Lucerne:

an asset to the environment

Introduction

Protecting the environment is essential for maintaining quality of life today and for future generations. Combating climate change, the loss of biodiversity and the pollution of natural resources (air, water, land) rank among the priorities of the EU's environmental policy.

In March 2007, the European Council began its campaign to transform Europe into an economy with high levels of energy production and low emissions of greenhouse gases (GHGs). The Council decided that the EU would independently undertake to make a firm commitment to reduce GHG emissions by 20% before 2020 in comparison with 1990. In the event of a worldwide agreement on reductions of GHG emissions for after 2012, the European Union (EU) could go beyond this commitment. The European Council has also adopted an energy action plan for the 2007-2009 period setting very ambitious targets on energy efficiency, the promotion of renewable resources and biofuels and also called for the implementation of the Biomass Action Plan.

Nitrogen-fixing plants, which include lucerne, contribute to meeting these energy and environmental challenges; saving fertiliser and energy from fossil fuels, reducing surface areas needed to produce each tonne of vegetable protein and consequently reducing deforestation, combating climate change and also lowering water pollution. Furthermore, the drying factories found in several EU Member States have a role to play in developing alternative energy sources for heating in the home (pellet heating).

Comparison between lucerne and other types of protein producing crops[1]

Territorial Balance (Effective use of land)

Lucerne is a very effective means of using land. In order to produce one tonne of protein, 0.43 ha of lucerne[2] are needed, compared with 1.31 ha of soya[3] i.e. a gain in surface area of 0.888 ha! It is the least greedy plant in terms of space needed to produce one tonne of protein; it has the lowest territorial intensity.

Figure 1 below illustrates the gains in land intensity for lucerne compared to soya, i.e. the changes in use of avoided land (shown by trees on the diagram) or the gains in surface area, per tonne of protein, when transferring from soya to lucerne.

With the area that is saved, there are three conceivable options:

- **Grow other types of food**. This is a very important aspect at global level considering demographic growth in some areas of the world.
- **Grow non-food plants or reforest the land** in order to produce bioenergy as a means of replacing fossil fuels, thus simultaneously improving the energy and GHG balance.
- **Avoid deforestation while producing more protein.** Converting forests and savannah into farmable ground so that production can be increased effectively leads to considerable GHG emissions in both temperate areas and intertropical areas.

Figure 1 below shows a diagram of the gains in the land intensity of lucerne, as opposed to soya, i.e. the changes in use of avoided land (shown by the trees on the diagram) or the gains in surface area, by tonne of protein when moving from soya to lucerne.

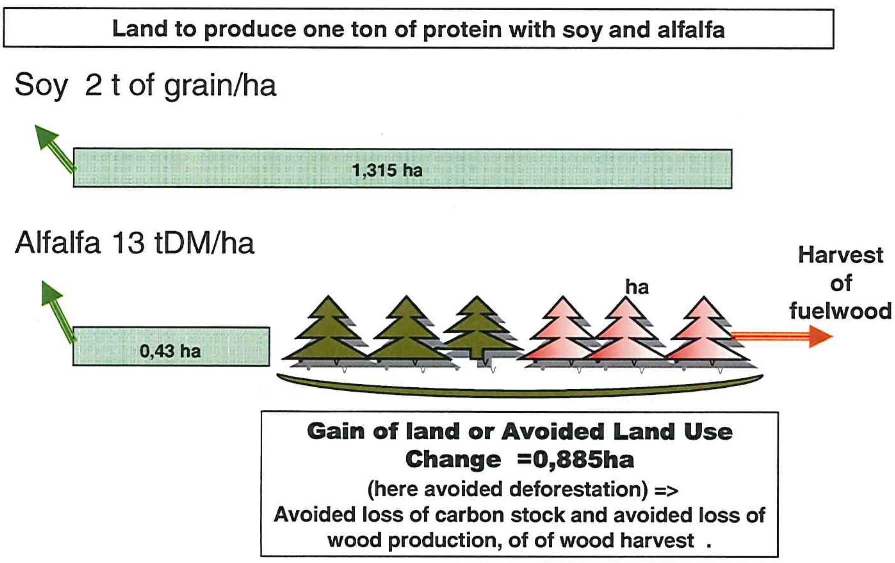

Figure 1: Diagram to illustrate the comparison beween the land intensity of lucerne and North American soya for the production of one tonne of protein.

