# Organic markets: a safe haven from volatility

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## Abstract

With a demand that is not met and constantly growing, as well as higher prices, organic markets offer promising prospects to farmers. In addition, organic markets seem to still be rooted in the real economy, as opposed to conventional ones that are more financialized. Can this be a reason for farmers to convert to organic farming? This article explores the validity of a conversion motivation that brings together ethical and economic reasons: the rejection of agricultural modernization reflected in the high volatility of commodity markets. This study finds that organic prices for French milling wheat and French corn are higher and indeed more stable than conventional wheat and corn prices. Also, the organic markets seem isolated from the financial markets for both milling wheat and corn, and cross hedging organic wheat and organic corn using Euronext's futures contracts is not possible.

## Introduction

While conducting interviews with French grain producers and elevators on an ongoing but different project, an interesting claim echoed from several farmers. They stated that they were in the process or were planning to convert to organic farming because they were "fed up" and "frustrated" with how unstable conventional agricultural prices were, and that organic farming can make them "regain their freedom" (see appendix for verbatim reports). With that in mind, the literature on the motivations to switching from conventional to organic farming was reviewed to see if the volatility of agricultural markets was mentioned. And indeed, a few researchers took the price stability path to explain the conversion, or at least highlighted the lower volatility of organic prices (Bouttes et al., 2019; Franco, 1989; Haldar & Damodaran, 2021; Kleemann & Effenberger, 2010; Su et al., 2013). In this study, the organic milling wheat

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and corn markets are examined to see if they can be a safe haven for farmers escaping the European financial market's volatility.

According to the French Agency for Development and Promotion of Organic Farming, the COVID19 crisis and the lockdowns that followed, favored the development of a strong interest to consume healthy and sustainable, local and seasonal (Agence BIO, 2021). Thus the French organic market amounted to nearly 13.2 billion euros in 2020, that is an increase of 10.4% since 2019 (Agence BIO, 2021). Field crops (including wheat and corn) are also part of this increasing trend as they recorded strong expansion of certified organic areas (+ 29%) (Figure 1). This progression is not specific to France (even though along with Germany they represent more than 53% of the organic market in the European Union) : in 10 years, the European organic market has more than doubled (x2.6 since 2009) (Agence BIO, 2021).

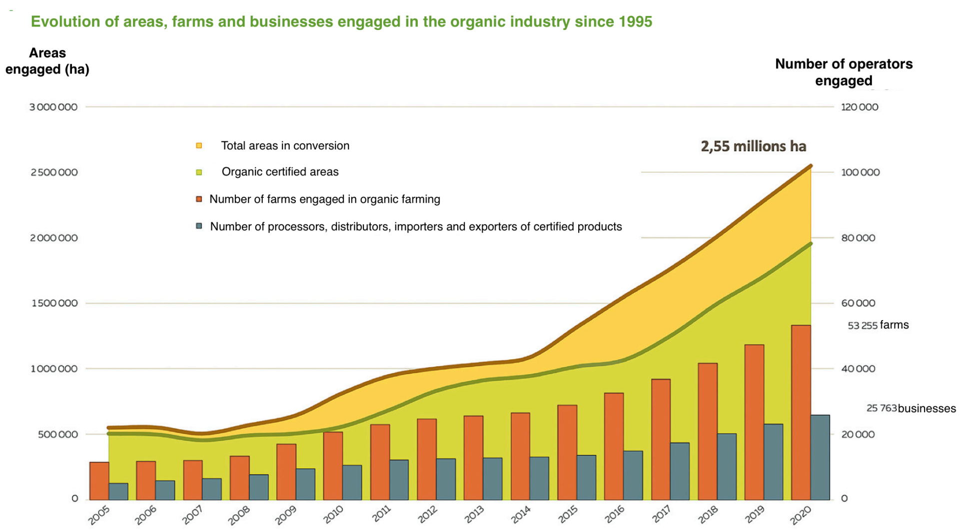


***Figure 1*** *- Evolution of areas, farms and businesses engaged in the French organic industry - Source: Agence BIO/OC, Agreste/SAA 2020 translated by author*

This increasing trend does not imply that conversion to organic farming is easy and that farmers can simply replace chemical products by organic ones. Organic farming requires important technology shifts to meet a more wholistic approach of organic fertility and improvement of soil life in the long term. A conversion period of 2 years for field crops should also be respected.

During this phase, the producer strictly complies with the specifications of organic farming without marketing his organic products. In exchange, producers receive public aids. These additional constraints as well as a lower yield (Berentsen et al., 2012; Crowder & Reganold, 2015; Nieberg & Offermann, 2003) make organic farming more costly than conventional farming.

It is impossible to give a specific production cost for organic milling wheat or corn, because each farm is different by its geolocation for example, or the structure of its soils, which influence yields. However, it has been shown that organic farming entails more important production costs. In experimental farms ran by ARVALIS Plant Institute, the production costs of organic farms varied between 254 and 293 euros per ton for wheat (ARVALIS, 2019). They state that the higher organic production costs are mainly due to the lower yields. In Europe, cereal grain production yields are 60-70% of the yield conventional cereals (Nieberg & Offermann, 2003). But this production risk is offset with a higher selling price due to the existence of an organic premium. Crowder & Reganold (2015) examined the financial performance of organic and conventional farms and found that with the premiums, organic agriculture was significantly more profitable (22–35%) and had higher benefit/cost ratios (20–24%) than conventional agriculture.

