Sunflower in Spain: Past and present trends in an international context

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ABSTRACT

Despite sunflowers having been brought to Spain at the beginning of the 16th century, and in-shell sunflower seed production having been traditionally grown in this country, the oilseed type was not introduced into Spanish agriculture until the end of the 1960's. The development of the oilseed sunflower in Spain has been through several stages marked in many cases by national and EU political decisions. The present trend points towards a recovery of the sunflower area lost in Spain during the last decade and the demand of vegetable oils for biodiesel production or for specific food uses may also serve to secure a plateau price and keep the oilseed oil demand higher than ever. A binding target of 10% for biofuels has been set in the EU for 2020. One output and one input trait are segmenting the sunflower market. The high oleic (HO) sunflowers, including mid oleic (NuSun), have continued to grow, NuSun representing over 96% of the total high oil sunflowers in the US, while in Europe in some countries such as France, Spain and Hungary, the HO area is expanding very quickly. The recent development of herbicide-tolerant sunflowers solved one of the historical deficits in sunflower crop management: i.e., post emergence weed control and may also serve for the chemical control of broomrape and contribute to increase seed yield. The combination of high oil value and potential yield increase makes sunflowers a competitive choice option for farmers.

Key words: herbicide-tolerant – high oleic – market trends – mid oleic – Spain

INTRODUCTION

Sunflowers were introduced into Europe via Spain at the beginning of the 16th century (Putt, 1978). After this, it moved in an eastward direction in Europe, in the beginning as an ornamental plant, and, in a second phase, becoming a food. The earliest record of using sunflower seeds as a source of oil was found in an English patent of 1716. Although this patent refers to the use of sunflower oil for wool, paint, leather, etc. manufacture, most of the crop was used for food. The commercial manufacture of sunflower oil started in Russia between 1830 and 1840.

Although "in shell" sunflower seeds have been traditionally produced in Spain, the oilseed type was not introduced until the second half of the last century. There are different stages in the history of oilseed sunflower production in Spain (Fig. 1). These have been influenced in many cases by political decisions, which have had a great impact on the area planted. These influences and other factors having an effect on sunflower evolution and present situation in Spain are analyzed in this review.

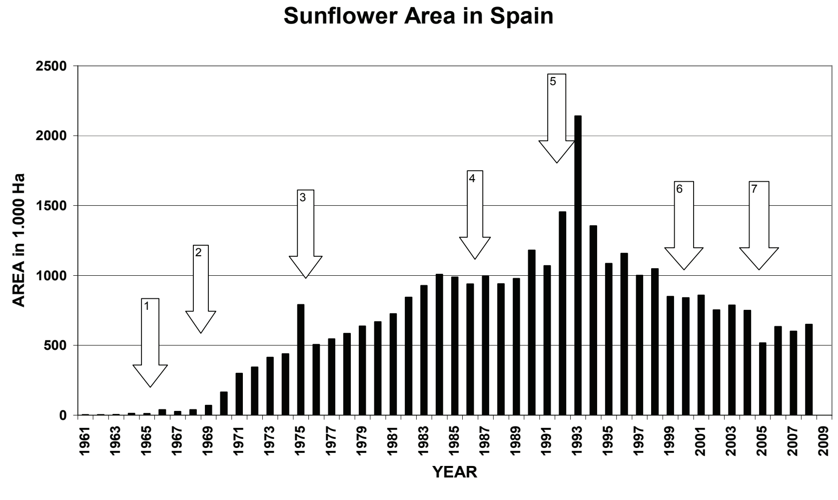

Fig. 1. Historical Oilseed sunflower planning area in Spain Source (MAPA, 2007)

DISCUSSION

Stages in the history of sunflower development in Spain

First Stage: 1965 to 1969. During this period, Spain was deficient in edible oil production and had to rely on imports for consumption. The first sowing of oilseed sunflowers with a black shell opened up a unique opportunity for Spanish farmers and industry. For farmers, to plant the traditional fallow land after cereals´ with sunflower, and for the industry to develop a crushing industry that pushed the crop area up.

Second Stage: 1969 to 1975. This period corresponds to the rapid expansion of the sunflower crop in Spain. At the end of this period the sunflower area planted in Spain was of 781,800 ha. The crushing industry played a key role in the development of sunflower crop as it provided:

- Certified seed for planting.
- Technical staff and mechanical planters to spread crop management techniques.
- Local agents who contracted and collected the crop.
- Financing of the crop, anticipating in many cases payments before harvesting

Also, by the year 1971, the World Bank had launched a program to assist in the development of sunflower in Spain, establishing a research centre for oilseed research in Córdoba in CRIDA 10 within the National Institute for Agricultural Research (INIA). Some of the young researchers from that time have made their scientific careers in working in sunflowers in Spain and are now relevant scientists in sunflower research.

Third Stage: 1975 to 1986. During this period, Spain's vegetable oil imports were restricted to state commerce. Only the Government could import both oilseed for crushing, and oil. Imports were made in the event of any shortage of oil. Additionally, the Government fixed a contract price for the crop that the industry had to pay the farmer. The Ministry of Agriculture assured itself the first bid for the oil. With this intervention, the period was marked by a notable increase in sunflower in Spain. The sunflower-planted area grew in over a million hectares in 1984. The period ends with the entry of Spain into the European Economic Community (EEC) in 1986.

Fourth Stage: 1986 to 1992. The EEC protection system was based on a *price support mechanism,* as a means of increasing agricultural output and productivity and ensuring agricultural income. The most important feature of this mechanism was to ensure that Community farmer prices *were higher* than the world average. The EEC set reference prices for a guaranteed maximum production (GMP) of oilseeds. The farmers received these prices. The crushing industry received aid for the oil extraction, which was fixed by the difference between the reference price and the international market price at the time of extraction. During the transitional period of ten years set for Spain in 1986, the Spanish Ministry of Agriculture established an Intervention price for the farmer at the intervention centres. This price would rise 1/10, to reach the annual Community price. It also established a target price for the local industries to calculate the aid for oil extraction. There was also an aid scheme for the export of surplus oil. The sunflower-planted area in Spain rose to 1,454,500 ha in 1992.

