weather. Flexible organisation of machine use by different owners means that farmers can respond quickly to different degrees of soil dampness over a large area.

There are also **soil management techniques** which **reduce the frequency, intensity and working depth**, and these also strengthen the load-bearing capacity of the soil. The

development of new machinery dedicated to seedbed preparation also leads to a reduction in the frequency of interventions, while at the same time, improving the quality of preparation. In this regard 'sowing into mulch without deep loosening' (tilling depth 10-12cm) contributes to an improvement in the load-bearing capacity of the soil because it is less invasive than 'sowing into mulch with deep loosening' (tilling at crust depth). Soil structures created by fauna and roots are more stable than those created by soil tilling.

In 2007, the Association of German Engineers published guidelines for machine operations with regards to the suitability of soil for machinery use. The information and knowledge contained in these guidelines were made accessible to developers, manufacturers and users of agricultural machinery by means of an information sheet entitled 'Agricultural Machinery Use with Low Soil Impact' which was widely distributed in Germany to farmers, including beet growers.

REDUCING SOIL TARE

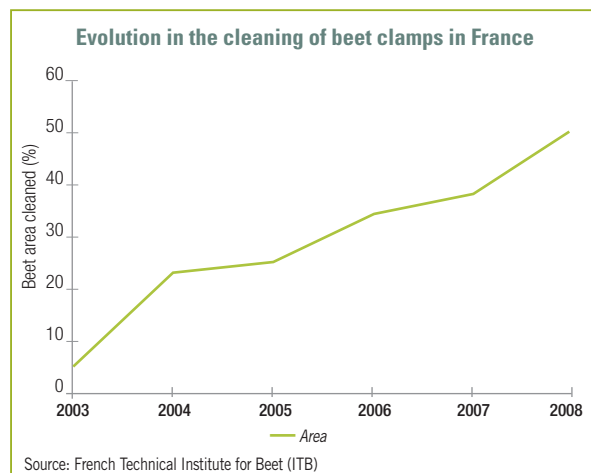
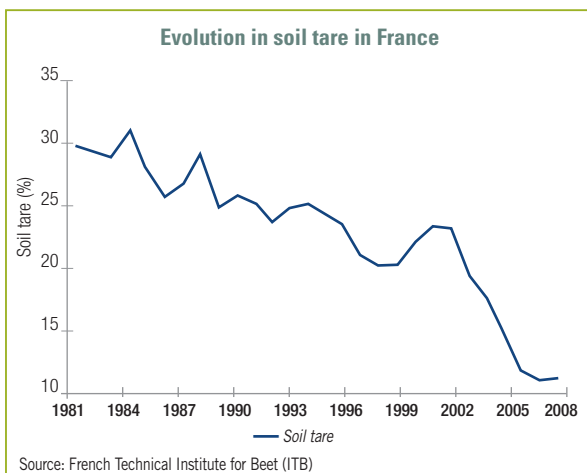
During harvesting, a quantity of soil adhering to the beet (soil tare) is removed from the field. This is a direct consequence of the shape of the beet. It is in everyone's interest to remove as little soil from the field as possible. Soil tare depends on the soil texture and moisture at harvest time and leads to additional transport, cleaning and recycling costs. Inter-professional agreements invariably encourage continuous improvement in harvesting, storage and cleaning/loading operations.



fields. There is a clear relationship between the use of beet cleaning machinery and soil tare. In several countries (e.g. CZ, DE, UK) all beet is cleaned during loading. In many countries (BE, CH, DK, DE, GR, IT, HU, NL, AT, PL, SK, FI, SE, UK and TR) soil tare levels are already below 10% - and both farmers and processors continue to try and make further improvements.

The progress made in France is a good example of this. Cleaning beet clamps has contributed to reducing soil tare significantly. Now the net tare is about 10% in France (a 65% decrease in 25 years).

The trend is a **drastic decrease in soil tare** through **better harvesting techniques** and the **use of cleaning machinery** in the



RECLAIMING THE SOIL AS A VALUABLE PRODUCT

It is important for both beet growers and sugar companies to minimise soil loss. Beet growers are committed to reducing the amount of soil tare, as a beet quality criterion. In partnership with growers, the soil is first pre-cleaned in the fields by special harvesting and loading machines. These improvements benefit the environment, and not just by minimising soil erosion in fields. Transport of soil with the crop is also reduced, saving energy and road congestion and reducing soil handling and treatment at the factories.

Most of the soil arriving with the beet is directly returned from the factory to the fields or stored in settling ponds in order to dry out and form high quality arable soil. The remaining soil is reclaimed and marketed in a wide range of productive applications (e.g. agricultural land improvement, landscaping, restoration, civil engineering projects, building and sports ground construction). All the soil is treated as a valuable resource in the most sustainable way.

IMPROVING AGRICULTURAL LAND AND SOIL FERTILITY

Sugar factory lime is a fertiliser highly appreciated in agriculture. In addition to calcium carbonate, it also contains other essential nutrients like magnesium, phosphate and potassium. It is used to improve soil structure and reduce soil acidity. The sugar industry thus makes a valuable contribution to environmental protection by providing farmers with a sustainable option for soil pH correction, and also by significantly avoiding the extraction and use of valuable limited limestone reserves. Sugar factory lime is also recognised as a soil conditioner within the EU Regulation on organic production of agricultural products (EEC 2092/91). The **composting** of beet leaves and beet tails also makes a useful soil conditioner. **Vinasse**, a co-product of sugar beet ethanol, is another such fertiliser. Characterised by a high potassium content, it is also approved for use on organic crops.

Soil management and mitigation of climate change

Good soil management in beet growing can help regulate emissions of three key greenhouse gases (carbon dioxide, methane and nitrous oxide) from agriculture, which contribute to climate change:

- nitrous oxide emissions can be reduced by increasing the efficiency of nitrogen management to meet crop requirements and minimise residual nitrogen
- the supply of nitrate to soils can be reduced, whether in fertiliser or mineralised organic matter, as this supply increases the likelihood of nitrous oxide release
- a reduction in soil compaction will help improve the amount of air in the soil and also minimise nitrous oxide losses from soil
- the application of fertiliser (and manure) at optimal times and rates, using recognised nutrient management plans and fertiliser recommendations, reduces nitrous oxide emissions and maximises crop uptake
- a reduction in the intensity and frequency of disturbance will help protect soil carbon sinks. Cultivation techniques may be changed to minimum till or no till where appropriate
- farmers can potentially improve and maintain organic matter in soil (and their carbon storage capacity) by the regular addition of crop residues and manure or organic materials such as compost and digestate.

IMPROVING WATER QUALITY AND MANAGEMENT

Plants require water to live and carry out photosynthesis. In Europe, water for agriculture is mainly provided by rainfall. In the EU, only about 10% of the EU's Usable Agricultural Area (UAA) of 185 million hectares is irrigated.

Over 75% (14 million ha) of irrigated land in the EU is concentrated in 5 countries (Spain, Romania, Italy, France and Greece). Other countries have modest proportions of irrigated

land: with around 17 million ha UAA, Germany has less than 0.5 million ha of irrigated land. Poland and the UK, each with around 17 million ha UAA, have even less irrigated area (less than 0.2 million ha each).

With the Water Framework Directive (WFD), the EU is taking the necessary steps to promote greater water use efficiency and water awareness among its citizens.

The Water Framework Directive – a milestone towards sustainable water management

The Water Framework Directive (WFD - 2000/60/EC) came into force in 2000, subsuming former water legislation to deliver long-term protection of water and improve the quality of all water in Europe. The WFD requires that all inland and coastal waters within defined river basin districts reach at least 'good status' by 2015. This requires Programmes Of Measures (which may include measures to

manage specific pressures arising from agriculture, control regimes or environmental permitting systems, water demand management measures and economic instruments such as incentives, taxes on fertiliser, etc.) for each River Basin District to be operational by 2012.

2009 and 2010 are crucial years for the implementation of the WFD:

- in 2009, the river basin management plan, including a Programme Of Measures, was implemented in 16 Member States and its implementation is ongoing in others

- in 2010, water pricing policies are to be introduced by the Member States.

MINIMAL WATER REQUIREMENTS OF SUGAR BEET

In most growing regions in the EU, **sugar beet has a relatively low water requirement** and, with sufficient rainfall, rarely requires irrigation. Sugar beet makes efficient use of soil water and can thus withstand much drier conditions than other crops without affecting quality or yield significantly. The water requirements of sugar beet are about 50% less than the water requirements of sugar cane.

In moderate climates, the relative water demand (evaporation transpiration coefficient) of sugar beet is about the same as that of maize and potato, lower than that of cereals and is usually covered by natural precipitation. Efficient use of soil water supply is achievable by a root system that often grows deeper than 1.5 m.