The demand for organic products appears to be growing, and the market more attractive in terms of prices, so can farmers escaping volatility find shelter in it? To answer this, the main research question is sectioned into different ones, along the same lines as Drugova et al. (2019). First, the organic price risk is analyzed by comparing historical volatilities of French organic milling wheat prices and the futures contract of conventional milling wheat on Euronext (EBM), as well as the historical volatilities of French organic corn prices and the futures contract on conventional corn on Euronext (EMA). The organic premiums for the French milling wheat and the French corn are also analyzed, and their distributions are estimated. Second, French organic wheat and corn are examined to see if they can be hedged using the Euronext milling wheat and corn futures contracts. The relationship between the organic and futures price series is thus analyzed and the optimal hedging ratios are estimated using a multivariate GARCH model and an OLS model with lags.

In the next section, a review of the different literature fields that helped structure this paper is presented. Then the data and methodology used are clarified. Later, the results are presented and discussed, and a conclusion is given about how the organic milling wheat and the corn markets are still independent and can still be a haven for volatility-averse farmers.

# Literature review

*Determinants of converting to organic farming*

The motivations to switching from conventional to organic farming have been extensively studied in social sciences. Fairweather (1999) finds for his case study of New Zealand farmers that there is a first type of motivation, linked to ethics and concerns for chemicals in food and concerns about personal health. This kind of motivation joins the concept of livability of the farm, as analyzed by Hellec & Blouet (2010) for dairy farmers that feel that their organic farms are more livable. The second type of motivation put forward by Fairweather (1999) is economical and related to the premiums of organic products that sell for a higher price than conventional ones. The third type of motivation is linked to problems faced when farming conventionally (including concerns for the soil).

The importance of the economic incentives relative to ethical ones is a matter of debate. Just like Fairweather (1999) found that economic factors do not come first, other researchers concluded that the motivations for converting to organic agriculture were not primarily economic (Dubgaard & Sorensen, 1988; Hong, 1994; Lockeretz & Madden, 1987; Wilier & Gillmor, 1992). Other studies however concluded that the main reason to converting to organic farming is to increase their income (Hellec & Blouet, 2014; Sainte-Beuve, 2010; Su et al., 2013), whereas a third opinion is that the motivations can be economic for some farmers and ethical for others (Latruffe et al., 2013a, 2013b; Lund et al., 2002).

Nonetheless, the process of conversion to organic farming should not be conceived as merely a binary question of economic versus ethical motivations. Researchers are increasingly studying different categories of converted farmers, taking into account the diversity and heterogeneity of models (Darnhofer et al., 2010; Gafsi & Favreau, 2014; Morel et al., 2003; Ruault, 2006; Sylvander et al., 2006; Van Dam, 2005). Indeed, "there is not one motivation for the conversion, but many, and these motivations evolve with time" (Lamine, 2009, p. 235). For example, new motivations have emerged like the central role that networks play (Belzile et al., 2015), or the importance of farmer's knowledge in organic processes (Wheeler, 2008). Geniaux et al. (2010) conducted a comprehensive literature review on the determinants and obstacles of the conversion to organic farming and classified all these motivations into different categories: specific to the farmer (competences, psychology, conviction, socio-demographic); specific to the farm (structure, technical factor, economic factors); and external (institutional, distribution availability, localization).

One motivation that joins the ethical one is the conversion to organic farming not just because conventional farming damages the environment, but as a total alternative and protest against the increasing modernization of agriculture (Alroe & Noe, 2008; Barrès et al., 1985; Darnhofer, 2005; Le Pape et al., 1986; Schreer & Padmanabhan, 2020; Tress, 2013). Darnhofer (2005) found in her Austrian case study that farmers use organic farming to free themselves from the hold of modern agriculture. Organic farming enables them to reduce their dependence towards financial markets and commodity prices. This rejection of modernization by organic farmers joins the literature on the rupture between rural farming practices (that organic farming is a part of), and modern conventional farming (Van Der Ploeg, 2000; Van Der Ploeg et al., 2000; Van Der Ploeg & Renting, 2000).

*Volatility and the financialization of agricultural commodity prices*

The modernization of agriculture is reflected in an increasing mechanization and motorization, as well as the use of chemical products, that facilitated the creation of highly specialized farms. It also has a socio-economic dimension which allowed a more massive and standardized production (Fouilleux, 2015). For example, for grain crops, quality evaluation grids are used that make it possible to categorize crops according to their quality (Premium A1, Superior A2, Medium A3, Access A4 for milling wheat). This led to an integration of markets, thus milling wheat from all over Europe can be traded interchangeably and can also be traded in financial markets, like Euronext.

Starting 1992 the European Union's common agricultural policy initiated the deregulation of the markets by lowering the floor price it was prepared to pay farmers. This intervention price granted in the event of a price drop has been devalued to 101.7 €/ton for milling wheat, making it less suited to price levels of the time.

Furthermore, since commodity prices are volatile (Pindyck, 2004), the deregulation of agricultural markets becomes problematic during episodes of high volatility. For instance, in 2007/2008, volatility of agricultural commodities reached high levels creating a food price crisis worldwide (Robles et al., 2009). Numerous researchers, investors and financial experts believe that excessive speculation and the presence of index investors in commodity markets play an important role in similar crises (Babusiaux et al., 2011; Baffes & Haniotis, 2010; Hollands, 2009; Masters, 2008; Soros, 2008). Guilleminot et al. (2013) review and develop the literature on the financialization of agricultural commodity markets to show how the behavior of index investors is likely to disconnect the prices of physical commodities and the fundamentals of supply and demand. Nevertheless, this increased participation of index investors did not make financial markets any less relevant as they still are efficient to hedge against price volatility (Revoredo-Giha & Zuppiroli, 2013). What it is important to note however is that a disconnection between the prices of physical commodities and the fundamentals of supply and demand, make the price swings even less predictable by farmers. Organic products on the other hand are not traded in financial markets, and as such their volatility is more likely to result from supply and demand changes. In addition, organic products with their high premiums seem more stable (Franco, 1989; Haldar & Damodaran, 2021; Su et al., 2013) which can be a conversion motivation itself (Bouttes et al., 2019). Though income risk can stem from a low yield, meaning a production risk rather than a price risk (Berentsen et al., 2012; Crowder & Reganold, 2015; Nieberg & Offermann, 2003). Especially since farmers must learn new ways of producing.

