# AN ANALYSIS OF THE ECONOMICAL EFFECTS OF CROP MANAGEMENT MODIFICATIONS IN ORDER TO IMPROVE THE SUNFLOWER OILSEED CONTENT AT THE SCALE OF A PRIMARY ELEVATOR SUPPLYING AREA

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**Abstract**

The crushing sector is very interested in being supplied with sunflower (*Helianthus annuus* L.) seeds with high oil content. Therefore, they pay the primary elevators for seeds in accordance with their oil content. At present, the main strategy used by the primary elevators in order to increase the mean seed oil content of their storage receipt is to advise farmers to grow varieties with high oil content. Nevertheless, other strategies can be used, for example a better adjustment of the N fertilization. These two crop management strategies have been studied in order to compare their economical effects for the primary elevator and for the farmers in a supplying area (at a global level). Taking several hypotheses into account in terms of description of the primary elevator supplying area of sunflower seed oil content elaboration and of economical margins, it appears that the choice of a high oil content variety could lead to a better margin for the elevator than a better adjustment of the N fertilization.. For the farmers, the economical result is better with the adjustment of the fertilization. On the global scale the best result for a primary elevator and the farmers is reached with the adjustment of the fertilization.

## Introduction

The crushing sector is very interested in being supplied with sunflower seeds with high oil content. Therefore, they pay the primary elevators for seeds in accordance with their oil content. The primary elevators are looking for crop management in order to produce seeds with higher oil content. Nowadays their advice relies only on the choice of cultivar. But this

strategy is not so successful when the higher oil content cultivar is less productive; farmers do not buy it. Indeed, generally they do not receive any direct profit for a higher oil content crop. In order to increase sunflower oil content in crops, there are other opportunities such as the management of nitrogen (N) fertilization and the choice of the soils and fields where sunflower is sown.

Consequently, the aim of this study was to analyse the economical result for the primary elevator and the farmers of different strategies relying on a combination between soil, variety, and nitrogen fertilization choices. Is there a strategy of sunflower management able to increase the seed oil content of sunflower harvest, which is profitable for the farmers as well as for primary elevator?

## Materials and Methods

***Description of the Production Area.*** The area of sunflower production and collection chosen for the study is situated in the Poitou-Charentes region (in the West of France). It has been described with the help of the primary elevator, and with the information available in the region.

The production area covers 25,000 hectares, of which sunflower represents 4,000 ha/year. It is grown only on the rendzina soils, locally called "groie." Three types of "groies" are distinguished (Table 1), according to their water content and their potential yield.

Table 1. Distribution of sunflower within soil type and N fertilization practice.

| Soil type | Soil water content (mm) | Mean potential yield | Relative area | Sunflower area | Relative area of three N fertilization applications ( kgN. $ha^{-1}$ ) | | |
|---|---|---|---|---|---|---|---|
| | | | | | 0 | 50 | 80 |
| Superficial« groie » | 50 – 70 | 2.0 t . $ha^{-1}$ | 30 % | 1200 ha | 12 % | 18 % | 0 % |
| Middle « groie » | 70 – 90 | 2.5 t . $ha^{-1}$ | 50 % | 2000 ha | 14 % | 36 % | 0 % |
| Deep « groie » | 90 – 120 | 3.0 t . $ha^{-1}$ | 20 % | 800 ha | 0 % | 10 % | 10 % |

Sunflower is considered to be part of a rotation following wheat that produces grain with high protein content. Consequently the farmers apply high amounts of N fertilizer, so mineral N in the soil is high at the wheat harvest, and frequently at the sunflower sowing date.

Investigation among local advisors shows that N is applied in chemical fertilizers, with a variable amount according to the different farms and soils (Table 1), and that the total amount is the same each year on a given farm and soil type.

The data available from the primary elevators indicates that a classical seed oil content of variety "A" is sown over 50 % of the sunflower area. Fifteen percent is cultivated with a high oil content variety, variety "O" for which the potential yield is lower. This last variety is promoted by the primary elevator, through a reduction in the price of the seeds (cost reduction of 7.61 euros/ha).

The interannual variability of climate through rainfall has an important effect on crop yields in this region, and thus on the oil content of sunflower and on the soil mineral N content. So, in order to address the risks, the climate has been characterized through two parameters: the N balance of the previous wheat crop, and the yield of sunflower. The first parameter concerns the climatic conditions during the end of the wheat cycle, and its consequences on yield, N uptake by the wheat, mineral N content of the soil, and available N for the subsequent crop (sunflower). When conditions lead to a low yield, the N uptake is also low, and the soil mineral N content at harvest and the available N for subsequent crops are high, and vice versa. The second parameter is the water deficit after sunflower flowering, which is an important factor for yield and oil content. The temporal variability of the two parameters has been described by the local experts and is represented through the data in Table 2.