[1] First analysis of environmental interest in lucerne, Arthur Riedacker, Director of Research, INRA (France)

[2] With a yield of 13 tonnes of dry matter per hectare.

[3] With a grain yield of 2 tonnes per hectare.

By moving from soya to lucerne, new areas of land become available for producing alternative products without reducing the production of vegetable protein.

The gains in surface area of lucerne compared to soya is also known as 'changes in the use of avoided land'. With this surface area, forests' average carbon stocks can be preserved as well as the flow of biomass harvested in a sustainable manner (here wood harvesting) (Fig2).

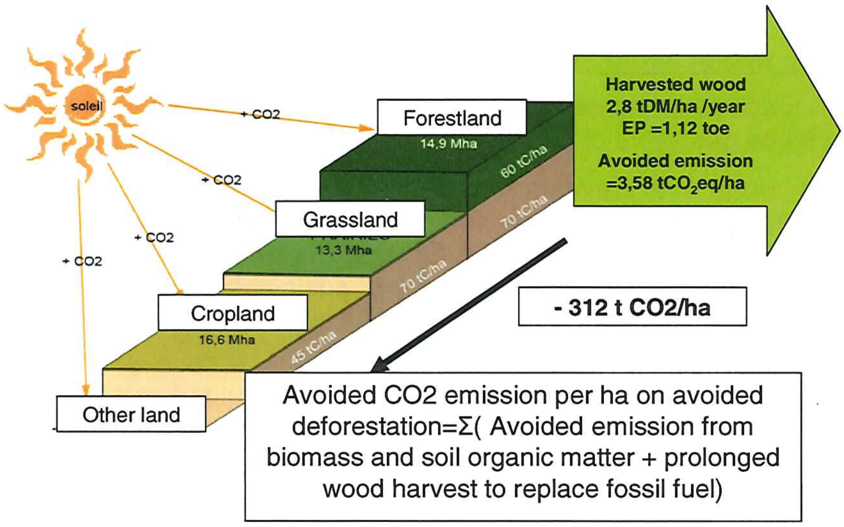

Figure 2: Preservation of the harvesting of wood and CO2 emissions avoided by 'changes in the use of avoided land' or by the preservation of one hectare of forest in a temperate area (The carbon stocks per hectare and CO2 emissions avoided per hectare correspond to the average values for France).

Energy balance

There are two different stages; cultivation and processing of the products.

- **The cultivation of lucerne requires less energy consumption than that of soya;** to the tune of 0.9 GJ/t of protein compared to 4.9 GJ/t of soya protein.
- **Lucerne on the other hand currently requires more energy for processing than soja**; With advances made in technology, it now takes 1 TOE of primary energy per tonne of dried protein. *There has already been an energy gain of approximately 40% over the last thirty years, but other energy efficiency gains are still possible, notably with the wet process at the forefront.* This energy can be produced with fossil fuels, cereal straw, ligno-cellulosic waste or even with specially produced biomass, for example 'changes in the use of avoided land', i.e. on the 0.885 ha gained by changing from soya to lucerne (fig. 1). Under these conditions, per tonne of protein from lucerne compared to a tonne of soya protein, there will be ground gained of 0.38 and 0.63 ha respectively[4].

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[4] With this surface area, it is not only possible to produce the energy needed to dry out one tonne of lucerne protein, but also to have an energy surplus or crops for other purposes! With energy crops generating 2 TOE/ha by producing 5 t of DM/ha (dried matter) or 4 TOE/ha by producing 10 t of DM/ha. Whereas to produce 1 TOE of primary energy to dehydrate one tonne of lucerne protein, it is necessary to have 0.5 ha and 0.25 ha of biomass crops respectively. Note that wheat produces on average 11 t of DM/ha and miscanthus produces 15 t of DM/ha, if not more.