In Belgium, Poland, Denmark and Finland (representing about 20% of EU beet area), sugar beet is not irrigated at all. In the Czech Republic, Germany, France, the Netherlands, Romania, Sweden and the UK (representing more than 2/3 of EU beet area), only a small proportion of beet area (< 10%) is irrigated. Due to the climate in these countries, the low evapotranspiration rate of the sugar beet crop necessitates only a small quantity of external water supply and can thus be considered as marginal.

In Italy, Hungary, Austria and Slovakia (representing about 10% of EU beet area), between one quarter and one third of beet area may be irrigated.

Irrigation of sugar beet is widespread only in Greece and Spain, representing less than 5% of EU beet area. In Greece, where annual precipitation is insufficient to meet the evapotranspiration of beet, the water used is mainly taken from surface water resources (rivers and supply networks) rather than pumped from underground reservoirs. In Southern Spain and southern parts of Italy, autumn sowing of sugar beet represents a common strategy for using the available water for plant growth more efficiently in months with lower temperatures, thus partially avoiding summer drought and reducing irrigation requirements. Overall in the EU, the quantities of water used for irrigating sugar beet remain moderate.

Moreover, responsible and controlled irrigation management is carried out in close co-operation with local water authorities and is subject to strict rules and taxes. The sugar beet crop is in line with current national and/or EU legislations. Systematic over-irrigation of the beet crop does not occur. The crop's water requirement is determined at all stages of development using increasingly sophisticated software technology. This provides a sound basis for irrigation recommendations regarding both quantity and timing. The implementation of good irrigation practices, coupled with technical support, contributes to limiting the total volume of water applied, thus avoiding unnecessary water use.

For example, in Spain most beet growers using irrigation are part of a national irrigation plan which consists of a legal framework to

control and optimise the use of this precious resource to assure the sustainability of irrigation. This has led to a reduction in water use by up to 50% in recent years and thus to a significantly lower quantity of water used per tonne of beet produced. This helps to maintain levels of river flow and ground water reserves.

Examples of water management software

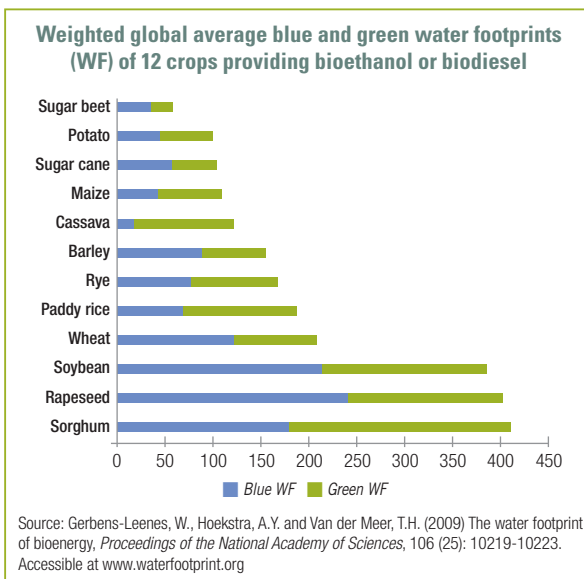
'Acqua Facile', developed by Beta Italia, consists of a dataset with historical temperatures (with updates) for all Italian beet-growing provinces and a multiple function to calculate water requirements and to set up appropriate irrigation systems.

'Balance Hídrico', developed by AIMCRA, allows farmers to know the water needs of their crops in real time, via the internet and mobile phone.

'Irribet', developed by ITB, allows each grower to calculate (by referring to the nearest rainfall and evapotranspiration measuring stations) the water balance for each field, based on a model specifically adapted to the beet crop.

WATER USE AND CLIMATE CHANGE

There is increasing research into - and awareness of - the impacts of climate change on water. Numerous EU countries have initiated appropriate adaptation plans, strategies or programmes. According to the European Water Partnership, which coordinated the European contribution to the 5th World Water Forum in March 2009, scarcity and droughts represent serious and growing threats to Europe. Therefore, it is not surprising that all activity, including agriculture, is increasingly scrutinised for its 'water footprint'.



According to a study carried out by the University of Twente on different crops grown all over the world, sugar beet is the most favourable crop for producing bioenergy (and electricity) in terms of water footprint (see graph). The results only deal with the quantities of water used. Furthermore, the water footprints are global weighted averages, taking into account the world's top 20 sugar beet producing countries in 2006 (according to FAO statistics). These, while including 9 countries from the European Union (France, Germany, Poland, UK, Spain, Belgium, the Netherlands, Italy and the Czech Republic, representing about 90% of EU beet production), also include Russia, the USA, the Ukraine, Turkey, China, Iran, Belarus, Japan, Egypt, Serbia and Morocco. This study is an interesting analysis which merits further investigation, particularly as regards weighting a crop's water footprint relative to the water availability of the crop-growing regions in question.

In November 2009, a UNESCO-IHE study clearly showed that the global weighted average water footprint of sugar and bioethanol from sugar beet (935 m³/tonne of beet sugar and 1 355 litres/litre of beet ethanol) was considerably lower than that of cane (1 500 m³/tonne of cane sugar and 2 855 litres/litre of cane ethanol). In addition, the water footprints in the 10 EU countries included in the study were all lower than the global weighted average water footprint of beet sugar and of beet ethanol. (Source: 'The water footprint of sweeteners and bio-ethanol from sugar cane, sugar beet and maize', <http://www.waterfootprint.org/Reports/Report38-WaterFootprint-sweeteners-ethanol.pdf>)

The Water Footprint concept

The water footprint is an academic concept which was introduced as an indicator of water use in 2002 by A.Y. Hoekstra from the IHE (International Institute for Hydraulic and Environmental Engineering, which in 2003 became the UNESCO-IHE Institute for Water Education). Since then, the idea of considering water use along supply chains has gained interest.

The water footprint of a product is the volume of freshwater used to produce that product, measured in the place where the product was actually produced. Water use is measured in water volume consumed (blue and green) and/or polluted (grey):

- the blue water footprint is the volume of freshwater that evaporates from global

blue water resources (surface water and groundwater) to produce the goods and services consumed by the individual or community

- the green water footprint is the volume of water which evaporates from global green water resources (rainwater stored in the soil as soil moisture)
- the grey water footprint is the calculated volume of polluted water theoretically associated with the production of all goods and services for the individual or community.

The water footprint offers a wider perspective on how a consumer or producer relates to the use of freshwater systems. It is a volumetric measure of

water consumption and pollution. It is not a measure of the severity of the local environmental impact of water consumption and pollution. The local environmental impact of a certain amount of water consumption and pollution depends on the vulnerability of the local water system and the number of water consumers and polluters that make use of the same system. Water footprint accounts give spatial-temporal explicit information on how water is appropriated for various human purposes. They can feed the discussion about sustainable and equitable water use and allocation and also form a good basis for local assessment of environmental, social and economic impacts.

AVOIDING WATER CONTAMINATION

Water is not only used by the crop, it is also affected by how the crop is grown. More specifically, the inputs used in growing sugar beet, such as fertilisers and plant protection products, are generally used in such a way that the positive impacts on the crop (improved yield and quality, protection against weeds, pests and diseases) is maximised while at the same time the negative impacts on the environment, especially on water, are minimised. In fact, these two objectives are far more often complementary than contradictory.

In the case of fertiliser (and more specifically nitrogen fertiliser) use, the EU's waters are protected by comprehensive legislation embodied by and emanating from the EU Nitrates Directive, which strictly monitors agricultural practices and their impact on water.

Sugar beet is a deep-rooting crop and an excellent nitrogen user, taking most of the available nitrogen left in the soil by the preceding crops. Thus, sugar beet can contribute to reducing the risk of nitrate leaching into groundwater.

Continuous improvement in the analysis of nutrient requirements and availability in the soil at each stage of the crop cycle enables the precise determination of the crop's fertiliser requirements.

Examples include the EUF-method for nitrogen (N), phosphorus (P) and potassium (K), as well as lime, magnesium and boron in Southern Germany, the N-min method used in Belgium, Northern and Central Germany or the N-balance method used in France.

The progress in estimating the crop's nutrient requirements, along with improved dissemination methods, as well as software programs which allow growers to determine field-specific fertiliser requirements (such as LIZ-NPro in Germany, Azofert for N requirements and Fertibet for P and K requirements in France, Betakwik modules and Betatip documents in the Netherlands), in many cases online, have resulted in the application of less fertiliser, as well as the better timing and improved techniques of these applications.

Apart from the potentially negative impact on the environment by nitrate leaching into water courses, oversupplying sugar beet with nitrogen has negative consequences for both the beet grower (low sugar content and in some cases lower beet internal quality leading to lower beet quality payment) and the sugar industry (lower beet quality and therefore poorer sugar extraction performance). As a result, oversupply of the beet crop with N-fertiliser generally does not occur.