Table 2. Climatic scenarios: types and frequencies.

| Post-flowering water deficit for sunflower (year "n") | Wheat yield (year " n-1") | |
|---|---|---|
| | High (B) 6 years out of 10 | Low (b) 4 years out of 10 |
| High (t) : 7 years out of 10 | 4.2 years out of 10 (Bt) | 2.8 years out of 10 (bt) |
| Low (T) : 3 years out of 10 | 1.8 years out of 10 (BT) | 1.2 years out of 10 (bT) |

***Modelling of Sunflower Yield and Oil Content.*** The oil content for one variety, one soil type, and one climate scenario depends on the N balance, which is estimated from the difference between the N demand of sunflower and the N supply in the soil. The N demand is proportional to the yield. The N supply depends on the previous crop (type and yield) and on the soil.

The oil content of the variety "A" is 44% when the N is balanced. If the N supply exceeds the demand, the oil content decreases with a constant slope of one point for 30 kg/ha N. If the N supply exceeds the N demand, the oil content is considered to remain at the level of 44 %. The difference between the oil content of the two varieties is 2.5 points. The yield difference between the varieties varies from 0.1 to 0.4 t/ha depending on the yield of the variety "A": 0.1 t/ha for a yield of 1.6 t/ha and 0.4 t/ha for a yield of 3.5 t/ha with a simple linear interpolation between two successive yields.

***Estimating the Primary Elevator and the Farmers' Crop Margin.*** The economic margin obtained by the primary elevator is the addition of the margin obtained on the storage receipt (quantity and quality, i.e., oil content) and the margin obtained from the sale of sunflower seeds and N fertilizer. The selling price (P) of sunflower seeds harvested from the primary elevator to the crusher depends on the oil content: increase (and decrease, respectively) of 1.5 % of the basic selling price per point of oil above (and below, respectively) the trading oil content standard of 44% (seeds at 9% of water content and 2% of impurities): « $P = Pb \times [1 + 0.015 \times (OC - 44)]$ » (OC = oil content of sunflower crop; Pb = basic selling price: 220 euros/t). The primary elevator has supplied the other parameters: margin on purchase of sunflower crop (15.2 euros/t), and margin on N fertilizer sale (49.7 euros/t). It has been considered that the discount for variety "O" was supported by the seed producer, and not by the primary elevator.

The economic margin of farmers depends on the price, the yield and the production costs (seeds and N fertilizer). The different values chosen are: selling price of sunflower to the

primary elevator: 200 euros/t; discount for the variety "O": 76.2 euros/t; N fertilizer cost: 430 euros/t.

On the scale of the whole area, scenarios of N fertilization affect only the crop management of the varieties "A" and "O" (65% of the area, 2,600 ha out of 4,000 ha), without any change in the N fertilization of the other varieties (35% of the area, 1,400 ha out of 4,000 ha).

***Nitrogen Fertilization Scenario.*** This scenario consists of improving the adaptation of the fertilization to the previous crop yield and soil in order to reduce over-fertilization frequency. The N rate was calculated from a regional software (PCAzote), developed in western France. From the present practices of farmers, this scenario would lead to reduction in the frequency and the rate of sunflower fertilization on the area (Table 3), without yield losses.

Table 3. N rate for balanced fertilization.

| Soil type | Yield objective | Previous wheat yield | PCAzote N rate recommendation |
|---|---|---|---|
| Superficial « groie » | 2 $t.ha^{-1}$ | Low or high yield | 0 |
| Middle « groie » | 3 $t.ha^{-1}$ | Low yield<br>High yield | 20 $kgN.ha^{-1}$<br>30 $kgN.ha^{-1}$ |
| Deep « groie » | 3.5 $t.ha^{-1}$ | Low yield<br>High yield | 25 $kgN.ha^{-1}$<br>45 $kgN.ha^{-1}$ |

***High Oil Content Variety Scenario.*** This scenario consists of increasing the production area of the variety "O" with 50% of the sunflower area, and decreasing the production area of the variety "A" (15% of the sunflower area).

**Results**

***Nitrogen Fertilization Scenario.*** This scenario could lead to an increase in the mean economic margin of the primary elevator by about 10,000 euros/year for the whole area. It is the result of the increase of the margin on the sale of the harvested seeds, due to the increase in the oil content (12,500 euros/year) plus the decrease of the margin due to the reduction of the use of fertilizer by the farmers (2,500 euros/year). This increase of the margin depends on the year (climate type) and on the soil (Figure 1). The primary elevator can obtain an increase of margin from 6,000 to 13,000 euros/year, 9 years out of 10. And, 1 year out of 10, when the climate is appropriate for the oil content of sunflower but not for a high yield for the previous crop of wheat, the increase of margin can reach 18,000 euros/year.

The mean cost reduction for the farmers due to the decrease of the N fertilizer rate is about 8.4 euros/year/ha (about 22,000 euros/year on the whole area). For the farmers, the cost reduction can reach 2.9 euros/ha on superficial "groie," 8.60 euros/ha on middle "groie," and 12.0 euros/ha on deep "groie."

In the whole area, the N fertilization scenario can lead to an increase in the profitability of about 32,000 euros/year, shared between the primary elevator (10,000 euros/year) and the farmers (22,000 euros/year).

