Sunflower in the global vegetable oil system

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Sunflower is the third most produced oilseed, fourth most produced vegetable oil and third most produced oilseed meal among global protein feed sources. Competition has been tough on the very dynamic vegetable oil and oilseed meal markets, respectively driven by palm oil and soya bean meal. However, the sunflower sector succeeded in maintaining its competitiveness through continuous innovation in genetics, cropping practices and research on added value, leading to higher market segmentation.

Global dynamics of production

The global evolution of the sunflower crop is quite remarkable, going from 10 million tons for 9,6 million hectares in 1975, to 52 million tons for 27 million hectares in 2018 (*Figure 1*). Its seed contains around 44% oil and 16% protein. It competes with both the vegetable oil market, led by palm oil, and vegetable protein rich products, driven by soya bean.

From the world market point of view, sunflower is the third most produced oilseed in the word, with 45 million tons per year from 2014 to 2018, representing 9% of the global oilseeds production – soya bean makes up 60% and rapeseed 12%. It ranks fourth on the vegetable oils market with 9,2% in 2017/18 (19 million tons per year).

It is also the third oilseed meal worldwide with 5,6% of the global production after soya bean meal (66%) and rapeseed meal (10%). From 1975 to 2019, global oilseeds production doubled every 20 years and sunflower maintained a relatively constant share in global oilseeds production.

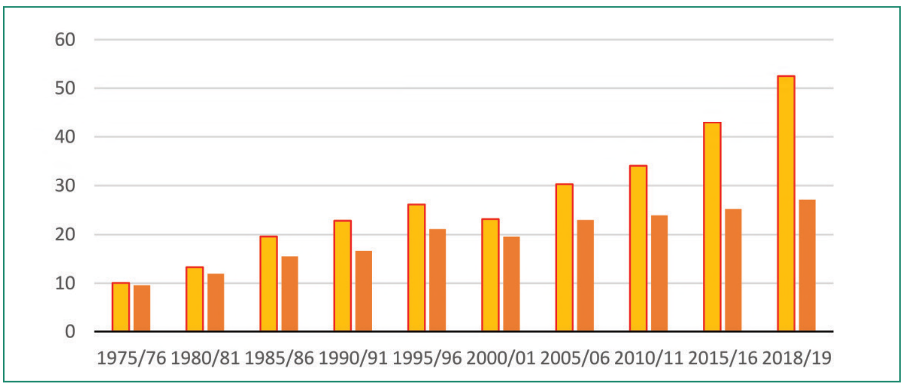
Sunflower is produced on a large scale in a limited number of countries, with two-thirds produced in Europe. From 2014 to 2018 the top ten countries – Ukraine, Russia, Argentina, China, Romania, Bulgaria, Turkey, Hungary, France and the United States (US) – represented 84% of the production and 76% of the acreage.

The observation of yield evolutions in the main producing countries is quite instructive about the capacities of the crop and its ability to keep pace with global competition between oil and protein sources.

Countries with flat or even decreasing yield curves (Spain and South Africa) maintained between 1 to 1,3t/ha of yield, while yield in France has been stagnating and decreasing since 2012. In contrast, countries in the Eastern part of Europe have seen yield increases. These tendencies reflect changes in the improvement of cultivars, including the increased use of modern hybrids and improvements in cropping practices, and should be analysed for each country.

In France, most sunflower crops (94%) are grown in non-irrigated areas and thus face climate risks in spring and summer. A study by Sarron *et al*., (2016)

Figure 1: Evolution of sunflower seed world production (million tons in yellow) and acreage (million hectares in orange) from 1976 to 2018. (Source: *Oil World, 2019*)



comparing the periods 1989 to 1994 and 2013 to 2015, based on the crop model SUNFLO and surveys of agricultural practices, concluded that the changes in the regional localisation of sunflower crops in France would not have affected sunflower yields significantly, but that shifts in agricultural practices towards less input intensive practices would have had a negative effect, when genetic progress would have raised yields by 0,48t/ha and climate evolution by 0,06t/ha.

With the observed yield increment being 0,19t/ha, the yield gap evolution between these two periods is evaluated at 0,32ha. Studies focussed on the assessment of genetic progress (Vear and Muller, 2011) also concluded that the progress in genetic potential has been maintained at around 1% per year.

Shifts in agricultural practices seem to be a key explanatory factor for the yield evolutions. Furthermore, sunflower is traditionally a crop of which genetic resistances play a major role in the control of diseases and parasitic weeds. The durability of yield progress is also largely dependent on breeding effort of qualitative traits.

Global dynamics of consumption

Oil production and consumption more than doubled within the last two decades. Total oil consumption increased by 209% between 2001 and 2019. The total growth of 105 million tons per year in oil consumption during that time may be attributed to population growth, the development of biodiesel production, as well as changes in dietary habits and other non-food uses.