Fifth Stage: 1993 to 2000. The early development of the Common Agricultural Policy (CAP) allowed the EEC to move quite rapidly from a complete deficit to a surplus of production in the main products, and, therefore, to transform the EU from being a net importer to a net exporter on the world market. In 1992, the MacSharry reforms (named after the European Commissioner for Agriculture, Ray MacSharry) were proposed to pacify the EU's external trade partners at the Uruguay round of the GATT trade talks with regard to agricultural subsidies and to cope with EU budgetary difficulties. The 1992 reform, implemented in 1994, took a decisive step towards market orientation by gradually changing the basic mechanisms of the CAP from a *price support system* towards *direct income support.*

In 1993, Spain renounced the last years of the transitional period to become fully integrated into the new CAP. In the absence of any limitation of surface and with sunflowers taking advantage of a particularly high per hectare grant, its cultivation grew in over 2,000,000 ha. Then, the Spanish government imposed a series of restrictions on sunflower planting to limit the undesirable presence of "Premium hunters." These measures stabilized sunflower area to around 1,100,000 hectares. Two systems limited the oilseed area planted. One reduced the aid in proportion to the exceeding of the Maximum Guaranteed Area imposed by the EU/USA Blair-House agreement. The other was a reduction in the aid per hectare if the local oilseed prices exceeded the international reference prices fixed for the period to calculate the amount of aid per hectare. This last calculation could have also led to bonuses in the case of a fall in international reference prices for oilseed by fifteen percent below the reference prices.

The free import/export of oilseeds and oil in Spain, coupled with the no tariff barriers in the EU, created a complex situation for many local crushing industries and collectors. Losses were frequent in those taking long sunflower positions during the harvest due to fluctuations in international prices. Meanwhile, cereals continued to enjoy tariff protection and an intervention price in the EU.

Sixth Stage: From 2000 to 2005. The EU's total budget on agricultural spending fell substantially from 1992 to 1999. However, almost 50% of this budget was still being spent on agriculture in a declining economic sector, which did not create new jobs. Therefore, criticism has focused more and more on the fact that agriculture absorbs huge amounts of money, depriving other policies and tasks of the EU of their potential to create new jobs due to a lack of appropriate financial resources necessary for their development. Agenda 2000 seems therefore to be the Commission's attempt to define new, or, rather, additional, objectives of the CAP, by extending it to function as a rural development strategy. The 'Agenda 2000' reforms divided the CAP into two pillars: production support and rural development. Several rural development measures were introduced including diversification, setting up producer groups and support for young farmers. Agri-environment schemes became compulsory for every Member State.

In Spain, as in other EU member states, there was a progressive lowering of the sunflower planting area as per hectare aid was fixed as being the same for all crops as well as fallow. Fallow is an attractive cereal rotation in countries with periodic droughts. The intervention price for cereals was also lowered during this period. The sunflower area fall was inevitable in Spain despite the environmental fixed aid of 60€/Ha allowed by the EU to Spain for sunflowers. This aid, in many cases, was not implemented as there was no extra budget for it. Many Regional Governments in Spain were devoting all their rural development funds to other five year programs thus limiting their access to it.

In 1997, I reviewed what was then the draft of "Agenda 2000" (Alonso, 1997). Its optimistic estimate indicated that the reduction in Spain's sunflower sowing area could reach from 30 to 40%. The sunflower area planted in 2002 was 753,893 ha. i.e., a 32% reduction in the average area planted during the 1994-1998 period. The sunflower area fell further to 517,125 Ha in 2005 due to the EU policy and to the local drought conditions.

Seventh Stage: After 2005. On 26th June 2003, the EU farming ministers adopted a fundamental reform of the CAP, through the Council Regulation (EC) No 1782/2003, (Official Journal of the European Union, 2003a) based on "decoupling" subsidies from particular crops (though, as Spain did, the Member States could choose to maintain a limited amount of a specific subsidy). The new "single farm payment" is subject to 'cross-compliance' conditions relating to environmental, food safety and animal welfare standards. Many of these were already either good practice recommendations or separate legal requirements regulating farm activities. The aim was to make more money available for environment, quality, or animal welfare programmes.

The purpose of the single farm payment is to ensure income stability for farmers who are able to decide what they produce according to supply and demand. Thus, the EU has opted for less government influence and more of a market place drive for farmer's crop choice. These reforms came into force in 2004-2005. The Member States had the choice of applying for a transitional period delaying the reform in their country to 2007 and phasing the reforms up to 2012.

In 2004, after the expansion of the EU, the new EU member states had immediate access to price support measures (export refunds and intervention buying). However, direct payments will be phased over 10 years (2004-2013), starting at 25% of the rate paid to existing countries in 2004. The EU provided the 2004 entrants with access to a rural development fund for early retirement, environmental issues, poorer areas, technical assistance. The EU states agreed in 2002 that agricultural expenditure up to 2013 should not increase in real terms. This will require a cut in subsidies to the original states of around 5% to finance payments to the new members. With Romania and Bulgaria joining in 2007, the required cut will increase to 8%.

The sunflower area planted in Spain recovered in 2006 and 2007 from the 2005 lower yield. The 2007 recovery was moderated by the international increase in cereal prices at the end of 2006, when the oilseeds had relatively low prices. However, the price increase boost for vegetable oils in 2007 placed sunflowers as a very competitive alternative to cereals. This favourable situation is becoming better for sunflowers as the input prices for farming are also increasing very quickly, particularly fertilizers, and diesel. Thus, it bodes well for sunflower planting area recovery in Spain and the EU in the coming years.

Outlook on the international sunflower and oilseed situation.

During the second half of 2007, and up to the beginning of the new marketing year, prices in the oilseed complex have continued their pronounced rise, and vegetable oil prices have reached record high values (See Fig. 2).