Greenhouse gas balance (GHG)

Greeenhouse gas (GHG) emissions depend on (1) cultivation, (2) changes in the use of avoided land or additional land needs and finally (3) energy consumed and fuel used to dry the lucerne.

1. Emissions resulting from crop growth

Cultivation of lucerne requires fewer inputs than for that of soya; the emissions per tonne of protein are slightly lower;

2. Emissions by changes in use of avoided land

a) Drying lucerne with fossil fuels, cereal straw or other unused biomass waste avoids deforestation of 0.885 ha per tonne of protein.

- In temperate areas this prevents the stock reduction of 276 t of CO2 by preventing deforestation (according to the average values for France for forests, prairies and crops, indicated in figure 2). In doing so, by preserving the forests and therefore with the possibility of sustainable wood harvesting, (2.8 t of DM/ha/yr), this contributes to a reduction in emissions of 3.17 t CO2/yr.
- In tropical areas, for example in Amazonia, by avoiding deforestation, carbon stock reduction can also be avoided on the preserved surface area. It is well-documented that carbon stocks in unspoiled tropical forests can, per hectare, exceed 180 to 200 tonnes of carbon, i.e. more than 660 t of CO2! To this should be added methane and carbon monoxide generated from the incomplete burning of biomass from cleared forests, i.e. another greenhouse gas and a precursor to greenhouse gas. This again tips the balance of change in use of land towards the greenhouse effect. However, admittedly in these forests, before deforestation, there was no harvesting of wood for energy.

b) This gain is again 0.38 ha[5] and 0.63 ha[6] when lucerne is dried with biomass which is procuced especially for this purpose on the basis of these changes in the use of avoided land; on these surface areas, not necessarily for drying, biomass can be generated to replace other sources of fossil energy, therefore further reducing greenhouse gas emissions by 2.4 to 8 t CO2 per tonne of lucerne protein.

3. Emissions of fuels used to dry lucerne proteins

In order to produce around 1 TOE of energy for drying:

a) Less than 4 t CO2 is generated (approximately 3.6 t CO2 by using 80% coal, gas and electricity);

b) Emissions close to zero when this heat is generated with biomass.

4. Potential reductions in GHG emissions for use in harvested biomass

If instead of harvesting protein, as seen in the present example, wheat or other biomasses which can potentially be used for energy had been harvested, the primary potential for reducing GHG emisisons from harvested plants would also need to be taken into account.

[5] With production of only 5 t of dry matter harvestable per hectare

[6] With yields of dry matter of 10 t/ha

The "Integrated Environment Assessment" used here for the purpose of this analysis, compared to the "Life Cycle Analyse" traditionally used, has the advantage of taking into account the use of land surface areas, the energy balance and the balance of greenhouse gas emissions; three essential parameters for the future of the planet and for sustainable development[7].

Other environmental benefits of lucerne

Lucerne fields have a positive impact on biological and landscape diversity

Lucerne also contributes to maintaining biodiversity in cereal-growing areas. In this way, Lucerne, as a perennial legume, allows for the presence of an additional functional group distinguishing it from crops such as beet or cereals.

The durability of lucerne fields is important for the fauna as yardstick land parcels in a landscape which changes each year. It is an area of shelter but which also harbours food resources (insects for bustards and other birds, field mice, partridges, hares, roe deer, birds of prey…) and is used for breeding.

While the harvesting method does not allow the lucernes to flower by the time of each cutting, there is always a summer blooming period. The lucerne fields therefore have an important role to play in the feeding of pollinators and more specifically, bees and the maintenance of bee populations on large cereal plantations.

Lucerne fields protect the quality of water

The cultivation of lucerne has a proven effect on water quality. This plant appears to favour nitrate consumption in the soil and only fully puts in place its system of symbiotic air-borne nitrogen fixation (which avoids contributions from nitrogenous fertilisers) when the soil nitrate reserves are rare. It therefore has an important role to play in the reduction of nitrate-leaching. The water company Vittel has furthermore committed to undertake a lucerne plantation programme in order to protect the mineral water channelling areas.

The use of plant protection products in lucerne fields remains very limited

Weed control is carried out at planting and (or) during the winter months. The tighter legislation on the use of plant protection products and the limited market scope leave us with few commercial products and are leading us to consider alternative weed control techniques for lucerne (ploughing, mechanical weed control, etc).