*Cross hedging and optimal hedging ratio*

When an asset does not have a derivative market, cross hedging can help reduce the risk of that asset. In other words, cross hedging is the use of financial instruments on another correlated asset when there is no fully developed derivative market, or when the market is thin (Koeman & Bialkowski, 2015). As a matter of fact, cross hedging can be efficient as long as the correlation between the two assets is significantly different from zero (Anderson & Danthine, 1980).

For example, in an agricultural context, Rahman et al. (2001) find that soybean meal futures can be used as a potential cross-hedging vehicle for cash cottonseed meal. Similarly, Zacharias et al. (1987) find the same result for cross hedging rough rice with wheat futures. Koeman & Bialkowski (2015) also find that New Zealand Stock Exchange dairy futures are an effective cross hedging tool to international dairy commodities. On a more related topic, in the case of organic grain products, where no futures markets exist, Drugova et al. (2019) obtained different results depending on how their missing values were treated, and in some cases, there was evidence that cross hedging organic wheat using CBOT conventional wheat futures was possible.

Johnson (1960) and Stein (1961) use portfolio theory to explain that hedging consist of risk minimization (variance minimization) with profit maximization of a portfolio made of spot and futures contrats. In the case of cross hedging, the portfolio comprises a spot contract of the asset in question, and a futures contract on a different but related commodity. The variance minimization of the portfolio is solved by estimating the optimal hedging ratio.

Ederington (1979) defines the optimal hedging ratio as the ratio of the covariance between the futures and spot price, to the variance of the future price. It can be estimated as the slope coefficient of an OLS regression of spot prices on futures prices. This method implies a constant hedge ratio over time and has been used for different case studies (Benninga et al., 1984; Malliaris & Urrutia, 1991; Rolfo, 1980). Later on, this model has been improved to take into account time variations, by using a GARCH model (Baillie & Myers, 1991; Myers, 1991), or by simply adding lags to the OLS model that proved to be as efficient as the GARCH model (Lien et al., 2002).

The optimal hedging ratio is further developed in the next section.

# Data and methodology

### *Data*

Six price series covering the 10 year period from October 2011 to October 2021 were used for this study: the weekly organic prices for French milling wheat and French corn, collected by La Dépêche – Le Petit Meunier, the daily settlement prices of Euronext futures contract on milling wheat (EBM) and corn (EMA) collected manually from Euronext's website, and the daily spot prices for conventional milling wheat in the port of Rouen as well as for the conventional Atlantic corn free on board, made available online by the National Institution of Agricultural and Sea Products (FranceAgriMer). The conventional spot price series were used for comparison purposes with the organic series and to compute the organic premiums, that are equal to the difference between the organic prices and the spot (cash) prices of conventional wheat and corn. The futures price series were used for the cross hedging analysis.

The futures and spot series needed transformation to become weekly, and in addition, the futures series that consisted of contracts having different delivery dates were transformed into continuous price series by taking the nearest contract and rolling over to the next one, the last day before delivery (Carchano & Pardo, 2009).

Below are plots showing how organic prices largely exceed conventional spot and futures prices because of the high premiums (**Figure 2** and Figure 3).