The EU Nitrates Directive

The EU Nitrates Directive (91/676/EEC), concerning the protection of water against pollution caused by nitrates from agricultural sources, was adopted on 12 December 1991. It has led to the designation of vulnerable zones, defined as water containing, or likely to contain, more than 50 mg/l of nitrates. These vulnerable zones now represent 44% of EU-15 territory. Further designations of vulnerable

zones are to follow, particularly in the new Member States. Voluntary codes of good agricultural practice to be followed by all farmers throughout the country have been, or are being, established. In addition, action programmes in respect of designated vulnerable zones have either been established and implemented (examples of positive action cited by the Commission are 'FertiMieux' in France, 'Wallonia

Prop'eu Sable' in Belgium and 'Thessaly nitrate pollution project' in Greece) or incorporated into existing programmes (such as Denmark's 'National Nitrogen Management Programme' dating from 1987 or the Protected Area and Compensation Regulation 'SchALVO' in Baden-Württemberg, Germany's third-largest state, dating from 1988).



AVOIDING WATER CONTAMINATION FROM FERTILISERS

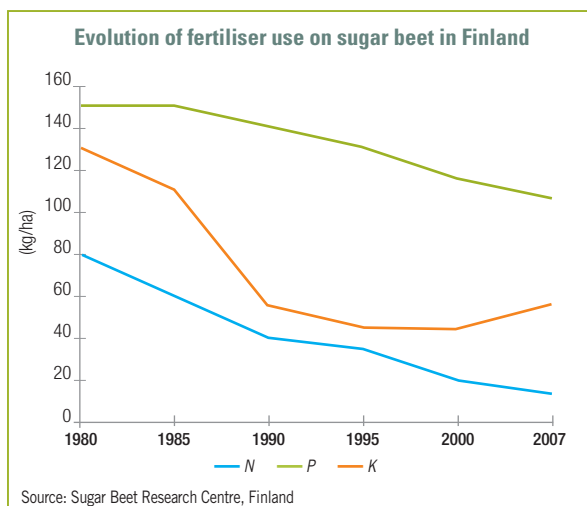
ACHIEVED REDUCTIONS IN FERTILISER USE

In most cases, sugar beet requires 60 to 160kg of mineral N fertiliser application per hectare (depending on the use of organic fertiliser and on a range of site specific characteristics like soil type and climate).

According to technical institutes dedicated to sugar beet cultivation and production in the EU, N-applications have been reduced in all major beet producing countries due to improved agricultural practices:

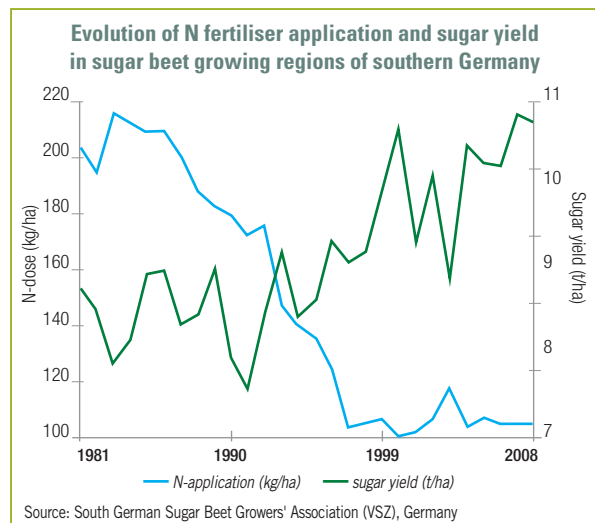
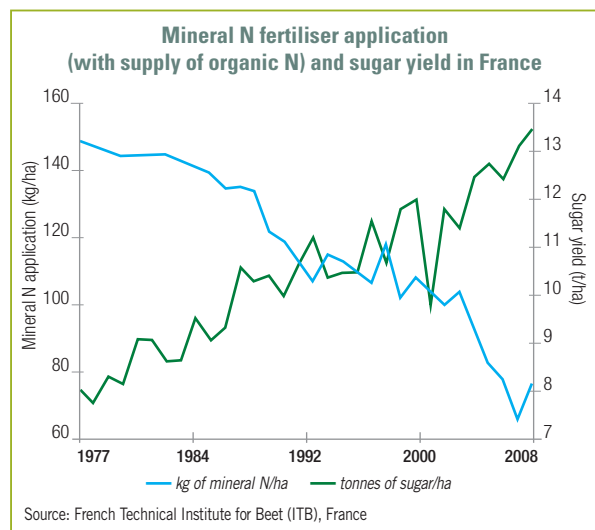
- In Germany, N-application per hectare has decreased by 50% in 20 years.
- In the UK, N-application has decreased by 35% in 25 years, while P and K applications have decreased by 45%.
- In Spain, N-application has decreased by 40% in 10 years.
- In France, N-application has decreased by 25% in 20 years.
- In the Netherlands, N-application has decreased by 30% since 1986.
- In Romania, N-application has decreased by 25% in 10 years.
- In Austria, EUF-based fertiliser recommendations, which are widely followed, have decreased spectacularly in the 1980s and have stayed at relatively low levels (less than 90kg N/ha) since then.
- In Finland, N-application per hectare has decreased by 30% since 1980, while K-application has decreased by almost 60% and P-application by over 80% (see also graph).

The application rates used in beet growing are generally well within the limits fixed by legislation. For example in Finland, N-application limits for sugar beet growing are 140kg/ha for clay and mineral soils and 120kg/ha for organic soils, while P-application limits vary from 0 to 42 depending on soil fertility. In Austria, where 90% of beet growers farm within the Austrian Agri-environmental programme (ÖPUL), N-application limits vary from 80 to 140kg/ha depending on the historic yield level of the field in question.



IMPROVED FERTILISER USE EFFICIENCY

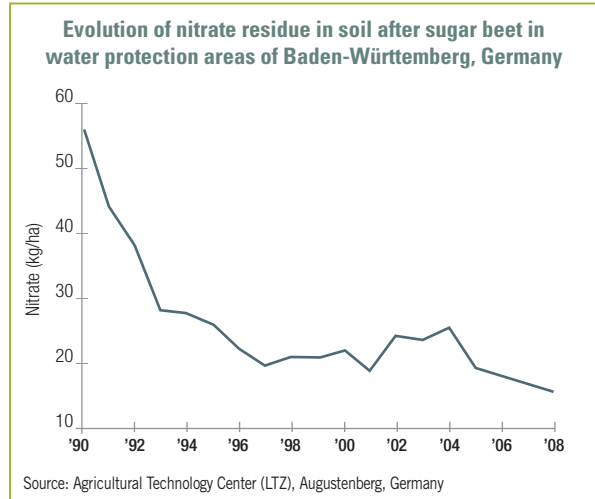
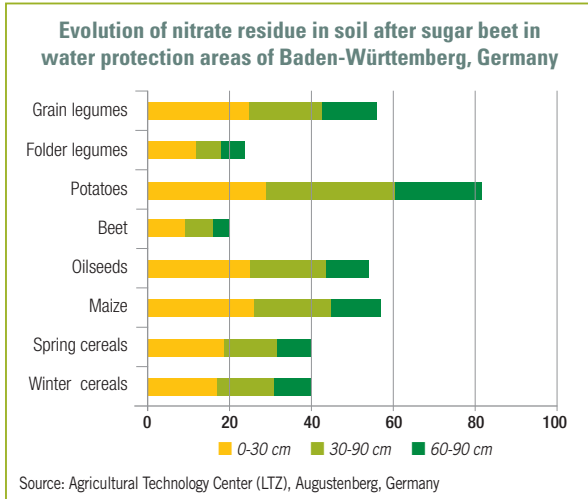
In parallel with the steady decrease in the use of fertiliser, yields have continued to increase, showing the excellent and continuously improving nitrogen use efficiency of sugar beet. The amount of sugar produced per kg of N fertiliser applied has steadily increased, as illustrated by the examples below from France and Germany. Thus in France, the amount of sugar produced per kg of N fertiliser applied increased from around 70kg in the 1980s to over 160 today. In Germany, this value also more than doubled, from around 40kg of sugar per kg of N fertiliser used in the 1980s to around 95kg today.



LOW NITRATE RESIDUES AFTER SUGAR BEET

Appropriate N-applications tailored to crop requirements generally result in lower residues after harvest. Hence, nitrate residues after sugar beet tend to be lower than after any other crop in Baden-Württemberg, a major beet growing region in Germany. In the same

region, nitrate residues after sugar beet have more than halved since 1990 and are now well below the authorised water quality limit of 40kg/ha (see graphs below).



AVOIDING WATER CONTAMINATION FROM PLANT PROTECTION PRODUCTS

During its development, the sugar beet crop requires protection from weeds, pests and diseases. However, recourse to plant protection products is not necessarily the first and certainly not the only line of defence.