As for insects, regular cutting (4 times every 45 days in France) regulates insect populations and removes the need for systematic treatment.

There is no need for fungicides in disease prevention. Selection has led to the effective control of major diseases or parasites.

It is still possible on some holdings to improve the environmental potential of lucerne fields by extending their period of use (to reduce costs linked to sowing, weed control and cutting).

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[7] **Riedacker A 2006 A global land use and biomass approach to reduce greenhouse gas emissions, fossil fuel use and to preserve biodiversity,** in "Climate Change Mitigation Measures in the Agroforestry Sector and biodiversity Future Joint Workshop Italy 14-16 October 2006" 21 pages

Agri-economic value of lucerne

Lucerne is an excellent break crop

Lucerne is an excellent break crop; when used in rotation with wheat, it saves around 50 units of nitrogen on the following crop. Saving nitrogen means saving fossil energy and reducing GHG emissions linked to the corresponding production of fertilizer. It also helps to increase stocks of organic matter in the soil and thus fertiliser retention, which is indispensable for the continuation of wheat production in certain regions. Wheat yields improve as a result.

Lucerne is an indispensable break crop for nitrogen supply in organic farming.

Lucerne is grown on the plot of land for 27 to 40 consecutive months, sharply reducing erosion due to surface water or wind. As such, it helps to slow down erosion.

The longer the life of the lucerne field the more effective the lucerne. A deep system of roots (up to 2 metres) develops, thus decompacting the soil and enhancing its structure for subsequent crops. Moreover, this improved soil structure improves earthworm activity and the effective recycling of organic material (reorganisation of 1.2t/ha of plant waste available on the surface).

The merits of lucerne on farms

Dried lucerne has enabled the European Union to considerably reduce its dependence on GM-free plant proteins by providing breeders with a lasting economic alternative to imported soya. The dried lucerne sector thus supplies 10% of the EU's supply of plant protein for animal feed. The main supplies go to cattle, small ruminants, rabbits, horses and poultry.

According to UN statistics, almost half of GHGs in European agriculture come from methane produced from enteric fermentation. Yet lucerne pellets may help to cut methane emissions by about 10%, thanks to the presence of malate.

Value of pelleting units in energy production

The equipment needed to produce lucerne pellets can also be used to produce sawdust pellets and other types of biomass. This doubling up of activity not only makes drying factories more profitable but also provides an alternative to the domestic heating system and a certain degree of resistance to market fluctuation in oil-based products as well as a reduction in GHG emissions. It is therefore paramount that existing pelleting units in Europe are preserved and developed, taking into account the particularly ambitious biomass development programme for energy in the European Union.

In the longer term, the production of gaseous biofuels for transport (purified biogas) from lucerne, must also be granted consideration.

Conclusions

Given the EU's ambitious overall plans for the environment (combating climate change, biodiversity, water protection) and energy (diversity and security of energy supply, promotion of renewable energy sources, energy efficiency), it is in the EU's interests to increase the profile of lucerne in agriculture. COPA and COGECA will submit their proposals on the future of the Common Market Organisation for Dried Fodder (Regulation (EC) n°1786/2003) at a later date.

Note to editors:

In Europe, the dehydration sector (4 million tonnes of dried lucerne spread over 340 000 hectares in 2005/2006) is a local agri-industry. Its businesses currently employ more than 10 000 people and therefore, together with 150 000 farmers, contribute to land planning by safeguarding the economic fabric of rural areas.

CIDE (the European Dehydrators Association) currently assembles almost all drying firms. The majority of these factories (240) are agricultural cooperatives and are located for the most part in Spain, France, Italy, Holland, Denmark, Germany and the Czech Republic, etc.

COPA (Committee of Professional Agricultural Organisations in the EU) defends the development of a multifunctional and sustainable European Model of Agriculture at the European Institutions, while COGECA (General Confederation of Agricultural Cooperatives in the EU) is the body and platform that represents and works with agricultural cooperatives in the EU. For more information, please visit www.copa-cogeca.be.

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