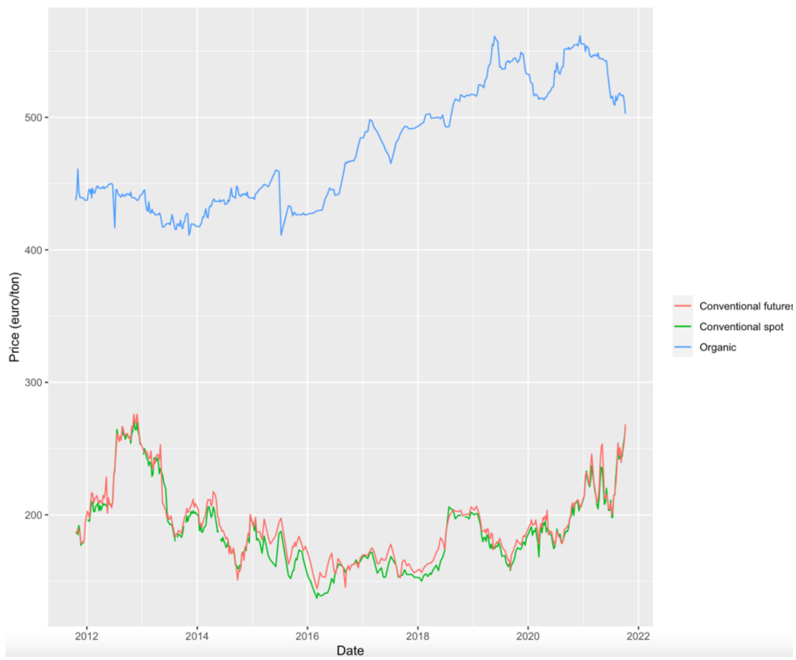


***Figure 2*** *– French Organic wheat and conventional spot and futures prices (EBM) evolution - Source: author*

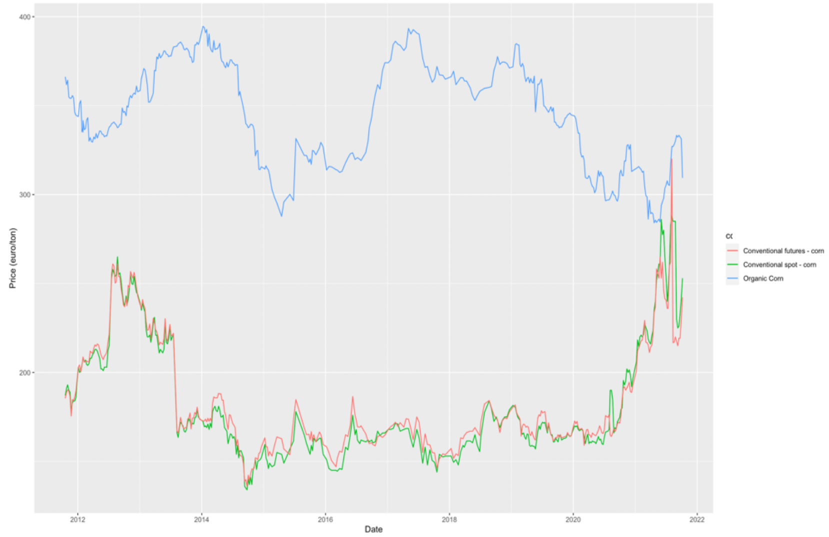


***Figure 3*** *- French Organic corn and conventional spot and futures prices (EMA) evolution - Source: author*

To prepare the data for the analysis, it was cleaned from outliers, and as there were 13 missing prices from the organic wheat series, and 21 for the organic corn series, a linear interpolation was applied to fill the missing points. I then decomposed the price series to remove the seasonal components.

### *Methodology*

The data was tested for stationarity using the augmented Dickey-Fuller (ADF) test to detect unit-roots, and the Kwiatkowski-Phillips- Schmidt-Shin (KPSS) test for trend stationarity.

To understand the links between the organic prices and the futures prices, and to assess whether the organic prices were indeed more stable, the standard deviations for the returns were computed, an F test was performed to compare the variances of the organic and futures series and the correlation between both series were computed. Historical volatilities were also computed using the returns as follows:

$$r_t^j = \text{long}(p_t^j) - \log\,(p_{t-1}^j)\ (1)$$

Where $p$ is the price, and $j$ is either the organic or futures price.

Also, the Kernel density were estimated to fit the organic premium series and have a more accurate idea about the chances that the premium could cover the additional organic production costs.

Cointegration was also examined, to see if the organic and futures prices deviate from each other in the long run.

For the cross hedging analysis, two models were used. First, a multivariate GARCH (generalized autoregressive conditional heteroscedasticity) model, for which the variance estimates capture the time-varying optimal hedging ratio. The GARCH model (Bollerslev, 1986; Engle, 1982) has been used since the early 90's to estimate the optimal hedging ratio (Baillie & Myers, 1991; Myers, 1991). The dynamics of the spot (organic) and futures price changes are shown in equations (2) below :

$$S_t = \alpha_0 + \alpha_1(S_{t-1} - \gamma F_{t-1}) + \varepsilon_{st} \quad (2)$$

$$F_t = \beta_0 + \beta_1(S_{t-1} - \gamma F_{t-1}) + \varepsilon_{ft}$$

Where $S_t$ and $F_t$ are the spot (organic) and futures prices, and the residuals follow a Normal distribution.

$$H_t = \begin{bmatrix} h_{ss,t} & h_{sf,t} \\ h_{fs,t} & h_{ff,t} \end{bmatrix} = \begin{bmatrix} h_{s,t} & 0 \\ 0 & h_{f,t} \end{bmatrix} \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix} \begin{bmatrix} h_{s,t} & 0 \\ 0 & h_{f,t} \end{bmatrix} \quad (3)$$

$$h_{st}^2 = c_s + a_s \varepsilon_{s,t-1}^2 + b_s h_{s,t-1}^2 \quad (4)$$

$$h_{ft}^2 = c_f + a_f \varepsilon_{f,t-1}^2 + b_f h_{f,t-1}^2$$

Equation (3) details the conditional variance matrix and equations (4) show the multivariate GARCH (1,1) model.

The optimal hedging ratio (OHR) at time t is: $OHR = \frac{h_{sf,t}}{h_{ff,t}}$ which is why the conditional variance and covariance matrices of the fitted multivariate GARCH model were also estimated for each week, and the covariance between the spot (organic) and futures returns as well as the variance of the futures returns were computed to estimate the hedging ratio.

Several studies compared the GARCH and OLS models for the hedging ratio computations and found that the GARCH only slightly outperforms the OLS model (Holmes, 1996; Kroner & Sultan, 1993; Lien et al., 2002; Myers, 1991), making the latter an acceptable estimation method. For this reason, in addition to the multivariate GARCH model, a linear regression of the change in spot prices on the change in future prices was estimated (Benninga et al., 1984). In this particular case, the spot prices are the organic prices, hence the linear regression should be as follows:

$$\Delta S_t = \alpha + \beta \Delta F_t + \varepsilon_t \quad (5)$$

Where $\Delta S_t$ is the change of organic prices between two time periods, $\Delta F_t$ is the change of futures prices between two time periods, $\alpha$ is the constant term, $\beta$ is the slope coefficient and the estimate of the optimal hedge ratio, and $\varepsilon_t$ is the error term.