One of the crop's worst parasites, the beet cyst eelworm, is combated mostly by rotation, but also by choosing tolerant or resistant beet varieties. Similarly, root diseases affecting sugar beet such as rhizomania and rhizoctonia are also exclusively contained by variety choice. Varieties resistant to the leaf disease cercospora are also increasingly prominent.

Purely mechanical means of weed control, such as inter-row hoeing or harrowing, can have a role in weed control during the early stage of the beet crop when the young beet plants are vulnerable to competition from weeds. However, inter-row weeding does not solve the problem of weeds within the rows. Thus, the use of plant protection products is inevitable in order to avoid serious yield losses or even crop failure. However, such products are used in a strictly controlled way, both regarding the products actually used as well as how, when, and how much they can be used. These already strict rules are currently being strengthened further at EU level by the recently adopted Directive on the Sustainable Use of Pesticides and the Regulation concerning the Placing of Plant Protection Products on the Market.

In practice, beet growers – along with the sugar industry and researchers - tend to anticipate such increasing regulatory constraints. Beet growers systematically use crop monitoring, early warnings, crop damage thresholds and information systems to

optimise the timing and quantity of application and to reduce the use of plant protection products.

Invariably, national technical institutes dedicated to beet cultivation and sugar production have played and continue to play an important and innovative role in optimising input use, minimising environmental impacts and in improving yields. In the sphere of plant protection, several institutes have pooled resources to establish online pest identification systems. Thus BBRO in the UK, ITB in France, IRBAB in Belgium, IRS in the Netherlands, AIMCRA

EU regulatory framework on plant protection products

The Directive on the Sustainable Use of Pesticides (2009/128/EC) and the Regulation concerning the Placing of Plant Protection Products on the Market (EC/1107/2009) were approved by the European Parliament in January 2009 and entered into force on 24 November 2009. According to the European Commission, this new legislation will increase the protection of human health and the environment, will lead to a better protection of agricultural production and will extend and deepen the single market of plant protection products. Based on numerous cut-off criteria, several of which still remain to be established, the most dangerous chemicals will be banned in due course. Essentially, this represents the further strengthening of the strict environmental and safety rules which already apply in Europe.

in Spain, LIZ and BISZ in Germany as well as Nordic Sugar have set up a weed identification system in seven languages, while a similar system has been set up regarding pests and diseases.

Other examples of crop protection programmes at national or regional level include 'FAR-Consult', 'Betakwik' and 'Betsy' for weed control in Belgium, the Netherlands and France respectively, LIZ-programmes for herbicides and fungicides in Northern and Central Germany and numerous BISZ programmes for weeds, pests and diseases in Southern Germany.

Such programmes not only list the authorised plant protection products (as well as their application constraints), they also establish situation-specific (crop stage and vulnerability, problem picture, climatic conditions) product mixtures and indications regarding the best time for application. Some (e.g. BISZ) also point out rules regarding minimum distance to water courses and ecotones (field edge ecosystems), the use of low-loss application machinery and maximum allowable frequency of product application.

In practice, beet growers more than fulfil legal requirements. Thus, the IP (integrated crop production) beet system in Austria voluntarily applies stricter criteria regarding the types, mixtures, amounts and application frequencies of plant protection products used.

Beet growers, along with industry and research, seek to optimise production, i.e. to obtain the highest possible yield for the lowest possible amount of input and cost. In this way, they seek to both optimise production on the one hand, and minimise environmental impact on the other. The SUSY (Speeding Up Sugar Yield) and LISSY (Low Input Sustainable Sugar Yield) projects launched by the Dutch sugar sector in 2006 are examples of this.

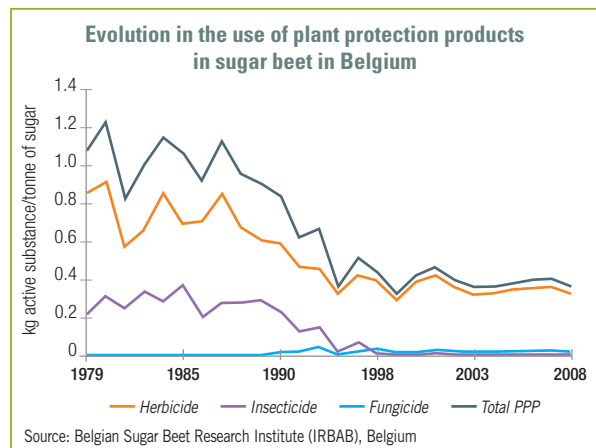
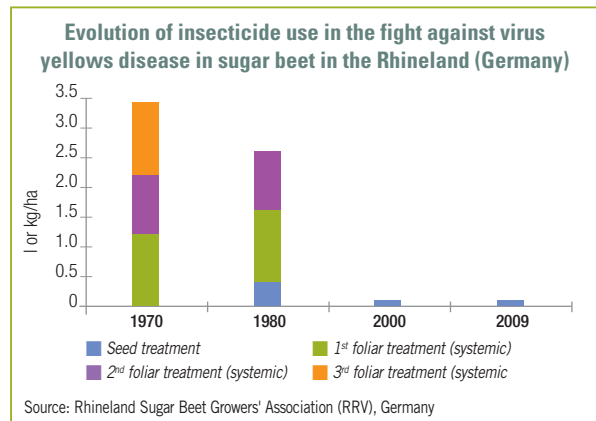
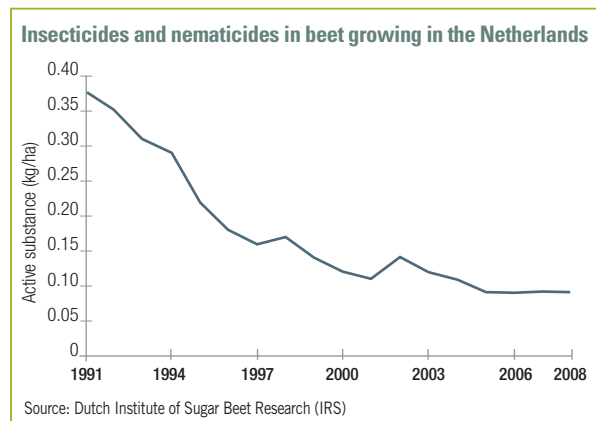
ACHIEVED REDUCTIONS IN THE USE OF PLANT PROTECTION PRODUCTS

As a consequence of the above, the use of plant protection products has been substantially reduced over the years:

- In the UK, granular insecticides in beet growing have been reduced by over 95% since 1982.
- In Belgium, the total use of plant protection products has more than halved since 1979.
- In France and Italy, plant protection products have been reduced to about 4kg of active substance per hectare.
- In Finland, the use of pesticides has decreased from 5kg of active substance per hectare in 1990 to 3kg today.
- In Romania, the use of herbicides has decreased from almost 5kg of active substance per hectare to about 3.5kg/ha.
- In the Netherlands, insecticides in beet growing have been reduced by over 75% since 1991 (see also graph).

Furthermore, the development of effective seed treatments has had a dramatic effect on insecticide use. In the Rhineland, the need for up to 3 foliar treatments was eliminated, thereby reducing the use of active substances from over 3kg to 100g per hectare, as the graph illustrates.

In Belgium, 8 active substances (haloxyfop-R-methyl, benfuracarb, carbendazim, flutriafol, fipronil, dichloro-propene, carbofuran and carbosulfan) were taken off the register in 2008. While the use of plant protection products is decreasing in volume and thereby decreasing its environmental impact, yield performance has continued to increase. The Belgian example (see graph) illustrates how the amount of plant protection products used has decreased significantly in the last 30 years – from over 1kg to less than 0.5kg per 1 000kg of sugar produced. This is very low, as it corresponds roughly to 70g of plant protection products used per tonne of sugar beet harvested, or to around 5kg per hectare.



USE OF SAFER PRODUCTS

Not only has there been a reduction in the amount of pesticides used. There has also been an increase in the use of safer products as well as the gradual phasing out of products which are considered dangerous by the increasingly strict environmental and safety standards.

In the Netherlands, the environmental impact of crop protection for sugar beet decreased by over 50% (from 1 945 to 900 environmental impact points) between 2002 and 2007 - even though the quantity of plant protection products used had actually increased by 20% (from 4 to 4.8kg active substance per hectare, see table). This was mainly due to the fact that the registration of products with a high environmental impact had ended. The table also shows that the environmental indicator for crop protection in sugar beet had been, and still is, considerably lower than for crop protection in other field crops.

In addition, by means of the Betatip documentation, Dutch beet growers can choose products while knowing the estimated environmental impact on soil and water fauna of each product used in their fields. Since then, further high-impact products (such as aldicarb and haloxyfop-P-methyl) have been phased out. This suggests that we can expect the environmental impact in the Netherlands of crop protection for sugar beet to decrease even further.