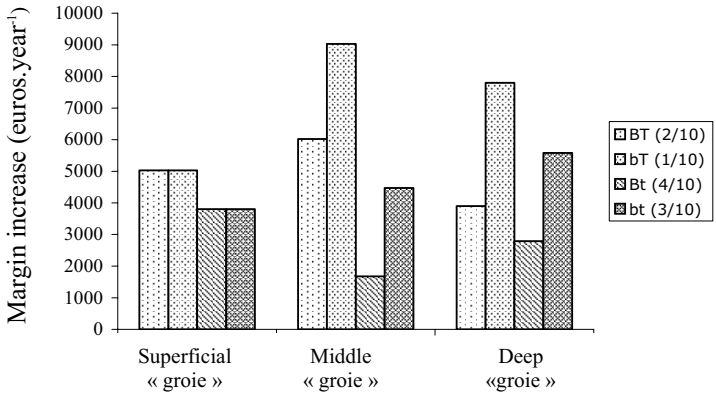


Figure 1. Results of the N fertilization scenario on the primary elevator margin depending on soil and year.

***High Oil Content Variety Scenario.*** With this scenario, the elevator margin increases with proportions depending on the year (Figure 2). The average increase due to the increase of the mean oil content is about 24,500 euros/year, while the decrease due to the reduction of the mean yield is about 4,500 euros/year (variety "O" being low yielding). All in all, the average increase of elevator margin is about 20,000 euros/year.

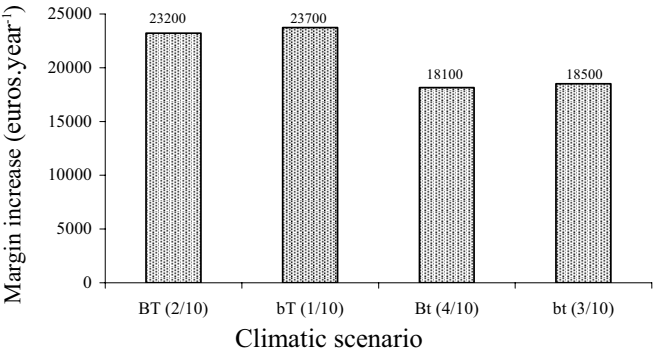


Figure 2. Results of the high oil content variety scenario on elevator margin depending on year type

For the farmers, this scenario leads to a reduction of the mean yield and consequently of the mean margin, depending on the climate (about 51,000 euros/year, with high water deficit for sunflower, and 86,000 euros/year, with a middle water deficit) due to the difference in yield between varieties depending on climatic potential yield. The mean loss of margin for the farmers appears to be about 51,000 euros/year.

In the whole area, this last scenario is negative, with a loss of 31,000 euros/year. It is the result of an increased margin for the primary elevator (+20,000 euros/year), but a decreased margin for the farmers (51,000 euros/year).

## Discussion

The calculations have been developed from hypotheses including simplification of the area description, the primary elevator profitability, and the modelling of sunflower yield and oil content. These hypotheses are to be discussed, and the uncertainty of the results can be high.

Nevertheless, it is interesting to discuss in this study the strategy of the primary elevator. Nowadays, in order to increase the oil content of the harvested seeds, there is focus on the variety choice. The manager of the storage receipt tries to increase the oil content by choosing the best variety, while the manager of the inputs tries to increase the sale of N fertilizer, but nobody takes into account the interaction between the N fertilization and the oil content. What is the more profitable strategy for the primary elevator: to maximize the sale of fertilizer, and accept a reduction in oil content due to frequent over-fertilization, or to focus on the different techniques able to increase the oil content, and accept a reduction in the profitability of the fertilizer activity of the company? The results show that the second strategy is the most profitable for the primary elevator as well as for the farmers.

The scenario based on an increased area of variety “O” with higher oil content but lower yields results in a higher profitability for the primary elevator, but a lower profitability for the farmers. On the scale of the whole area, this varietal choice seems less profitable than the N fertilization scenario.

Changing the variety from “A” to “O” is technically more effective on oil content of the crop than a reduction of fertilization of 30-45 kg/ha N. Nevertheless, from the global point of view, the N fertilization strategy is more profitable. Analysis shows that, with these conditions of prices and costs, in order to be profitable a high oil content variety must maintain its yield under the limit of a reduction of 1.5% (about 0.05 t/ha) for each point of oil over the variety “A”.

These results seem to be valid for an area where the over-fertilization of sunflower is frequent, mainly in soils where potential yield may be low. Variety choice is not to be neglected: how to adapt the variety to the soils? It would be interesting also to continue the study, assessing a combination of the two strategies, and even a new strategy with another repartition of sunflower on the soils of the area.

## Conclusions

The aim of this study was to assess the profitability for a whole area, including farmers and primary elevators, of two scenarios including elementary changes in crop management: variety choice and N fertilization. It shows the importance of global assessment of profitability at the level of the primary elevator as well as at the level of the whole area. It also shows the limits of sectorial or technical approaches. Now a more accurate modelling of yield and oil content of sunflower is needed to pursue these studies, in order to devise a decision supporting tool.