However, the simple OLS regression does not account for past information (Drugova et al., 2019) and can be enhanced by taking into account the lags of futures and spot prices. The optimal number of lags is determined using the Akaike Information Criterion (AIC). The regression becomes, in case of no cointegration, as explained in Lien & Tse (2002):

$$\Delta S_t = \alpha + \beta \Delta F_t + \sum_{i=1}^{k} \gamma_i \, \Delta S_{t-i} + \sum_{i=1}^{k} \mu_i \, \Delta F_{t-i} + \varepsilon_t \quad (6)$$

For equation (6), the optimal hedging ration remains the coefficient $\beta$.

In case cointegration is found, an error correction term is added.

To verify that the model is well specified, the hypothesis that there is no serial correlation between the residuals is tested using a Ljung-Box test.

All computations were carried out using the software R.

# Results and discussion

*Comparison between organic and conventional prices*

Descriptive statistics of the six price series are presented in Table 1. As mentioned in the previous section, organic prices are higher and more than double than futures prices. Also, the standard deviations of the returns show that organic prices are less volatile than conventional futures prices. The standard deviations of organic returns for wheat and corn are lower to that of both spot and futures conventional prices implying that the uncertainty in the conventional market is more important. An F-test was also conducted and shows that the variance differences are statistically significant between the organic and convention spot prices for both wheat and corn, as well as between the organic and conventional futures prices for wheat and corn. These results are different than the findings of Drugova et al. (2019), who show that the organic market for US milling wheat is more volatile.

| | Organic milling wheat | Conventional spot prices for wheat | Conventional futures prices (EBM) | Organic corn | Conventional spot prices for corn | Conventional futures prices for corn (EMA) |
|---|---|---|---|---|---|---|
| Number of observations | 394 | 394 | 394 | 394 | 394 | 394 |
| 1st Quantile | 435.0 | 172.0 | 177.1 | 320.0 | 162.0 | 165.0 |
| Mean | 477.5 | 193.4 | 197.5 | 344.2 | 185.8 | 187.1 |
| Max. | 560.0 | 272.5 | 276.0 | 395.0 | 288.0 | 320.0 |
| Min. | 405.0 | 137.0 | 144.2 | 285.0 | 134.0 | 136 |
| Median | 450.0 | 187.9 | 192.2 | 340.0 | 171.0 | 173.9 |
| 3rd Quantile | 522.5 | 207.0 | 210.7 | 370.0 | 209.5 | 211.9 |
| NA's | 13 | 8 | 0 | 21 | 0 | 0 |

***Table 1*** *- Descriptive statistics of the price series*

Going into more depth, historical volatilities of the organic and conventional futures and spot series were computed. For clarity purposes, only the organic and conventional spot volatilities were plotted (Figure 4 and Figure 5). As confirmed by the standard deviation of the returns, the organic volatility does not seem to be higher than the conventional spot one for both wheat and corn. In addition, for each week, the difference between the conventional and organic volatilities is computed (conventional volatility-organic volatility), and the number of negative positive counts shows that the conventional volatility for wheat is higher for 334 weeks, while the organic volatility is higher for 59 weeks. As for conventional corn, the volatility is higher for 234 weeks, and lower for 62 weeks.

The plots also show that the conventional spot prices reach higher volatility peaks. It follows that organic prices are more stable for the French milling wheat and corn. This is consistent with the literature findings for different agricultural products. Haldar & Damodaran (2021) found that organic farming can protect producers from high price volatility and that this volatility can be a key factor in choosing production techniques. Su et al. (2013) found similar results with high and stable prices for organic milk, and dairy farmers who stated that price stability was one of the main conversion reasons. Kleemann & Effenberger (2010) also analyzed conventional and organic pineapple prices and concluded that organic prices are more stable in the short run.