A study carried out by the Institute for Sugar Beet Research (IfZ) in Germany suggests that the environmental risk from plant protection in sugar beet is low and decreasing. The SYNOPSIS model, using plant protection scenarios based on expert opinion on standard spraying sequences on sugar beet in Germany, shows that the acute risk from chemical crop protection in sugar beet for non-target aquatic organisms such as fish, algae and water fleas has decreased considerably over the past 20 years (see graph). Both the considerable reduction in the use of plant protection products in beet growing as well as the systematic phasing-out of products with a high environmental impact have led to significant improvements in the environmental performance of crop protection on the sugar beet crop. Studies in Sweden (Division of Water Management of the Swedish University of Agricultural Sciences) and France (IFEN, the French Environmental Institute) have shown that the contamination of surface water by active ingredients specific to sugar beet cultivation is rare compared to contamination derived from substances used in other crops in the rotation.

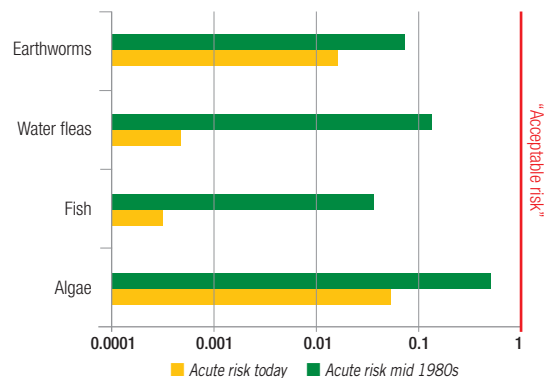
The Dutch national environmental indicator

The Dutch national environmental indicator is a widely used software system which evaluates the potential environmental impact of plant protection products used in agriculture. The environmental indicator provides an overview of the burden on the environment of all allowed remedies in the Netherlands and enables remedies to be compared. This way the least damaging combative measure can be chosen.

The environmental indicator for field crops shows the following data for each allowed pesticide:

- percentage active matter
- environmental impact points for water life (surface water)
- environmental impact points for terrestrial life
- environmental impact points for infiltration into ground water
- risks for useful organisms (biological controllers and pollinators).

Estimate of acute risk from chemical crop protection in sugar beet in Germany 20 years ago and today



Source : Institute for Sugar Beet Research (IfZ), Germany

Impact of environmental crop protection in the Netherlands

	Wheat		Ware potatoes		Sugar beet	
	2002	2007	2002	2007	2002	2007
PPP use (kg active substance per ha)						
total	2.7	2.1	10.1	15.8	4.0	4.8
fungicides (%)	24.0	27.0	75.0	75.0	3.0	8.0
herbicides (%)	72.0	65.0	19.0	13.0	80.0	83.0
environmental impact points (per ha)						
total	2 690.0	1 265.0	6 210.0	4 715.0	1 945.0	900.0

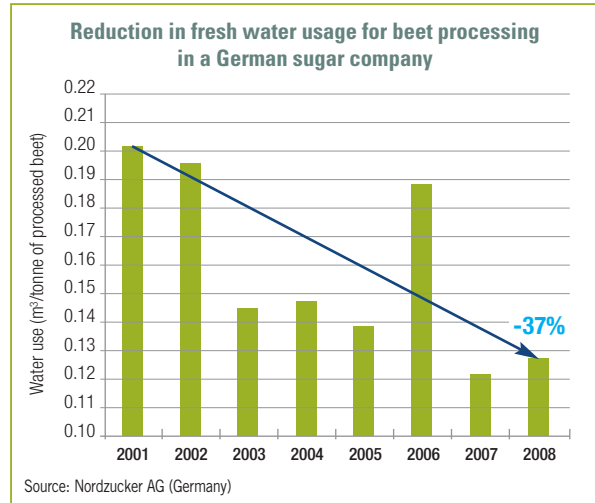
Source: Wageningen UR (LEI), 2009

INCREASING WATER USE EFFICIENCY AND RECYCLING IN THE SUGAR FACTORY

One of the objectives of the EU sugar industry is to keep fresh water usage to an absolute minimum. In order to reach this goal a number of different measures are applied.

CONDENSATE AND PRESS WATER RECYCLING

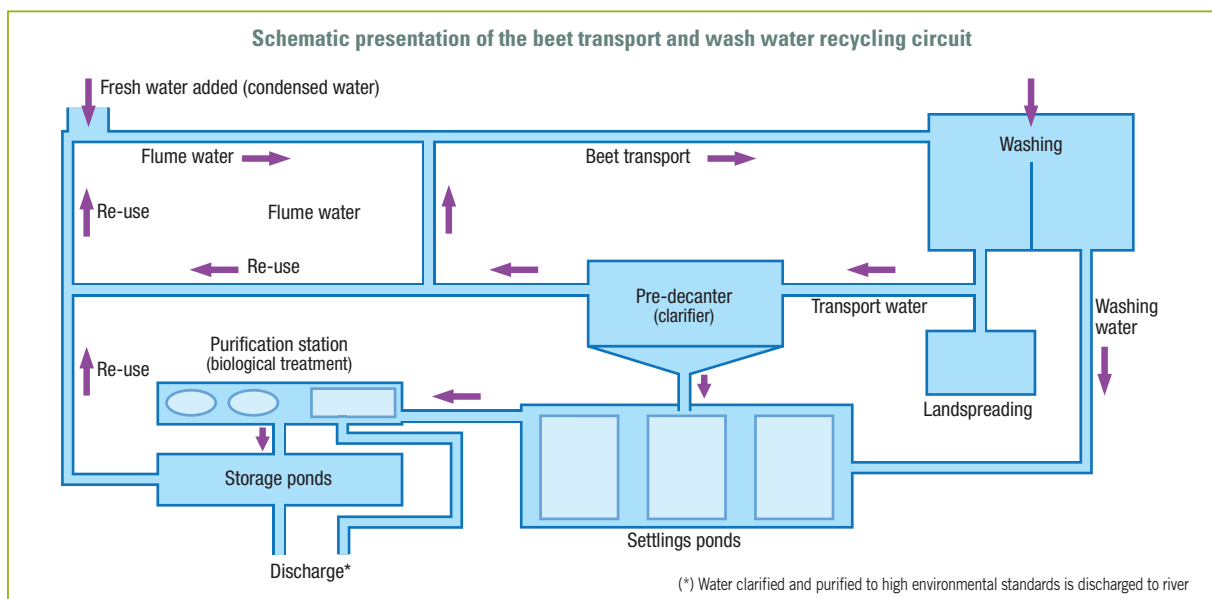
Beet sugar factories are net water producers. The most important source of water in the factories is the sugar beet itself which contains around 75% water, most of which is turned into steam during the production process, then condensed and recycled several times. The condensate is used for beet transport and washing water, as well as for extraction and crystallisation. This enables the sugar factory to reduce fresh water use to a minimum. Water from pressing the exhausted pulp is also recycled. Consequently, the processing of beet and the extraction of sugar require minimal fresh water, but also avoid producing waste water from the pulp pressing.



THE BEET TRANSPORT AND WASHING WATER RECYCLING CIRCUIT

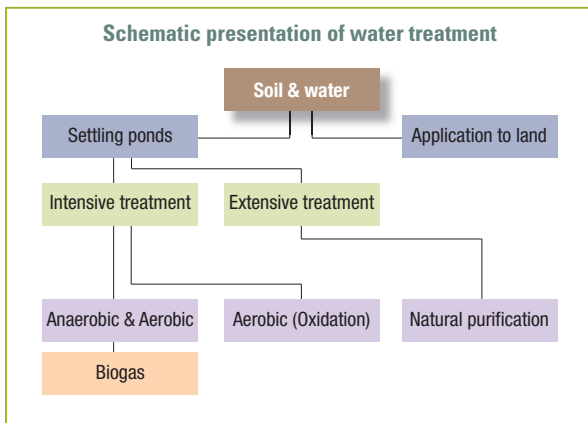
In sugar factories, the water used for beet transport and cleaning is recycled several times, therefore minimising fresh water usage. When beet is delivered to sugar factories, it is either unloaded directly from the transport vehicles or flushed along with water in a channel, ending up in the washing installation. To recycle the

transport and washing water, it is necessary to separate soil, plant parts and stones after the washing process, using screening systems. The water then flows into settling ponds. After the remaining soil has settled, the decanted water is reused for transporting and washing the beet.