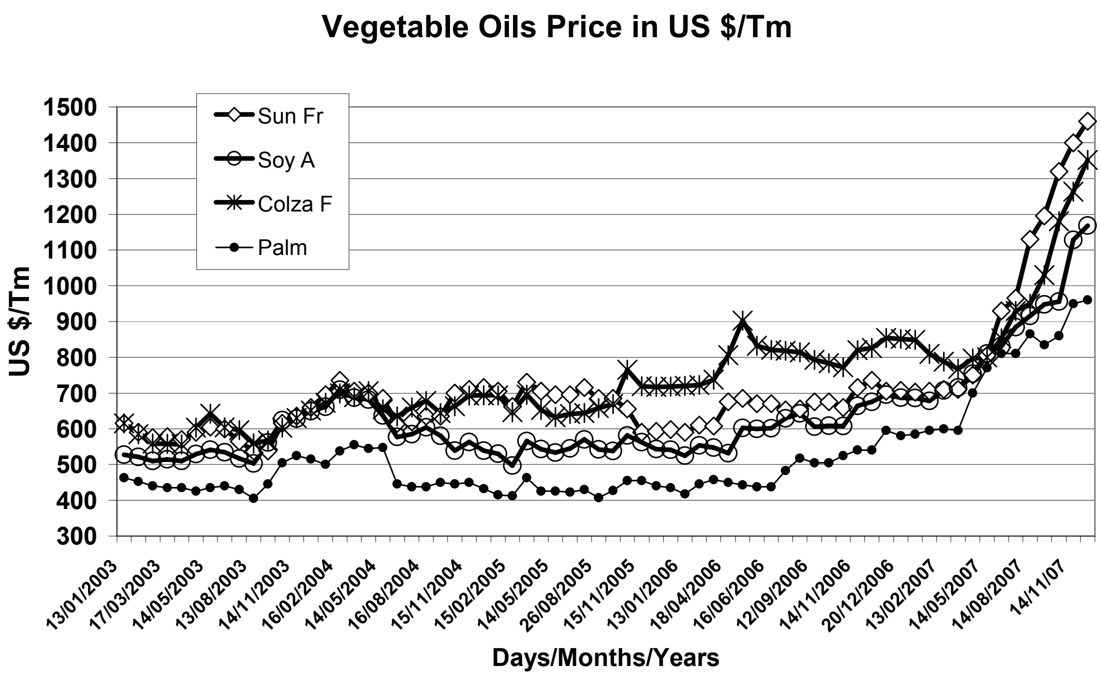

Fig. 2. Vegetable oil prices since 2003. Source: SOS. Elaborated from Oil World (2007)

According to the FAO outlook global market analysis (FAO, 2007), a key factor behind this price rise is that oil-crop markets have come under the direct influence of developments in the related feed grain market. The unprecedented rise in international maize prices has spilled over to the oilseeds and meal market, and, in particular, to the soybean complex.

World stocks and stock-to-use ratios of both oil and meals are falling to critical levels, because of a significant drop in oilseed production in 2007 (see Table 1), coinciding with a steady expansion in global demand for food, feed and energy use, thus calling for a steep reduction in inventories (See Table 2). The two main factors behind the drop in total oilseed output are: first, increased competition from grains, notably in the United States but also in China and CIS (Commonwealth of Independent States) countries, which has interrupted the steady expansion in the world oilseed area. Second, unfavourable weather conditions which have affected oilseed production in several key growing areas or countries, including the European Union, CIS, Australia, Canada, China, Turkey and the United States. The decline in production of soybeans and sunflowers has been responsible for the drop in oilseed production in 2007. Sunflower production in 2007/08 was 8.2% lower than in 2006/07. Sunflower production went down by 26.3% in the EU, 20.7% in Ukraine and 16.2% in Russia (see Table 3).

The present forecasts for global supply/demand in 2008 point towards a continued firmness in international prices for oilseeds and oilseed products. Furthermore, the growing biodiesel requirements have led to an increased demand for vegetable oils. This trend, combined with a constant rise in the consumption of vegetable oil as a food, has led to a gradual tightening in global supplies, thus explaining the recent rise in vegetable oil prices, which may continue during 2008.

Table 1. World production of major oilseeds

	2005/06	2006/07 Prel.	2007/08 Proj
	Million Tm		
Soybeans	220.59	237.27	219.85
Cottonseed	43.95	45.82	45.37
Rapeseed	48.74	46.80	47.62
Groundnuts (unshelled)	33.04	32.41	33.11
Sunflower	30.02	30.15	27.67
Palm kernels	9.98	10.27	11.11
Copra	5.50	5.28	5.37
Total	**391.82**	**408.00**	**390.10**

Source: USDA Marc 2008 (USDA;2008)

Note: The split years bring together northern hemisphere annual crops harvested in the latter part of the first year shown, with southern hemisphere annual crops harvested in the early part of the second year shown, For tree crops, which are produced throughout the year, calendar year production for the second year shown is used

In USA, the USDA January 2008 report (USDA, 2008) showed an unexpected sharp decline in corn ending supplies. In order to compensate for the corn shortage, 2.4 million acres of corn would be needed in the new plantings. On the other hand, soybean needs to gain between 8 and 10 million acres in 2008 to prevent ending supplies from dropping to dangerously low levels. But it was not just the USDA reports that gave markets a lift to new highs. There was also a continuous flow of fund money into all commodities, and this will continue during 2008. Poor weather conditions in South America's soybean growing areas, such as the warm, dry summer in Argentina, also had an effect on oilseed prices during February and March 2008.

Table 2. World oilseeds and product markets at a glance

	2005/06	2006/07 *estim.*	2007/08 *f'cast*
	Million Tm		
Total oilseeds			
Production	404	417	403
Vegetable Oils and Animal Fats			
Production	149	151	154
Supply (Production + Opening Stocks)	168	172	174
Utilization[1]	146	152	157
Trade[2]	72	76	79
Stock-to-utilization ratio (%)	14	13	11
Oil meals and cakes[3]			
Production	101	106	102
Supply (Production + Opening Stocks)	113	121	119
Utilization *	98	102	108
Trade *	55	59	62
Stock-to-utilization ratio (%)	15	17	11

Source: (FAO, 2007)

[1]Residual of the balance.

[2]Trade data refer to exports based on a common October/September marketing season.

[3]All meal figures are expressed in protein equivalent; meals include all meals and cakes derived from oilcrops as well as fish meal and other meals from animal origin.

Table 3. Sunflower seed; World supply and disappearance in 1000 t

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08F
Seed Production						
Argentina	3,700	3,240	3,600	3,800	3,500	4,500
Other Europe	749	876	867	830	850	490
European Union 27	5,183	6,155	6,463	5,958	6,483	4,772
Peoples' Republic of China	1,946	1,743	1,552	1,927	1,900	1,800
Russian Federation	3,685	4,850	4,800	6,450	6,750	5,650
Ukraine	3,270	4,252	3,050	4,700	5,300	4,200
United States	1,112	1,209	930	1,823	972	1,310
India	1,625	1,700	1,224	1,550	1,280	1,650
Turkey	820	600	650	750	850	700
Other	1,897	2,266	2,270	2,290	2,294	2,599
TOTAL	**23,987**	**26,891**	**25,406**	**30,078**	**30,179**	**27,671**
Seed Import						
Turkey	229	660	529	345	408	380
European Union 27	705	1,066	413	627	572	400
Other	451	442	192	316	663	294
TOTAL	**1,385**	**2,168**	**1,134**	**1,288**	**1,643**	**1,074**
Seed Export						
Argentina	213	46	107	45	70	200
United States	166	170	141	178	181	166
Russia/Ukraine	517	1239	57	616	484	365
Other	571	852	918	783	1,219	752
TOTAL	**1,467**	**2,307**	**1,223**	**1,622**	**1,954**	**1,483**
Area Harvest (1000 Ha)	**20,202**	**23,287**	**21,369**	**23,117**	**23,841**	**22,790**
Yield Tm/Ha	**1.19**	**1.15**	**1.19**	**1.30**	**1.27**	**1.21**

The US has passed a new energy bill adding a more bullish sentiment to the corn and vegetable oil markets. The new energy bill also raises the corn-based ethanol mandate.