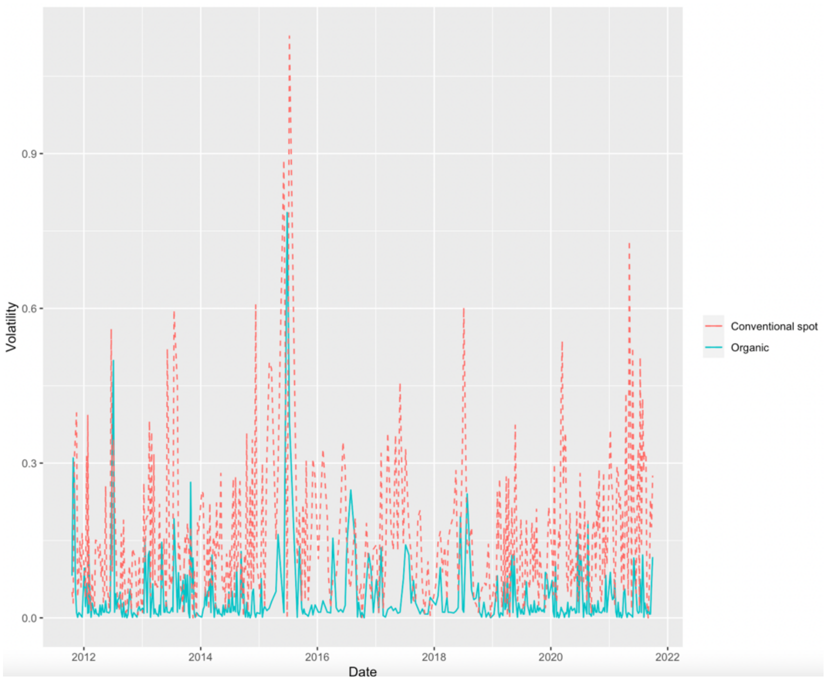


***Figure 4*** *- Historical volatilities of organic and conventional spot and futures wheat prices*

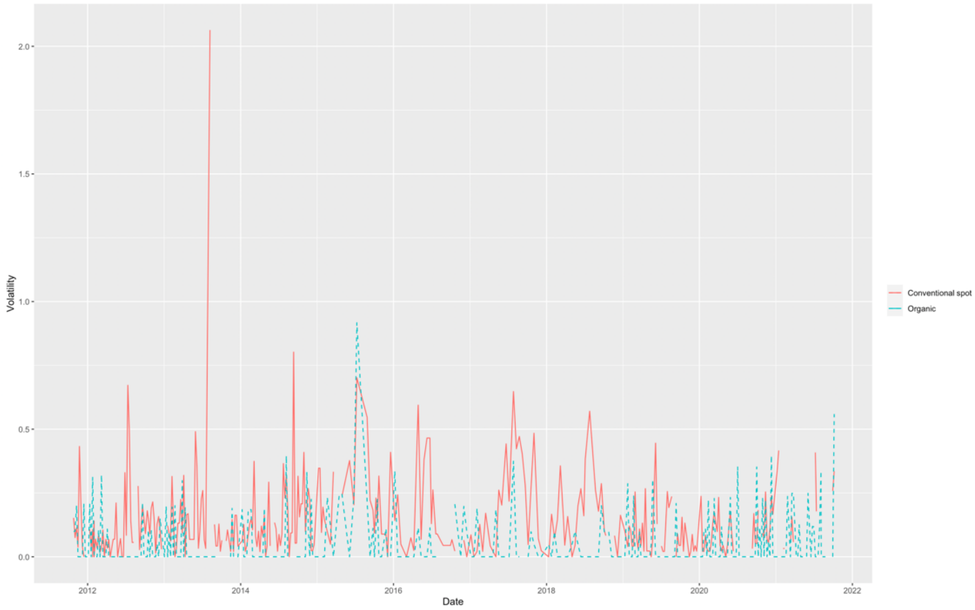


***Figure 5*** *- Historical volatilities of organic and conventional spot and futures corn prices*

What about the risk associated to the organic premium? Following Drugova et al. (2019), the Kernel density is estimated to assess the organic premium's risk. The goal is to gauge the probability that the premium would be lower than a certain amount. As seen in Figure 6, the density for the organic wheat premium appears to be multimodal (3 modes) with a major mode around 350 euros. As for the organic corn premium, the density appears to be skewed to the right meaning that there is a higher probability for the premium to be higher than 100 euros (Figure 7).