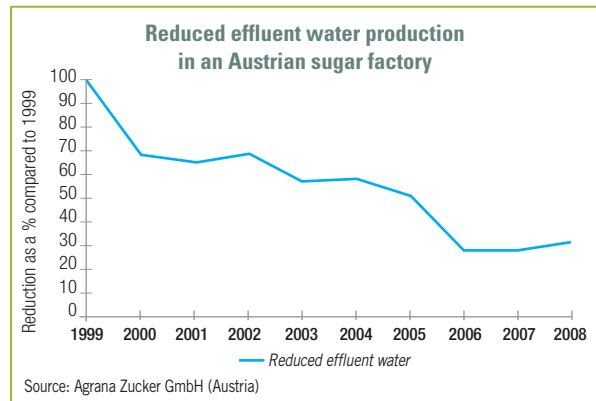
EFFICIENT BIOLOGICAL WATER TREATMENT IN THE SUGAR FACTORY

The sugar industry has developed efficient water treatment systems which reduce the organic load of all the effluent water by more than 90% before it is reused in agriculture or returned to local water courses. These water treatment systems all fulfil legal requirements and comply with local quality standards. In Southern Europe, extensive treatments using water ponds (lagooning) or land spreading (to reduce groundwater irrigation) are the norm. In northern regions, purification takes place using a combination of techniques in water treatment plants. The water remaining in the settling ponds after sedimentation is further purified in water treatment plants. The individual components of a beet sugar factory water treatment system vary from factory to factory, but generally consist of soil settlement ponds and some form of biological treatment plant.



The objective of biological water treatment is to reduce the organic load of the water to such an extent that it can be returned to water courses without harming the environment. Originally, water treatment consisted of soil settlement in large lagoons followed by storage of the water for a period of a couple of weeks to a couple of months, during which time naturally occurring bacteria reduced the biochemical oxygen demand (BOD) of the water (natural purification). The BOD is an indicator of the amount of naturally biodegradable organic matter in water.

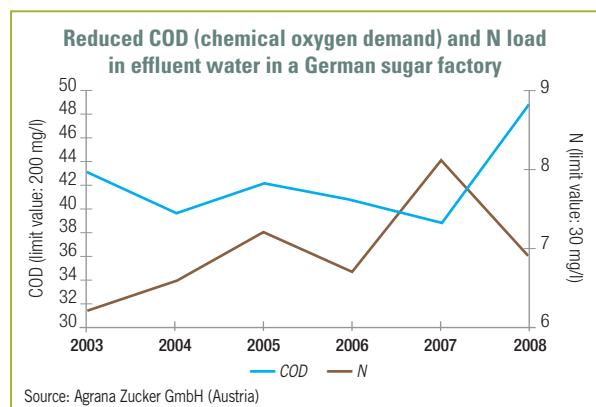
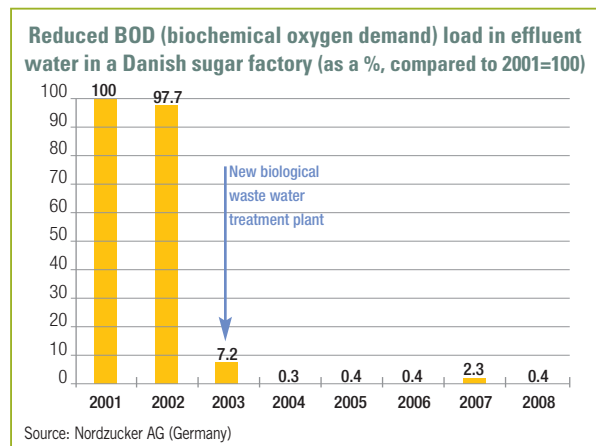
As environmental performance improved, the industry invested in intensive treatment plants, which mostly combine anaerobic and aerobic systems. Anaerobic systems can treat high concentrations of BOD. Thus water does not need to be stored for so long and odour formation is reduced. After anaerobic treatment, the water is fed to an aerobic plant where nitrogen is eliminated. Overall, these treatments reduce the BOD, as well as the COD (chemical oxygen demand) in the water by more than 90%, allowing the water to be directed to local water courses with complete safety. In Southern Europe, due to the higher temperatures, treatment can take place in open lagoons. Valuable methane gas is produced in the anaerobic process. This biogas is used as a sustainable alternative either for fossil fuel in beet pulp drying, or in boilers for producing steam.



As the graph shows, in Austria the effluent water has been reduced by up to 70%.

The following results of waste water treatment indicate the high performance of biological water treatment plants:

- Before the 2003/2004 campaign, a new biological waste water treatment plant, with an aerobic digestion system was built at a Danish sugar factory. This has importantly reduced the organic load (BOD) of water by 99%.
- At a German sugar factory, the COD and N load of water are far below the minimum limit values, and demonstrate the high performance of the water treatment operations.



CLIMATE CHANGE: ADAPTATION AND MITIGATION

The effects of climate change, as well as the efforts made to face them, affect all individuals and economic sectors, but in particular rural communities and agriculture.

Agriculture is the economic sector most strongly dependent on natural conditions, including climate. For this reason, the efforts required to adapt to a changing environment are particularly important for farmers.

Climate change may have some positive effects for certain crops (e.g. higher yields) in some parts of Europe. Nevertheless, the

negative effects of climate change on agriculture could be serious and some are already visible in certain regions: the impoverishment of the environment; an increase in the frequency and scope of extreme natural events; the increasing variability of the seasons; rises in temperature; changes in rainfall patterns; large scale fires; and the arrival of new pests and diseases. In some parts of the EU, these phenomena can have harmful effects on agriculture, leading to a decrease in agricultural activities, yield uncertainty and quality loss.

What is climate change?

Human activity, particularly the burning of fossil fuels (coal, oil and natural gas) is releasing the carbon stored in the fuels into the atmosphere and upsetting the natural carbon cycle system by which carbon is exchanged between the air, the oceans and land vegetation. According to the United Nations Framework Convention on Climate Change, this mechanism has made the blanket of greenhouse gases (GHGs) around the earth 'thicker'. More of the sun's energy is being trapped in the atmosphere, and much more of the world's

carbon (in the form of carbon dioxide) is remaining in the air rather than in trees, soil, or subterranean deposits.

The result, known as the 'enhanced greenhouse effect', is a warming of the earth's surface and lower atmosphere, which is accompanied by changes in climate, such as in cloud cover, precipitation, wind patterns, ocean currents, the duration of the seasons and the distribution of plant and animal species. In a world that is crowded and under stress, millions of people depend on

weather patterns to continue as they have done in the past.

These changes are happening at an unprecedented speed and some consequences of global warming are already apparent. With regards to future effects, the complexity of the climate system means predictions vary widely, but even the minimum changes forecast could mean frequently flooded coastlines, disruption to food and water supplies, and the extinction of many species.

ADAPTING EU BEET GROWING TO CLIMATE CHANGE

EU beet growers and processors regularly adapt their management decisions and operations to changing local climate conditions, but the magnitude and complexity of current climate change is of particular concern and requires specific efforts.

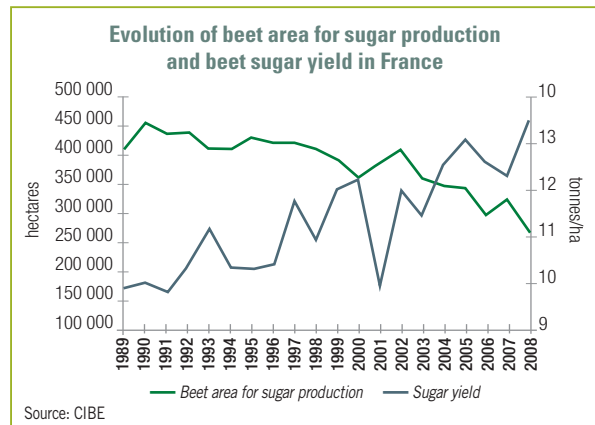
A key element of this adaptation process is the continuous research into new varieties and cultivation strategies, which is carried out by sugar beet research institutes with the intention of minimising the adverse effects of climate change and also maximising the opportunities arising from the changing environment.

Here are some concrete examples of how EU beet growers are already adapting to climate change, and also making use of these new opportunities:

- Climatic changes such as higher temperatures favour the spread of pests and diseases such as rhizomania, nematodes, rhizoctonia and cercospora in the EU. As explained in further detail on page 24, EU beet growers are dealing with these and other new pests and diseases by turning to varieties which are either tolerant or resistant to one or more of these diseases and have a higher sugar content (e.g. increased dry matter allocation to root rather than to leaves). In most EU countries these new varieties are already well established and are proving successful in facing these new challenges resulting from climate change.
- Higher temperatures affect beet growing in the EU. Beet growers are trying to take advantage of these changing weather patterns by producing more on less land. Thanks to these practices EU beet growers are already achieving very positive results: over the last 10 campaigns (1999/2000 - 2008/09), while the beet area for sugar production in the EU 27 has almost halved, the average sugar yield per hectare has risen by around 30%. In the 2009/10 campaign, average sugar yield in the EU-27 reached a new record of well over 11 tonnes of sugar per hectare.