Reduced growth in global oils/fats supplies and an unprecedented fall in meal supplies, because of a significant drop in oilseeds production in 2007, are expected to coincide with a steady expansion in global demand for food, feed and energy use, thus calling for a severe reduction in inventories. World stocks and stock-to-use ratios of both oil and meals have fallen to critical levels.

The biofuel impact

Another favourable situation for oilseeds in general, was the impact when the European Commission brought forward the legislative proposals that were adopted in 2003 in the form of the bio fuels directive (Directive 2003/30/EC of the European Parliament and of the council of 8 May 2003) (Official Journal of the European Union, 2003b) and article 16 of the energy taxation directive of the Council Directive 2003/96/EC of 27 October 2003, (Official Journal of the European Union, 2003c).

The biofuels directive expressed the clear intention of *"promoting the use of biofuels… in each Member State, with a view to contributing to objectives such as meeting climate change commitments, environmentally friendly security of supply and promoting renewable energy sources"*. It included an interim target for 2005 and a target for 2010 of a 2% and 5.75%, respectively, share of the market for petrol and diesel. These indicative targets, once adopted, were not mandatory, but they constituted a moral commitment on behalf of Member States.

During the 2007 Spring EU Council, Europe's Heads of State agreed on the 3 targets for 2020: A binding target of 20% renewable energy (RES) by 2020 and a separate binding target of 10% for biofuels; A 20% energy efficiency target (EE) and 30% greenhouse gas (GHG) reduction target. These three targets have laid the foundations for renewable energy sources to become a major pillar of the EU future energy supply.

Table 4. European Biodiesel production capacity growth 2003-2007.

Country	**Production Capacity in 1000 t**				
	2003 EU15	**2004 EU 15**	**2005 EU 15**	**2006 EU 25**	**2007 EU 27**
Germany	1,025	1,088	1,903	2,681	4,361
Italy	420	419	827	857	1,366
France	500	502	532	775	780
UK	5	15	129	445	657
Spain		70	100	224	508
Greece			35	75	440
Belgium			55	85	335
Austria	50	100	125	134	326
Poland			100	150	250
Portugal			6	146	246
Sweden	8	8	12	52	212
Czech Republic			188	203	203
The Netherlands			0	0	115
Slovakia			89	89	99
Denmark	41	44	81	81	90
Romania					81
Bulgaria					65
Lithuania			10	10	42
Estonia			10	20	35
Hungary			0	12	21
Latvia			5	8	20
Slovenia			17	17	17
Malta			2	3	8
Ireland			0	0	6
Cyprus			2	2	6
Total EU	**2,049**	**2,246**	**4,228**	**6,069**	**10,289**

Source EBB, Situation at 01/07/2007 (EBB,2007)

The new 10% minimum target in 2020 (The impact of a minimum 10% obligation for biofuel use in the EU-27 in 2020 on agricultural markets) has also been seen to be relative to the existing legislation which put the target at 5.75% in 2010. The current directive may fail to produce the incorporation of 5.75% in 2010 due to the market and technologies having little time to react.

Since 2003, biodiesel has proved to be a significant demand shifter in the overall vegetable oil industry. The confluence of environmental concerns, high energy prices and government incentives has led to a significant increase in the biodiesel production capacity in the EU and worldwide. In 2007, there were 185 fully operational biodiesel plants, in Europe and another 58 plants were under construction. Thus, the EU biodiesel production capacity reached 10.2 million tonnes (see Table 4). In Spain in 2007 there were 23 fully operational biodiesel plants and 26 plants under construction, with a joint production capacity of 921,000 and 2,961,200 Tm/year, respectively. Furthermore, there were another 24 projects for a joint production capacity of 2,692,000 Tm/year (See Table 5).

This huge EU biodiesel production capacity risks remaining idle and the production stagnating or declining, the same as during the 2nd half of 2007. The record high vegetable oil prices at the end of 2007 and beginning of 2008 is making many operations unviable. To make things worse, the US Federal subsidies since 2004 (up to \$264/m^3 i.e., \$ USA 300/Tm ~ €200/tm) biodiesel blends tend towards increasing biodiesel imports in the EU. The US “B99” blend (a blend of a small amount of mineral diesel with biodiesel) exported to the EU, benefits the blender’s credit as this is not restricted to biodiesel produced and consumed on the US territory. Thus, “B99” exports to the EU were boosted in 2007 as in most cases B99 blends are sold in the European market as “pure biodiesel” and at a substantial discount (over €120-180/tonne), in some cases at a lower price than that of the raw materials purchased by the EU industry for producing biodiesel.

Table 5. Biodiesel number of plants in Spain in 2007 and their production capacity in 1000 Tm

	Operational		In Construction		In Project	
Province	**Number**	**Capacity**	**Number**	**Capacity**	**Number**	**Capacity**
A Coruña			1	200	1	103
Alava	1	30				
Alicante	1	20			1	200
Almeria	1	6	1	6		
Asturias	1	4			2	270
Badajoz			2	360		
Baleares	1	16				
Barcelona	1	31				
Burgos	1	8	1	49		
Cadiz			1	200	3	330
Cantabria			1	155		
Ceuta					1	250
Ciudad Real	1	32	1	100	1	110
Cordoba			2	7		
Cuenca	2	122	1	50		
Girona	1	5				
Granada					1	80
Huelva			2	400		
Huesca	1	50	3	102		
Jaen	1	100	1	200		
La Rioja			1	250		
Las Palmas			1			
León					3	310
Lleida					1	110
Lugo					1	20
Madrid	1		1	45		
Murcia					1	140
Navarra	1	70			2	124
Pontevedra			1	300		
Sevilla	2	86	1	60	1	300
Tarragona	1	50			2	80
Teruel					2	115
Toledo	3	156				
Valencia	1	110				
Valladolid			1	70		
Vizcaya			2	400	1	150
Zamora	1	20	1	7		
Total Spain	**23**	**921**	**26**	**2,961**	**24**	**2,692**

Source (Biodieselspain,2007): Situation 31/12/2007

The new US biodiesel mandate could eventually require as much as one-third of total US vegetable oil production, assuming no vegetable oil imports to the US. Eventually, all the biodiesel produced in the States may remain there, leaving more room for the EU biodiesel factories to produce EU biodesel needs.

The Latin American biofuel industry is headed by Brazil's mature ethanol industry. Brazil will also have included mandatory B2 and B5 by 2008 and 2013, respectively, including tax breaks. Argentina also has a B5 project for 2010.