Sunflower oil almost maintained its market share in this highly competitive market, reshaped by the development of palm oil. After a decrease from 13% in the 1990s, the market share of sunflower oil seems to have stabilised at 9 to 10% (*Figure 2*).

Trade and markets

Oilseeds and oilseeds products are highly traded commodities. If we compare the export/production ratio of the main products in the vegetable oil and protein markets, we see that sunflower is traded mainly after processing: 55% of the oil volumes was exported in 2018/19, 38% of the meal and only 5% of the harvested seeds.

The specificity of sunflower compared to other major oilseeds is that it is largely processed in the production countries. Market characteristics and national investment strategies probably explain part of this situation, as well as the fact that sunflower seed has a relatively low density due to its hull and occupies 15 to 20% larger volumes compared to other seeds.

Historically, sunflower oil has been considered a premium oil and its average prices were generally significantly higher than those of soya bean and rapeseed oil until 2016. The last three years have shown a lasting inversion of this tendency.

Some main importing countries, specifically India, are structural importers and are limited in their agricultural production capacities. Most of them operate in shifts in their procurements, optimising prices and origins, but sunflower oil is regularly imported for its nutritional aspects. India protects its internal production through import tariffs, notably for oilseeds, but in times when it succeeded in maintaining a satisfying level of self-sufficiency for cereals, its imports of edible oils and fats almost doubled within ten years (from 8,7 million tons in 2008/09 to 15,3 million tons in 2018/19).

The Organisation for Economic Co-operation Development and the Food and Agriculture Organization's (OECD-FAO) Agricultural Outlook for 2019 to 2028 considers that vegetable oil prices should recover due to the global expansion of food and oleochemical demands, coupled with the new domestic demand for biodiesel in selected countries.

Figure 2: Domestic consumption of sunflower seed oil by country in 1 000 million tons in 2019. (Source: IndexMundi, United States Department of Agriculture)

Sunflower meal

Countries producing sunflower are the main consumers of sunflower meal: 90% of meal production is concentrated in the European Union (EU), Ukraine, Russia, Argentina, Turkey, China and the US. The EU, despite its high production, is also the main importer. Belarus, India, Morocco and Israel are regular importers of significant quantities.

The normal non-dehulled meal offers 29% protein and a relatively high fibre content, limiting its use to the least concentrated animal feed rations, mostly for beef cattle, sows and rabbits. This situation explains the important price spreads observed regarding soya bean meal (44 to 49% protein), usually between US$150 and US$200/ton.

Peyronnet *et al*., (2012) showed that the price of interest of normal sunflower meal (29% protein) was 43% of soya bean meal, when improved semi-hulled sunflower meal (32% protein) and dehulled sunflower meal would reach 50 and 70% of the soya bean value, respectively.

The use of sunflower hulls for energy co-generation or biomaterials makes the process profitable, contributing to the expansion of dehulled meal. The classification of feed ingredients according to their energy (AMEn cockerels) and protein values show that high-protein sunflower meal is among the best feed protein sources.

Sunflower and biodiesel

Sunflower oil is not directly involved in biodiesel, but most economists conclude that the emergence of biofuels made energy prices a driver of long-run agricultural price levels and that instability in energy markets is transferred to food markets (Serra and Zilberman, 2013).

Considering the case of biodiesel alone, 44,8 million tons represent a significant part of 48% of the global oils and fats imports and 19% of the global oils and fats consumption, and the conclusion appears consistent: strong correlations are observed between diesel prices and vegetable oil prices.

This situation might change for sunflower. According to Sofiprotéol, France, 6% of the European sunflower oil consumption would have been used in biodiesel in 2018. Sunflower oil would represent around 2,5% of the European biodiesel production. This introduction of sunflower oil in biodiesel has probably been favoured by the recent trend of prices similar to that of soya bean oil and even lower than that of rapeseed oil, and by the favourable environmental life cycle assessment of sunflower oil.

Calculations in French conditions confirm this tendency and show that sunflower oil methyl esters present lower greenhouse gas emissions compared to other oil methyl esters (Bio2010 study, cited by Debaeke *et al*., 2017). These figures still offer margins of progress and make sunflower a good candidate for sustainable biodiesel standards. If this shift is confirmed, sunflower could be directly involved in the biodiesel market.

Oleic sunflower

High oleic sunflower contains four times more oleic acid than normal sunflower, with 84% oleic acid in oil. It has the highest oleic level compared to oleic safflower (78%), oleic rapeseed and canola (75 to 73%) and oleic soya bean (73%) (Tonin, 2018).

The non-GMO nature of oleic sunflower varieties gives them a competitive advantage over oleic canola or soya bean oils on the European market, even though this could be challenged by the controversies in Europe regarding the varieties obtained through mutagenesis – often for herbicide tolerant characters – and the positions of the Court of Justice of the European Union (July 25, 2018).