Specific analysis of the impact of global warming on the beet sugar yield has been carried out by the French Technical Institute for Beet (ITB). The results of this analysis, reported in the ITB publication 'Betterave sucrière : Progrès techniques et Environnement' (2007), show that around 60% of the sugar yield increase recorded in France between 1990 and 2006 was due to climate change, while around 40% of this increase has been obtained thanks to research and development on varieties and cultivation practices. However, whether climate change will still have a positive impact on sugar yield in the future will depend on a favourable combination of high temperatures and water supply. Similar results have been obtained in a study on the UK ('The impact of climate change on sugar beet yield in the UK: 1976-2004', 2006).

The proved expertise of the EU beet and sugar sector puts it in a strong position to deal with the challenges that climate change will present in the future. Commitment and expertise are the keys to our sustainable future.



MITIGATING CLIMATE CHANGE

If adaptation to climate change is a necessity, then the commitment and ability of all individuals and economic sectors to mitigate climate change by designing and implementing timely and effective measures becomes ever more important.

From Kyoto to Copenhagen and beyond

In 1992, at the 'Earth Summit' held in Rio de Janeiro, the United Nations Conference on Environment and Development produced the United Nations Framework Convention on Climate Change (UNFCCC). The goal of this international environmental treaty, signed so far by 192 countries, is to achieve the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would minimize dangerous anthropogenic interference with the climate system". In 1997, a protocol to the UNFCCC was added, the Kyoto Protocol, which sets binding targets for 37 industrialised countries and the EU for the reduction of GHG emissions (so far 187 countries have signed and ratified the Kyoto Protocol).

Before the end of the first commitment period of the Kyoto Protocol in 2012, a new international framework will have to have been negotiated and ratified that can deliver the stringent emission reductions needed according to the recommendations of the Intergovernmental Panel on Climate Change (the IPCC - an international group of experts, created in 1988, which reviews scientific research and offers assessments on climate change and its effects).

International efforts to address climate change have reached a crucial point. A series of UNFCCC meetings are designed to culminate in an ambitious and effective international response to climate change. One step in this process was the 'Copenhagen Accord' signed at the United Nations Climate Change Conference (COP 15) held in Copenhagen in December 2009. Parties agreed to hold global temperature increases to 2 degrees centigrade, and to take action to meet this objective.

EU beet growers and processors are aware of these challenges and of the role they can play in mitigating climate change.

It is within this context that the EU beet and sugar sector has contributed, during a long and complex legislative procedure, to the debate on the EU Climate and Energy Package, in particular the debate at the European Parliament. The contribution by EU beet growers and processors to climate change mitigation, in particular through the sustainable production of bioethanol and biogas from beet, was also presented by the International Federation of Agricultural Producers (IFAP) at the Copenhagen UNFCCC negotiations as a model of 'Farmers' Solutions' to climate change (http://www.ifap.org/events/story/climate_change).

In line with EU and international targets, EU beet growers and processors are committed to actively contributing to climate change mitigation through the development of two main strategies:

- the reduction of their impact on climate change, namely of the net GHG emissions and energy use directly and indirectly related to beet growing and processing
- the diversification of their outlets towards the production of renewable energies and materials which will replace more polluting and energy-intensive products.

The EU Climate and Energy Package

The EU has a leading role to play in the international fight against climate change. Its commitment resulted in a complex and sustained effort to design a far-reaching EU Climate and Energy Package, adopted in December 2008, which will deliver on the EU's ambitious commitments to fight climate change and promote renewable energy up to 2020 and beyond. The package will help transform Europe into a low-carbon economy and increase its energy security and diversification.

The EU is committed to reducing its overall emissions to at least 20% below 1990 levels by 2020, and is ready to increase this reduction by as much as 30% under a new global climate change agreement when other developed countries make comparable efforts. It has also set itself the target of increasing the share of renewables in energy use to 20% by 2020. The EU Climate and Energy Package sets out the contribution expected from each Member State to meet these targets.

Central to the strategy is the strengthening and expansion of the Emissions Trading System (EU ETS). Emissions from the sectors covered by the system will be cut by 21% by 2020 compared to 2005 levels. Emissions from sectors not included in the EU ETS – such as transport, housing, agriculture and waste – will be cut by 10% of the 2005 level by 2020.

The package also includes Directives on Renewable Energy and Fuel Quality, setting a target of a minimum 10% share for renewable energy in transport by 2020. The package sets out sustainability criteria that biofuels and other bioliquids will have to meet to ensure they deliver real environmental benefits (see page 48).

THROUGH THE REDUCTION OF ENERGY USE AND NET GHG EMISSIONS

MITIGATING CLIMATE CHANGE THROUGH SUGAR BEET CULTIVATION

Agriculture is fundamentally different from other sectors with respect to GHG emissions. Crop production naturally sequesters carbon through photosynthesis from the atmosphere into the soil and biomass, therefore acting as a carbon sink.

GHG emissions and agriculture

CO₂ (carbon dioxide) is absorbed by plants through photosynthesis from the atmosphere into the soil and biomass.

N₂O (nitrous oxide) emissions arise from microorganism activity through the processes of denitrification. The source of the material that they denitrify is fertiliser or N forms mineralised from soil organic matter.

CH₄ (methane) emissions arise from anaerobic decomposition of organic material, enteric fermentation in bovine digestive systems and manure application.

Based on the IPCC definition, global GHG emissions originating directly from agriculture account for 13% of total emissions. For the EU this share is 9%.

EU agriculture is aware of its impact on GHG emissions and is therefore committed to reducing it. According to the European Environment Agency and the Directorate-General for Agriculture and Rural Development of the European Commission, EU agriculture cut its emissions by 20% between 1990 and 2006.

EU beet growers and processors are being particularly successful at reducing their GHG emissions and in improving their energy balance and efficiency. The GHG emissions and energy consumption arising from beet growing largely derive from the production and use of agricultural inputs, in particular diesel fuel and fertilisers.

First of all, sugar beet is a key rotational crop. As explained in detail on page 16, sugar beet is grown on the same field only every three to five years over 8 months, and has become a very valuable part of arable farming. As demonstrated in some EU countries, because sugar beet breaks up the mainly cereal-based crop rotations, the increase in cereal yield is 10-20% compared to the yield after two successive years of cereals, thus reducing the need for fertilisers. Furthermore, because sugar beet is not a host to pests and diseases, which generally affect combinable crops, the cultivation of sugar beet reduces the level of weeds, diseases and pests and therefore reduces the amount of pesticides applied.

In addition to the benefits related to the use of beet in crop rotation, EU beet growers are aware of the environmental impact arising from the use of agricultural inputs, and are therefore committed to reducing their use and improving their efficiency. The results achieved so far, explained in detail on pages 37-40, include:

- Less and less mineral nitrogen (N) fertiliser being applied by EU beet growers: in major EU producing countries, a 30% reduction has been achieved over the last 10 years. And, as yields have continued to increase, this means that N-use efficiency has improved dramatically.
- The use of plant protection products (PPPs) in EU beet growing being substantially reduced over the past 10 years. For example, in the Netherlands, the environmental impact of PPPs used for sugar beet decreased by more than 50% between 2002 and 2007.

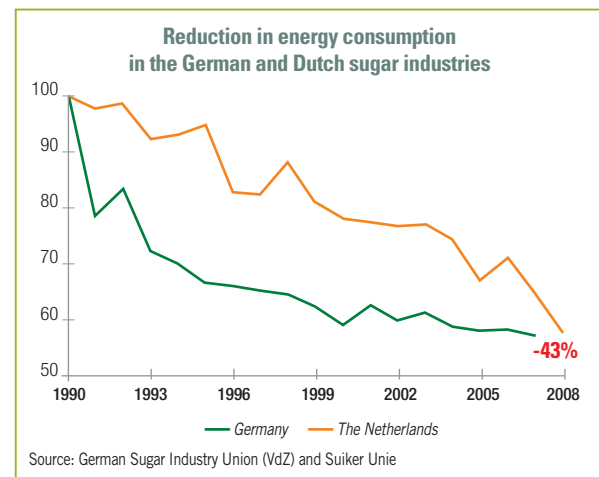
A reduced use of these inputs means, besides a relative reduction in production costs, a reduction in the use of energy and in GHGs emitted.

Therefore the results achieved so far by beet growers are clear examples of how commitment and efficient practices can achieve tangible results in the mitigation of climate change.

MITIGATING CLIMATE CHANGE IN THE SUGAR INDUSTRY BY CURBING GHG EMISSIONS

Improvements achieved in sugar factories in the EU in the field of energy-efficiency have led to lower GHG emissions. For this reason the successful efforts by the EU sugar industry to reduce its energy consumption have also made a major contribution towards mitigating climate change.