In Asia, in several southeastern countries, indicative B2 or B5 targets are gradually moving to mandatory targets. Malaysia has a B5 mandatory by 2010; Indonesia B5 by 2025; Thailand B10 by 2012 and Philippines B2 by 2009. China has no concrete biodiesel policy but is targeting 15% use of biofuels by 2020; South Korea has a mandatory B5 blending implemented in 2006 and India is preparing legislation on biodiesel to support cultivation and commercial activities of *Jatropha*-based biodiesel.

According to Rabobank reports on biodiesel (Hansen, 2006; Tan, 2007), the biodiesel production could have a considerable impact on global vegetable oil demand in 2010. Considering the 2005 vegetable oil production of 96 million tonnes, the vegetable oil demand for biodiesel production and the extra food demand may require another 18 million tonnes and 13 million tonnes, respectively, in 2010.

As was recently affirmed by Miriann Fischer Boel, the European Commissioner responsible for Agriculture and Rural development in a speech during the 2008 World Biofuels Market Congress in Brussels (Fischer Boel, 2008) the EU policy on this subject, despite being controversial, has a solid justification and everyone in the sector can be confident that no policy u-turns lie ahead. Biofuels must be a part of the future of sustainable energy production in the EU for two reasons: the fight against climate change, where biofuels are an important weapon, and energy security against future supply problems. In this speech, Ms. Fischer Boel, gave the answer to various objections raised recently against biofuels and in these answers we can find the clue to the next direction of EU policy. The first objection is that using first-generation biofuels in many cases supposedly does not cut down greenhouse gas emissions. It is true that some biofuels do not show clear benefits, but biodiesel made from European-grown rapeseed makes a greenhouse gas saving of 44 per cent compared to fossil fuels. The typical figure for ethanol made from sugar beet is 48 per cent. Under the rules proposed by the Commission, a given biofuel would count towards a Member State's target only if it made a greenhouse gas saving of at least 35 per cent compared to fossil fuels, which is a very healthy difference. And the standard applies both to domestic production and to imports. When calculating this saving, the EU proposes to take into account the value of by-products such as animal feed. The second objection to the 10 per cent target is that it will mean destructive land conversion. The Commission recognises these dangers and has proposed the following: no biofuel would count towards a Member State's usage target if it does not meet strict sustainability criteria. For example, this would exclude biofuel coming from either land with a high biodiversity value or land with high carbon stocks.

As regards the basic argument, that more biofuel means painfully high prices, and, therefore, less food for the poor, Ms Fischer Boel says, that it is not fair to make biofuel a scapegoat for the extreme market movements of recent times. According to the OECD, cereal use for ethanol in Europe, North America and Asia increased by 17 million tonnes in 2006. But, in the same year, the combined cereals supply shortage in these countries was 60 million tonnes – nearly four times as much. Clearly, this was not just a “biofuel story”.

In a 2006 study on agricultural market growth impacts on the production of biofuel, two scenarios were considered. In one of them, referred to as “High oil price scenario” with sustained crude oil prices at US $ 60/barrel, the summary conclusion was:

With sustained higher crude oil prices, there are two main forces at play that affect world markets for agricultural commodities. First, due to higher agricultural production costs that lead to lower quantities of production, commodity prices increase. At the same time, higher oil prices – and higher oil-based fuel pump prices – increase incentives to produce more biofuels (even though partially dampened by higher feedstock prices), which creates an additional demand for feedstock products. Again, this causes prices of agricultural commodities to increase.

Whatever the reasons behind the current very high vegetable oil prices, it is clear that these are limiting the potential use of biodiesel for economic reasons. On the other hand, the present crude oil prices above US $100/barrel, and the equally high values for protein meals are improving their profitability, in particular for integrated industrial facilities that can produce either vegetable oils for food or for biodiesel.

With the large demand for vegetable oils for biodiesel production and keeping in mind the mandatory uses of biofuels in many countries, we can expect that this industry will serve to prevent the oilseed market prices falling below the threshold prices at which the production cost of biodiesel is equal to the domestic tax-free diesel prices.

Sunflower oil quality traits and food and non-food market trends

High oleic sunflowers have been developed from the sunflower variety Pervenets obtained by Soldatov in 1976 (Soldatov, 1976). High oleic sunflower oil is specialty oil with high oleic acid (monounsaturated) levels. It must be at least 77% monounsaturated to meet product descriptions but often a level of above 80% is required by the industry.

Most of the world's vegetable oils and fats show a mixed fatty acid composition and their physical-chemical properties, as well as their physiological-medical benefits, are fixed in the fatty acid composition (Table 6). In triglycerides, the hydroxyl groups of a glycerol molecule are chemically bound to different fatty acids, varying in chain length and/or in number and position of C-C double-bonds, which cause bends in the C-C chain. In high-oleic oils, such as high-oleic sunflower oil, all properties are strongly dominated by its high content of oleic acid (C18:1) and low polyunsaturated fatty acid (PUFA).

Table 6. Differences in physicochemical characteristics between the two types of sunflower oil

Characteristic	**High oleic sunflower**	**Conventional Sunflower**
Fluidity	Liquid +	Liquid +
Resistance to heat	Good +	Average -
Resistance to oxidation	Good +	Average -
Effect on Cholesterol; LDL (Bad)	Reduces +	Reduces +
Effect on Cholesterol; HDL (Good)	No Change +	Reduces -

LDL is atherogenic; HDL is antiatherogenic

This combination of fatty acid content offers many advantages:

- For nutritional purposes: no *trans* fatty acids; low saturated fatty acid content; reduction in "bad cholesterol"; GMO free.
- For all uses: high oxidative stability, reduced rancidity; extended shelf life
- In processing: It is liquid ant thus easy to transport and to store.

High oleic sunflower oil offers advantages not only for the food industry but also for the biodiesel industry. The European Standard requirements set out in regulation EN 14214 (European Standard prEN 14214, 2002) defined 25 parameters for fatty acid methyl esters for bio-diesel. Among them, the iodine value is set at 120. While conventional sunflower oil has an iodine value of about 137, high oleic sunflower has about 87. This allows to reduce the iodine values in mixtures with other vegetable oils such as soybean, whose iodine value is around 133.

The development of high oleic sunflowers was limited in the US during the 1980's and 1990's as a consequence of two patents (Fick, 1984; Fick, 1985), which ended in 2005. In Europe and South America, there was only a limited interest in some industries, which triggered a special production of this type of sunflower in Spain, France, Italy and Argentina. Thus, farmers received a premium price of between 10 and 30 percent depending on market demand with wave fluctuations, and high oleic sunflower oil had a from 20 to 40 percent higher price than conventional sunflower oil.