On the other hand, the development of the use of cheaper oil blends – with lower oleic content – by the industries reduces the competitive advantage conferred by the high oleic content of sunflower oleic oils. For the time being, the oleic sunflower seeds may be considered a commodity in France and still a niche market in most other countries, and the still low rate of oleic sunflower in these countries reflects a high potential of development.

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The main uncertainty is the evolution of the oleic market for food industries and catering outside Europe and North America, where food safety and nutritional properties correspond to a real and growing demand from consumers.

Future perspectives and challenges

The future of sunflower must be considered in a much wider system than only production and markets. The global agricultural and food system will be largely influenced by the rapidity and intensity of climate change (Pilorgé and Muel, 2016).

Many studies have been conducted on the importance of the protein challenge, either seen as a quantitative challenge to 'feed the world' or as room for manoeuvre – a key factor to limit the impact of food consumption on the environment by diminishing the consumption of animal protein to the benefit of vegetal proteins, demanding much fewer resources.

The figures emerging from the calculations in terms of supplementary agricultural land availability are generally impressive. The answers for proper adaptations will involve both progress in animal nutrition and a larger use of vegetal proteins in human regimes, notably in the countries where animal proteins are dominant and even overconsumed.

Sunflower has the double advantage of already being used for food products and being non-GMO. If the non-GMO nature is of limited interest for oils, it is a key characteristic for the use of proteins for food. There is no doubt regarding the interest of developing added value from the protein fraction, which seems to be a real opportunity for sunflower. Knowledge and technological developments will be needed.

The valorisation of the oil fraction has been challenged for 20 years by the rapid development of palm in Indonesia and Malaysia, which puts pressure on vegetable oil prices since the growth of palm oil volumes was much faster than the evolution of edible oils demand.

Nevertheless, vegetable oils are highly valuable products for industry, able to substitute petroleum in chemistry with noticeable advantages regarding sustainability as renewable resources and biodegradable products. From 2011 to 2019, biodiesel production (based on non-recycled oils) absorbed the equivalent of 71% of the increase in palm oil production.

In the coming years, the growth in palm oil production might be slower than initially expected, due to the necessity to renew old plantations. The replantation dynamic will be influenced by the market itself and notably by incentive policies in Indonesia and Malaysia, and the development of specific demands on sustainability in the EU. According to Sofiprotéol, a slow replantation scenario would lead to the production of 79 million tons of palm oil in 2030, compared to 59 million tons in 2018 and 70 million tons in 2020, and a fast replantation scenario to 90 million tons in 2030, with a phase of stagnation, if not decline, between 2020 and 2025, followed by recovery.

The growth of palm oil production would range between 20 and 30 million tons until 2030. In the same period to 2030 the trend for edible oil consumption, due to population growth and diet evolutions, would be about 2% per year, or 25 to 30 million tons depending on scenarios. These figures tend to divert out of an 'ocean of oil' scenario, even if soya bean oil must also be considered a co-product of soya bean meal.

Non-food uses for oleochemistry could also influence vegetable oil consumption. We know that the development of oleochemistry is highly dependent on competition surrounding petroleum prices, as well as on

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regulations and policies. Innovation will probably meet this developing demand.

A communication by Isso Noda of Danimer Scientific (US) at the Canola Innovation Day in December 2019, Canada, reported a new process for making bioplastics from vegetable oils, based on bacterial fermentation, possibly competing with classical petroleum plastics. This kind of development might boost the potential added value in non-food uses, progressively relaying the first-generation biodiesel and contributing to sustaining vegetable oils markets.

From a 'biorefinery' perspective, the celluloses fraction should also be considered. The technologies are ready to valorise sunflower stem fibres and pith in biomaterial such as particle boards or insulating materials from renewable sourcing. The limiting factors are the cost of collection and logistics.

Concerning agronomy and cropping practices, the past evolutions of yield levels in different conditions demonstrate the adaptation capacity of sunflower, but also that the yield gap remains high and that yield progress can still be expected.

Regarding climate change, the review by Debaeke *et al*., (2017) concluded for Europe, that sunflower could improve in the northern latitude, but could be affected negatively in the medium term in Southern and Eastern Europe if proper adaptation of cropping practices and cultivars is not achieved, even if the CO_2 fertilisation effect could compensate for the negative impacts of high temperatures, water stress and reduced crop duration. The possibility of relying on a diversity of cultivars differing in their productivity behaviour will be important for adaptation.

Conclusion

Sunflower succeeded in maintaining its competitiveness on oilseeds markets in the previous decades, through continuous innovation in genetics, production and markets, and a growing segmentation.

The plasticity of sunflower makes it a crop relatively adaptable to different kinds of agricultural policies and resulting agricultural systems. The dilemma will be in the repartition of research and innovation efforts towards different and multiple objectives. Co-ordination and collaboration are not new concepts in the world of sunflower science and are now more important than ever.

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