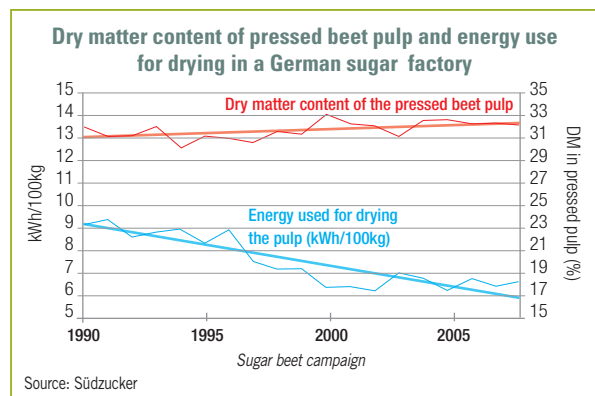
- **Reducing fossil energy use:** The decreasing use of fossil energy sources is directly related to a reduction in CO₂ output, thereby contributing to EU objectives to reduce CO₂ and other GHG emissions. Since the early 1990s, the EU sugar industry has significantly reduced carbon emissions. Indeed, over the last 15 years EU sugar producers have improved the performance of their installations and reduced CO₂ emissions by up to 50%. Processing more beet while using less energy has been a constant objective for the EU beet sugar industry. As shown by the graph, the German and Dutch sugar industries provide excellent examples: respectively -43% (2007) and -44% (2008) energy use per tonne of beet processed since 1990.



- **Improving energy efficiency by investing in state-of-the-art technologies:** Over many years, the EU sugar industry has made great strides in lowering its use of primary energy. This objective has been reached due to a combination of heavy investment in combined heat and power systems ('CHP'), the installation of multi-effect evaporation, the improvement in mechanical cossette pressing and the introduction and development of process control technology.
- **Combined heat and power systems:** Sugar factories use a power generation system called combined heat and power that produces both steam and electricity. The electrical power and the steam generated are both used efficiently in the manufacturing process. High pressure steam drives a turbine and generator, producing the electricity needed to power the factory. The low pressure (exhaust) steam which leaves the turbine is then used for evaporation and other functions in the factory, in particular to heat the sugar juice throughout the process. The remaining heat can be exported and sold to nearby heat consumers (private households and industrial users) in the form of hot water or steam. At a number of sugar factories, more electricity is generated than required. As electricity cannot easily be stored, this excess power is exported to the grid or sold to the electricity supply companies.

These CHP systems are far more energy-efficient than conventional power stations which have no application for the low pressure exhaust steam. Highly efficient cogeneration of steam and electricity has always played a central role in sugar factories. Each plant is sized to satisfy the steam demand for the site's production at maximum efficiency. The steam is used in the evaporation stages of the sugar manufacturing process and then also to heat the sugar juice throughout the process. In this way, highly efficient use of the energy contained in the fuel is made during the manufacturing process. Hence, highly efficient cogeneration in sugar factories can claim a net efficiency of 80-85% whereas conventional power plants supplying energy to the public grid will have around 30-50% efficiency. Hence, by producing both heat and electricity on-site and by not taking its supply mainly from the grid, sugar factories also contribute to saving GHG emissions.

- **Multi-effect evaporation:** After purification, sugar juice contains about 15% sugar. This requires concentration to above 68% to allow sugar crystallisation and extraction. The process responsible for this is called 'multi-effect-evaporation'. It is based on a principle of re-using the heat energy in the steam from each evaporation stage, by using it again in the next evaporator. This means that, for example in a five stage evaporation process, 1kg of steam is able to evaporate 5kg of water from the juice. This process is therefore highly efficient. The condensate from the first evaporator is recycled to the boiler for steam generation and the final condensate is used for other purposes, such as for process heating.
- **Increasing the efficiency of pulp pressing:** Once the sugar has been extracted from the sliced sugar beet, a high-energy fibrous material called 'pulp' is left. This has to be pressed to remove excess water, and to recycle the small amount of sugar it still contains. The sugar industry has invested heavily in improving the efficiency of this pressing process, to save fuel needed for pulp drying, and to improve product quality. The example below of a German sugar factory is representative of the gradual increase in the average dry matter content of pressed beet pulp due to increased pulp pressing efficiency since 1990. This has positively contributed to reducing the energy needed for drying the pulp.



Emissions Trading System (ETS), climate change and the EU sugar industry

In January 2005 the EU Greenhouse Gas Emission Trading System (EU ETS) commenced operation as the largest multi-country, multi-sector greenhouse gas (GHG) emission trading system world-wide.

The scheme is based on Directive 2003/87/EC, which entered into force on 25 October 2003.

The revised Directive on the EU ETS was published in the Official Journal on 5 June 2009 (Directive 2009/29/EC). In a wider context, in December 2008, the EU adopted the Climate and Energy Package containing measures to fight climate change and promote renewable energy. This package is designed to achieve the EU's overall environmental target of a 20% reduction in GHG emissions and a 20% share of renewable energy in the EU's total energy consumption by 2020.

The Council adopted a revised Emissions Trading System (ETS) for GHG in order to achieve greater emission reductions in energy-intensive sectors. From 2013 onwards, the biggest industry emitters will contribute significantly to the EU's overall target of cutting GHG emissions by one-fifth

by 2020 compared to 1990 levels.

To stimulate the adoption of clean technologies, the new ETS provides that GHG emission permits will no longer be given to industry for free, but will be auctioned by Member States from 2013 onwards. ETS sectors must start by purchasing 20% of their emission permits in this way. That rate will rise gradually to 70% in 2020, with a view to reaching 100% in 2027. Power producers, on the other hand, are obliged to acquire all of their emissions' allowances at auctions so as to prevent windfall profits. As a number of sectors could be exposed to a risk of 'carbon leakage', i.e. investments and production may move to third countries with lower environmental standards, the Council has introduced the possibility of reducing auctioning to the most efficient installations in a limited number of sectors. As of 2009, the EU sugar sector was considered by the Commission as a sector at risk of carbon leakage.

The ETS covers energy-intensive sectors including electricity generation, coking, mineral-oil refineries, ferrous-metal production, cement, lime, ceramics, bricks, glass, pulp

and paper. All these industrial activities are named explicitly in Annex 1 of the ETS Directive. Together with those named activities, there is a general category called 'combustion of fuels' which covers all big combustion installations in any other sector or industrial activity. Sugar beet processing factories are virtually always included in ETS due to the size of the combustion installations which power them. Indeed, sugar factories must be in close proximity to the beet fields and thus in rural areas with limited energy distribution infrastructure. Moreover, the short-time period available for processing the entire beet harvest (generally 3-4 months) leads to significantly high energy peak needs for factories and these needs cannot be satisfied by the infrastructure available in those areas. Hence, self-generation of both electricity and heat via highly efficient combined heat and power (CHP) systems is a must in all beet sugar factories in Europe. The isolation of sugar beet factories also has an impact on the type of fuels that can be widely used (for example due to the long distance between some factories and natural gas distribution pipelines) and therefore on the overall carbon emissions from factories.

THROUGH THE SUSTAINABLE PRODUCTION OF RENEWABLE ENERGY AND MATERIALS FROM BEET

The sustainable development of renewable energies (bioethanol and biogas) and materials (e.g. surfactants and polymers), which replace more polluting and energy intensive products (e.g. fossil fuels), plays a large part in the EU beet and sugar sector's commitment to the reduction of GHG emissions.

The development of renewables must be promoted and must comply with strict sustainability criteria. The first generation of biofuels produced in the EU gives these guarantees, represents an immediately available source, and leads the way towards the future development of next generation biofuels.

In particular, EU beet ethanol not only complies with strict sustainability criteria, as set by the EU Renewable Energy and Fuel Quality Directives, but is one of the most sustainable available sources of energy.

Sugar companies in many EU countries have invested in the production of ethanol to adapt to the new challenges posed by climate change. Sugar beet ethanol is obtained through fermentation of sugar in the beet juice, the sugar syrups, and can also be obtained from beet molasses. Used in the beverage, chemical and pharmaceutical industries, ethanol is also more and more widely used as a fuel. In the EU, sugar beet ethanol makes up to 30% of the bioethanol market.

EU Renewable Energy and Fuel Quality Directives

The EU Renewable Energy and Fuel Directives (2009/28/EC and 2009/30/EC), adopted by the EU in December 2008, state that each EU Member State shall ensure that the share of energy from renewable sources in transport in 2020 is at least 10%.

Irrespective of whether the raw materials are cultivated inside or outside of EU territory, energy from biofuels and other bioliquids shall be taken into account for the 10% target (and eligible for financial support for the consumption of biofuels and other bioliquids) only if they comply with strict sustainability criteria:

- their GHG emission saving compared to fossil fuels is at least 35% (and 50% from 2017)
- they shall not be made from raw materials obtained from land with a high biodiversity value, with high carbon stock or from peatland
- when produced with EU agricultural raw materials, these should be obtained in accordance with EU cross-compliance.

These Directives constitute a positive compromise for the development of sustainable bioethanol production and consumption in the EU. Their effective implementation will be of extreme importance for the mitigation of climate change.