The NuSun or mid-range oleic sunflower, whose oleic acid levels vary from 50 to 70 percent, was introduced in 1999 into the U.S. as a response to U.S. food processors' desire for a vegetable oil low in saturated fatty acids and suitable for fast-food frying applications without hydrogenation. In 1999, the U.S Food and Drug Administration (FDA) proposed regulations that changed the Nutrition Facts label to allow consumers to identify the amount of *trans* fat in a food by listing the grams of *trans* fat. Later, the U.S.A. FDA published a final rule that amended its regulations on food labeling requiring *trans* fatty acids to be declared on the nutrition label of conventional foods and dietary supplements (68FR41434). This was effective January 1, 2006. The NuSun sunflower planting area grew very quickly in the US, and by 2004 it was already the dominant oil sunflower grown in the States, and in 2007 it reached about 90% of the oil type sunflower grown in this country. The high oleic type was grown in about 6%. Thus, high and mid oleic sunflowers constitute about 96% of US oilseed sunflowers (Kleingartner, 2004; Kleingartner, personal communication).

In the EU, the *trans* fatty acid concern is also causing an impact on the food industry. In 2002, the Health Council of the Netherlands recommended that *trans* fat should be limited to 1% of calories. In a report on dietary reference intakes, the Health Council of the Netherlands recommended, among other things, that *trans* fat should be limited to one percent of calories. In 2003, the Danish government announced that, as from January 2004, the amount of *trans* fat from partially hydrogenated oil would be limited to 2% of the total amount of fat or oil in the food. Despite the initiatives being taken for an EU regulation on *trans* fats, different industries have positioned their products in line with the concept of "free of *trans* fatty acid". Some industries have chosen the use of natural saturated oils, such as palm oil, or total hydrogenation of unsaturated vegetable oils, which does not cause *trans* fatty acids, aiming to separate the concepts: "trans fatty acids" and "hydrogenation" (FEDIOL, 2006). In some cases, high oleic sunflowers has been chosen either pure or in blends with other vegetable oils. i.e., in 2003, SOS Cuetara, in Spain changed the formulation of fats in their cookies to reduce *trans* fatty acid content to below 0.5% of the oil fraction. They developed a special spread blend branded as Oleosan containing a large proportion of high oleic sunflower oil. This was achieved by blending high oleic sunflower oil with other vegetable oils. The Spanish fish canning industry also announces in TV the use of "high oleic" oils as premium quality.

As a consequence of the continuous demand increase of high oleic oils, the high oleic area planted in some European countries has grown rapidly during the last four years, while in others their presence is only testimonial. In 2007, the West European countries grew high oleic sunflowers in about 26% of the 1,349,400 sunflower-planted hectares. Two countries, France and Spain, were responsible for most of this (Fig. 3). In Eastern Europe, the high oleic area represents less than 3% of the sunflower area planted and only Hungary grew a significant 17% of its sunflower area with high oleic varieties.

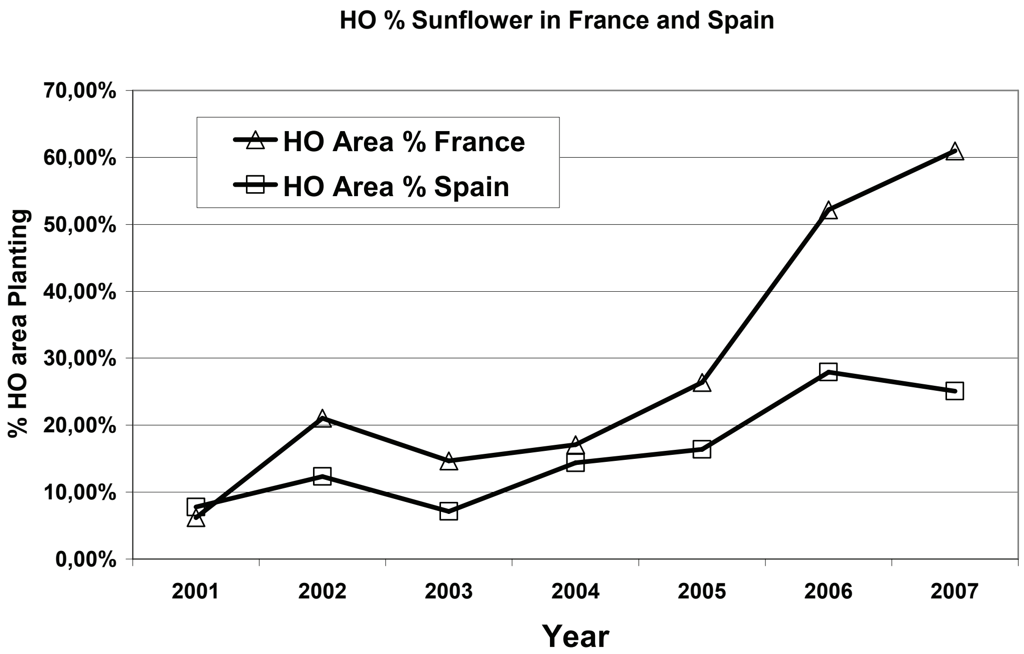

Fig. 3. High Oleic sunflower area planting growth in Spain and France in percentage of area planted.

The cosmetics and lubricant industries may also increase their use of high oleic sunflowers in the future. The EU uses more than 5 million tons per year of lubricants. This sector is dominated by mineral oils and only 2% is of vegetal origin. Besides its technical aspects as driving forces, the regulatory framework of the EU is also increasingly favouring the environment- friendly, readily biodegradable oil. Due to its high oxidative stability, high oleic sunflower oil is favourably compared to other natural oils as base oils or additives in lubricants. Compared to mineral oil-based lubricants, bio-lubricants still face disadvantages in product costs. Great perspectives are in store for very high oleic sunflower oil as it performs like synthetic esters (e.g. TMP-trioleates), but is somewhat lower in price (Vannozzi, 2006).

The continuous growth of high oleic sunflowers may be limited by two factors: the present sunflower oil prices and the lack of sunflower hybrids with the newest trait demands, such as herbicide tolerance, and/or different disease resistances.

Regarding the present very high sunflower oil prices, in order to make a contract with farmers and to preserve the identity of the seed in the whole factory supply chain, a premium has to be paid both to farmers and collectors. The amount of this premium can be either a fixed amount or a percentage of the commodity sunflower seed price. A fixed premium of 24 €/Tm of seed considered to be highly attractive by farmers two years ago, is not very encouraging in the present market situation.

The recent development in Europe, and worldwide, of herbicide-tolerant (HT) sunflowers, which allow the use of broad spectrum post-emergence herbicides is also segmenting the market very fast. The development of performing HT and high oleic sunflower hybrids is also limiting the expansion of high oleic sunflowers.