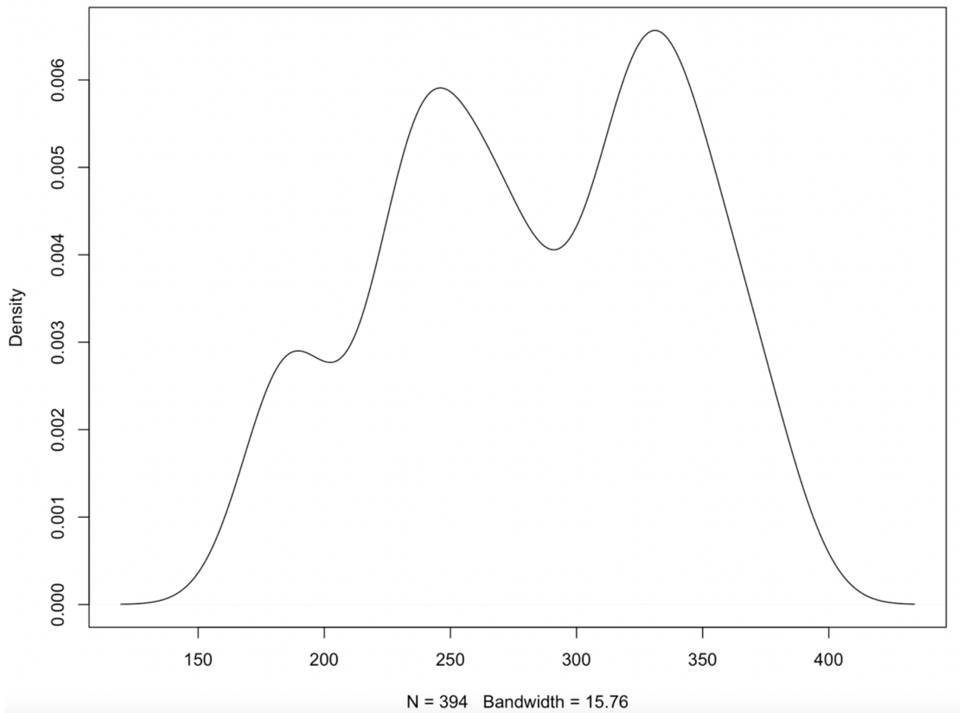


***Figure 6*** *- Kernel density for the organic premium for wheat*

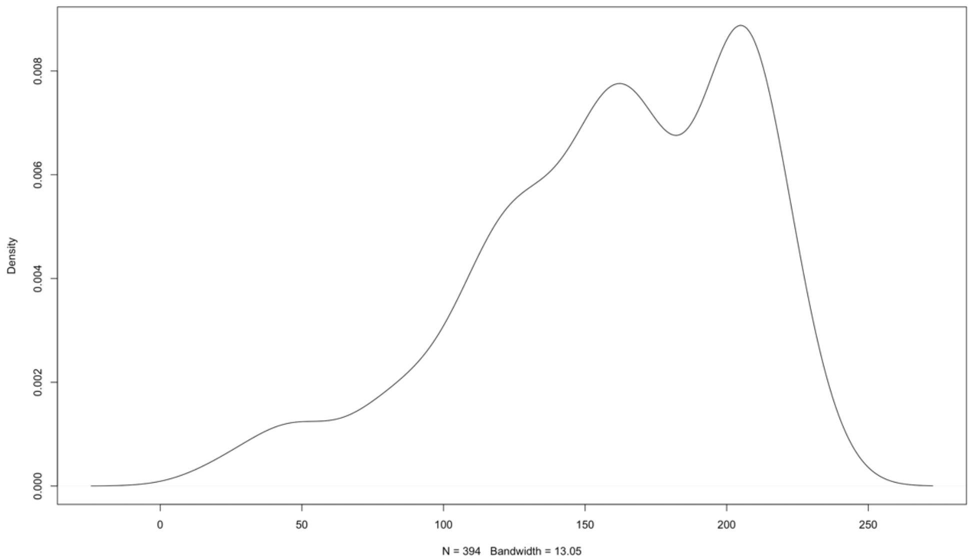


***Figure 7*** *- Kernel density for the organic premium for corn*

The cumulative distribution function indicates that for organic wheat, there is a 10% probability of obtaining a premium lower than 200 euros, and 56% probability of obtaining a premium lower than 300 euros. For organic corn, there is a 12.5% probability of obtaining a premium lower than 100 euros, and a 39% probability of obtaining a premium lower than 150 euros.

To have a clearer picture, the premium should be compared to the additional cost of producing organic crops compared to conventional crops. This task is complicated by the fact that every single farm has its own production costs. Nonetheless, Garnier (2009) estimated the costs for an organic farm to be 274 euros/ton for wheat and Chambre d'Agriculture Hauts de France (2017) gave 214 euros/ton as a production cost for conventional farms for wheat. The 60 euros difference is hence largely covered by the premium. This result is in agreement with the literature. Nieberg & Offermann (2003) analyzed the situation of European organic farms and found that in nearly all European countries, average farm gate prices for organically produced wheat were 50-200% higher than for conventionally produced wheat. Furthermore, organic premiums do not seem to be diminishing with time (Kleemann & Effenberger, 2010).

To better understand the links between the organic and conventional prices, the presence of cointegration is tested, meaning the long term relationship between the prices. Before that, stationarity should be examined using the augmented Dickey-Fuller (ADF) test to detect unit-roots, and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for trend stationarity. The results show that the null hypothesis of the existence of a unit root is not rejected with the ADF test, and the KPSS test show that the prices series are not trend stationary. Thus, the number of differences necessary to make the series stationary is computed and all series are differenced once to become stationary.

A two-step Engle Granger cointegration procedure is carried out and the results indicate that the series are not cointegrated (organic wheat with the futures contract on conventional wheat, as well as organic corn with the futures contract on conventional corn). This means that they are not linked in the long term. But are the prices still correlated? The Pearson correlation coefficient returns a -0.09 value for wheat and -0.16 for corn, meaning that the variables are almost independent, but the correlation test still shows that the correlation coefficient is significantly different from 0 at a 10% level (p-value = 0.065) for wheat and the 5% level for corn (p-value = 0.001). The absence of cointegration and the presence of a significantly different from zero correlation is in agreement with the findings of Drugova et al. (2019) for organic and conventional wheat in the US.

Overall however, it seems like the links between the organic and conventional prices are weak, so it is assumed that the conventional milling wheat futures contract cannot be used to hedge the price risk for organic wheat.

*Cross hedging feasibility*

The optimal hedging ratio was estimated first using the multivariate GARCH (1,1) model. The parameters of both GARCH models (for organic and futures wheat returns as well organic and futures corn returns) are presented below (**Table 2** – Optimal parameters for the multivariate GARCH (1,1) model between organic and futures wheat returnsand **Table 3 -** Optimal parameters for the multivariate GARCH (1,1) model between organic and futures corn returns.

***Table 2** – Optimal parameters for the multivariate GARCH (1,1) model between organic and futures wheat returns*

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| [Organic returns].mu | 0.00 | 0.00 | 1.72 | 0.09 |
| [Organic returns].ar1 | 0.63 | 0.25 | 2.52 | 0.01 |
| [Organic returns].ma1 | -0.18 | 0.16 | -1.14 | 0.26 |
| [Organic returns].omega | 0.00 | 0.00 | 3.26 | 0.00 |
| [Organic returns].alpha1 | 0.86 | 0.58 | 1.50 | 0.14 |
| [Organic returns].beta1 | 0.14 | 0.18 | 0.77 | 0.44 |
| [Futures returns].mu | 0.00 | 0.00 | 0.16 | 0.87 |
| [Futures returns].ar1 | 0.61 | 0.24 | 2.55 | 0.01 |
| [Futures returns].ma1 | 0.65 | -0.21 | -3.11 | 0.00 |
| [Futures returns].omega | 0.00 | 0.00 | 1.17 | 0.24 |
| [Futures returns].alpha1 | 0.10 | 0.12 | 0.84 | 0.40 |

| | | | | |
|---|---|---|---|---|
| [Futures returns].beta1 | 0.77 | 0.16 | 4.90 | 0.00 |