In a similar way, the expansion of new races of well known diseases, such as Broomrape race F, caused by *Orobanche cumana*, also limits the high oleic sunflower potential area until performing high oleic and *Orobanche* resistant sunflower hybrids are developed.

Herbicide tolerant sunflowers: The new market development

Recently, two herbicide-tolerant sunflower types have been introduced into the market for weed control with post-emergence specific herbicide treatments. These sunflower hybrids provide growers with a post-emergent control option, without killing the crop. Broadleaf weeds, both annual and perennial, are the leading weed spectrums affecting sunflower yields but grasses and volunteer cereals may also be important. In the past, the lack of choice in weed control forced many sunflower farmers to rely on more expensive, less effective pre-emergent options that often did little to eliminate weed competition losses in their sunflower fields. The recent ban in the EU of the pre-sowing herbicide Trifluralin is making the use of herbicide-tolerant sunflowers and post-emergence herbicide weed control more attractive. Thus, both systems are spreading very quickly.

Clearfield Sunflower production system

The CLEARFIELD Production System for sunflowers is a unique production system comprised of non-GMO herbicide-tolerant sunflower hybrids and a herbicide of the Imidazolinone chemical family. At present, the herbicide used in sunflowers is imazamox, which is a member of the herbicide family of AHAS or ALS inhibitors. Some members of this family control susceptible weeds by inhibiting the acetohydroxyacid synthase (AHAS) enzyme also called acetolactate synthase (ALS). Several variant AHAS genes conferring imidazolinone tolerance were discovered in plants through mutagenesis and selection, and were used to create imidazolinone-tolerant maize (*Zea mays* L.), wheat (*Triticum aestivum* L.), rice (*Oryza sativa* L.), oilseed rape (*Brassica napus* L.), and sunflower (*Helianthus annuus* L.). These crops were developed using conventional breeding methods and commercialized as CLEARFIELD® crops from 1992 to the present. While the Clearfield system is available for several different field crops, including corn, wheat, rice, and canola, the “IMI” chemical formulations are not interchangeable. Clearfield sunflower is not cross-tolerant to the sulfonylurea (SU) family of herbicides.

In 1996, a wild sunflower population of *Helianthus annuus*, highly tolerant to the herbicide imazethapyr, was found by Al-Khatib in a soybean field in Kansas, U.S.A (Lilleboe, 1997). The Agricultural Research Service plant geneticist Jerry Miller learned of Al-Khatib’s wild sunflower collection from John Nalawaja, a colleague at North Dakota State University-Fargo, and requested seed specimens. Their goal was to transfer resistance to cultivated sunflower. This prospect was very exciting because the list of broadleaf weeds and grasses controlled by imazethapyr herbicide and other herbicides of the imidazolinone chemical family (IMI) was extensive. Also, for sunflower to spread into no-till acreage, planting herbicide tolerant hybrids was the only alternative for postemergence weed control. In 2002, Miller and colleagues released two germplasm lines (USDA lines HA 425 and RHA 426) of imazamox (the new BASF IMI herbicide) -tolerant sunflower for commercial seed companies to use in developing their own hybrids (Miller and Al-Khatib, 2002). In 1997, I collected from the Kansas farm owned by Doug French the same wild sunflower population collected earlier by Al-Khatib and, back in Spain, Koipesol’s technical team proved that this herbicide tolerance offered an excellent opportunity for the chemical control of the parasitic weed *Orobanche cumana* Wallr. (Alonso et al., 1998). *Orobanche* chemical control is not race specific and may serve both to prevent the parasitic plant to spread to new areas and to control it in already infected areas.

Clearfield sunflowers, which are registered for use only with imazamox herbicide (Beyond™ in U.S.A., Pulsar® 40 in Europe) manufactured by BASF Corporation represented the first real post-emergence option for controlling key problem weeds. Imazamox herbicide provides contact and residual activity on a number of grasses and broadleaf weeds as well, including nightshade, pigweed, foxtail species, wild oats, volunteer cereals, puncturevine, non-Clearfield wild or volunteer sunflower and broomrape.

The Clearfield Production System for sunflowers started in 2003, in the U.S., when the Environmental Protection Agency registered Beyond™ herbicide. In Europe it has been introduced into different countries since 2002 and Syngenta Seeds was the first seed company marketing Clearfield sunflower hybrids.

Express Sunflowers production system

Express Sunflowers was introduced by Pioneer Hi-Bred International, Inc., and DuPont Crop Protection in 2006 in some European countries, and in 2007 in the U.S. This system facilitates a broad spectrum weed control option for sunflower growers: Sunflower hybrids with the DuPont™ ExpressSun™ trait which provides tolerance to Express® herbicide. This herbicide is a sulfonylurea. Sulfonylureas are a powerful family of herbicides discovered by DuPont in 1975 and first commercialized for wheat and barley crops in 1982. Sulfonylureas comprise a family of compounds which kill broadleaf plants by blocking the plant enzyme acetolactate synthase (ALS), an enzyme important to the plant for the synthesis of some amino acids (leucine, isoleucine and valine)

The Express Sunflowers production system only offers broad leaf postemergence weed control while the Clearfield sunflowers production system offers postemergence control of many weeds such as; broad leaf, grasses and volunteer cereals as well as broomrape control.

The expansion of herbicide tolerant sunflower and future development

Herbicide-tolerant (HT) sunflowers gain a market share very quickly once the HT traits are incorporated into performing hybrids. Often their expansion has been limited by the lack of planting seed. In some cases the sunflower area planted with HT hybrids is above 25% in only three or four years after the introduction (Table 7). This tendency is going to continue as more performing hybrids will be available and it will not be long before most of the sunflower grown will be HT.

It is more difficult to forecast which of the two methods will dominate in the market and most probably both will be present. Currently, in some countries the Clearfield method represents nearly 100% of the HT planted area. This is the case of Turkey, Spain and Serbia. In other cases, Clearfield and Express methods are both spreading but keeping to about 50% each of the total HT market in the country. Finally, in some cases, the Express method represents 75% of the HT market, for instance in Bulgaria. These differences may be caused by the different dates of introduction of each method into the different countries. Thus, we shall still have to wait a few years before we see the real share of each in the market. However, it is reasonable to think that in the areas where broomrape (*Orobanche cumana*) is a problem, the Clearfield solution will probably dominate. Also, the Clearfield method could be a better option in those cases where sunflower is rotated with cereals in areas where cereals are repeated one to three years before planting sunflower, so that the grasses could create a weed problem.

Table 7. Percentage of sunflower area planted with herbicide-tolerant production systems (Clearfield and Express) in Argentina and Europe

Argentina	Year of introduction	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8
Bs. As. (SO, SE y Oeste)	2002/3	2%	3%	9%	15%	27%	25%
S. Córdoba	2002/4	1%	2%	7%	21%	14%	21%
E. La Pampa	2002/5	1%	7%	12%	23%	22%	13%

Europe	Year of introduction	2003	2004	2005	2006	2007	2008
Turkey	2003	3%	10%	23%	25%	21%	24%
Bulgaria	2006	0%	0%	0%	9%	18%	33%
Romania	2005	0%	0%	1%	4%	9%	16%
Hungary	2006	0%	0%	6%	7%	14%	17%
Serbia	2006	0%	0%	4%	15%	5%	11%
Slovakia	2006	0%	0%	0%	0%	0%	6%
Russia	2006	0%	0%	0%	0%	1%	1%
Ukraine	2006	0%	0%	0%	1%	2%	3%
Spain	2003	0%	0,2%	0,2%	0,2%	1%	2%
France	2009	0%	0%	0%	0%	0%	0%
Croatia	2009	0%	0%	0%	0%	0%	0%
Czech	2009	0%	0%	0%	0%	0%	0%
TOTAL EUROPE		0%	0%	1%	2%	3%	6%

Source. Syngenta Seeds Marketing department

Both methods offer a tremendous potential for weed control and thus favour sunflower yield, particularly for the spreading of sunflower into no-till acreage as well as in very early planting in Mediterranean countries.

In several sunflower planting date studies made in Cordoba, Spain, during the 1980's, by the CIDA research group it was shown that sunflower planted during the winter (December and January) yielded about 30% more than when planted in March.

For some years, the Andalusian government sunflower trial network RAEA (Red Andaluza de Experimentación Agraria) planted, in the same location, sunflower hybrids at the end of January and in March in three years, 1994, 1998 and 2000. A number of common hybrids, (i.e., 32, 13 and 12 hybrids) were used both in winter and spring planting trials in 1994, 1998 and 2000, respectively (RAEA, 1994, 1998, 2000). The average yield for the three years in the nine trials (Fig. 4) was 2,069 kg/ha for the winter planting date and 1,694 kg/ha for the spring planting date. i.e., 375 kg/ha average difference. While in some locations the difference was minimal (near the coast and in very low yielding areas) the difference reached a peak of 911 kg/ha in the central part of Andalusia. Thus, the potential increase of yield due to early planting seems to be related to the flowering escape of these plantings from the extremely hot days that often occur in early June.

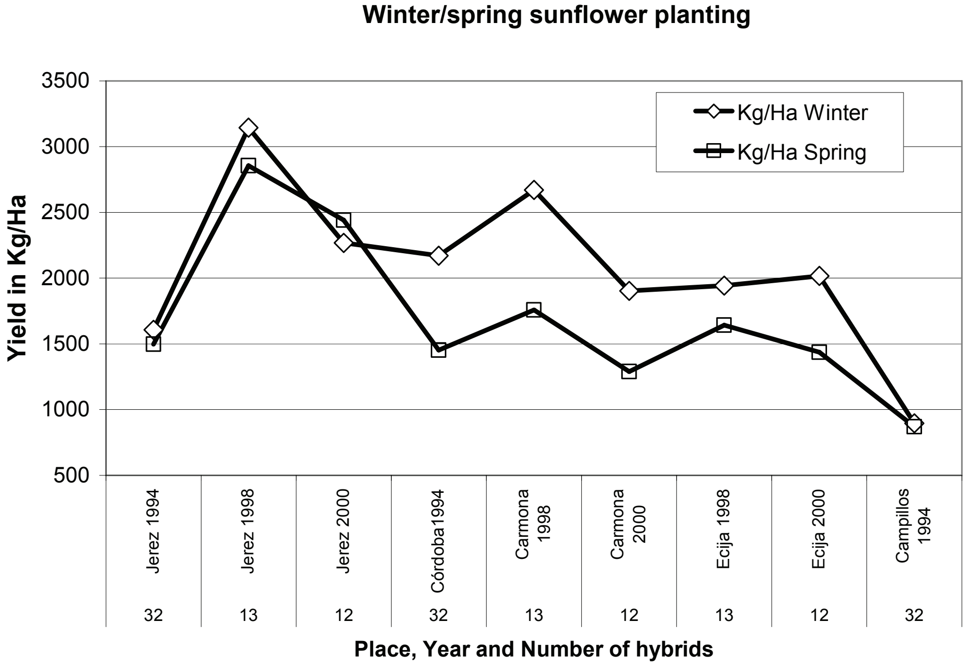

Fig. 4. Average sunflower yields of the same set (number) of sunflower hybrids planted in winter and spring in nine trials during three years. Source: RAEA (1994, 1998, 2000).

This potential yield increase was threatened by bird damage and herbicide damage from hormonal treatments in neighbouring cereal fields and weeds. The slow growth of sunflowers during January and February favoured the weed infection. There was no effective postemergence herbicide treatment for sunflowers at that time. The introduction of Clearfield sunflowers is allowing early planting in Andalusia with an effective control of *Orobanche* and weeds

CONCLUDING REMARKS

The sunflower planting area in Spain and other EU member states has been influenced in the past by political decisions and the CAP. This influence became less and less important through the successive CAP modifications. Yet, the recent political decisions at global levels on biodiesel production and use are again impacting on the prices of all oilseed oils.

The present high oilseed oil prices may be more related to production deficits than to biodiesel consumption. Sunflower oil use for biodiesel production is not significant. However, the present potential production capacity and the short term projected increase certainly may have an impact on preventing the oilseed oil prices from going down. Even if sunflower oil remains mostly as food oil in the near future, the biodiesel demand may impact on all oilseed oil prices including sunflower oil.

A high oilseed oil price is an incentive to increasing production, but cereal prices are also very high causing a competition for land among crops. High transport costs as a consequence of high crude oil prices and high fertilizer prices will also play a role in the farmer's choice of what crops to plant. Sunflowers may be favoured in this complex equation, as it is an easy-to- grow crop which uses deep soil fertilizers which every year escape from cereals. Additionally, the low test weight of sunflower seed will encourage more and more local crushing. i.e., few seed exports/imports.

The niche high oleic sunflower market may become dominant in the next years at least in Western Europe as has happened in the U.S with the NuSun high oleic sunflower oil may also be of interest to the growing bio-lubricant industry and for some blending in bio-diesel production.

In the present oilseed oil price situation, and with high input costs, it is reasonable to think that sunflower area may grow again in Western Europe as well as in several ex-URSS countries. Weed and *Orobanche* control with HT-tolerant sunflowers offers an excellent opportunity to increase sunflower yield in different countries and lead this regrowth. This is particularly important for early planting dates in hot Mediterranean countries giving North African countries an excellent chance to increase their sunflower production.

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