Akaike Information Criteria: -10.628

***Table 3*** *- Optimal parameters for the multivariate GARCH (1,1) model between organic and futures corn returns*

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| [Organic returns].mu | 0.00 | 0.00 | -0.09 | 0.93 |
| [Organic returns].ar1 | -0.42 | 0.13 | -3.25 | 0.00 |
| [Organic returns].ma1 | 0.34 | 0.15 | 2.30 | 0.02 |
| [Organic returns].omega | 0.00 | 0.00 | 69.93 | 0.00 |
| [Organic returns].alpha1 | 0.02 | 0.00 | 7.28 | 0.00 |
| [Organic returns].beta1 | 0.92 | 0.01 | 67.73 | 0.00 |
| [Futures returns].mu | 0.00 | 0.00 | 0.85 | 0.40 |
| [Futures returns].ar1 | -0.83 | 0.10 | -8.42 | 0.00 |
| [Futures returns].ma1 | 0.88 | 0.7 | 13.10 | 0.00 |
| [Futures returns].omega | 0.00 | 0.00 | 1.14 | 0.25 |
| [Futures returns].alpha1 | 0.22 | 0.12 | 1.75 | 0.08 |
| [Futures returns].beta1 | 0.58 | 0.24 | 2.45 | 0.01 |

Akaike Information Criteria:  -9.5921

But for this study, it is the variance and covariance parameters that are interesting. They are extracted to compute and plot the optimal hedging ratios (Figure 8 and Figure 9). For wheat, the ratio does not seem important as it is lower than 0.01 (1%) for most of the time. The few spikes remain low as well (a maximum of 0.065 is reached in 2015). The same is true for corn, on an even lower magnitude: the optimal hedging ratio is extremely close to zero. If cross hedging was possible between the conventional and organic wheat and corn, the ratio should have been closer to one.

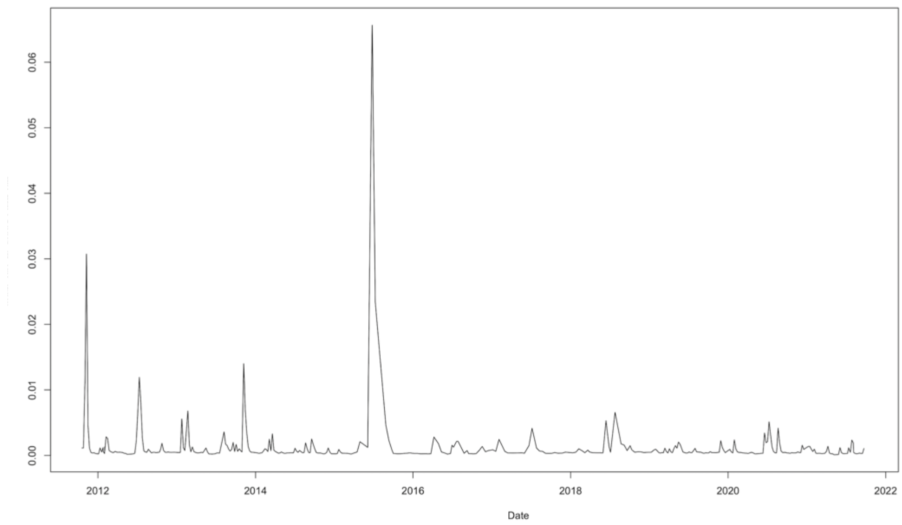


***Figure 8*** *– Optimal hedging ratio dynamics for wheat*

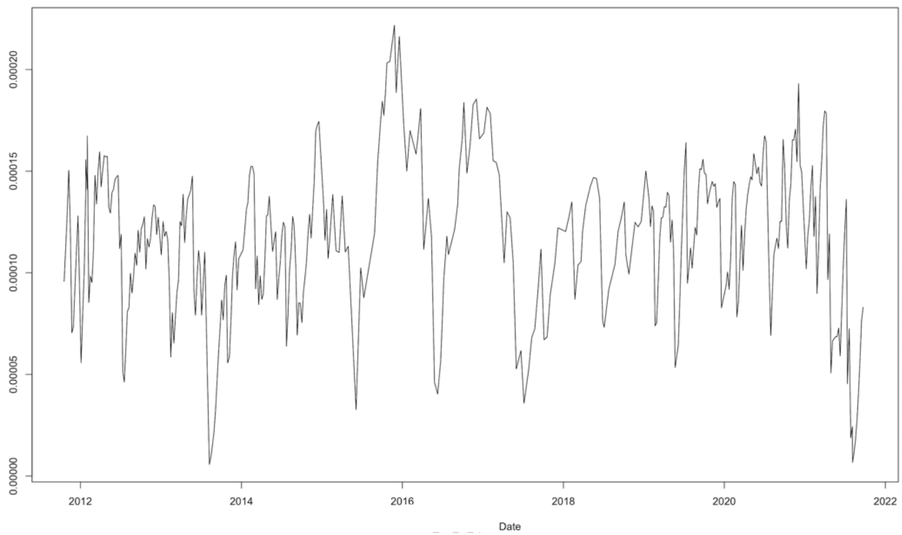


***Figure 9*** *– Optimal hedging ratio dynamics for corn*

To examine this ratio in a static context, an OLS model was used.

A simplified Engle-Granger cointegration model between organic and conventional futures prices show that there is no cointegration, so the OLS equation taking into accounts lags can be used, without adding an error correction term. The number of optimal lags selected using the Akaike Information Criterion was 9 for wheat and 10 for corn. The Ljung-Box test shows that the residuals are independent.

The regression results (Table 4) show that the coefficients $\beta$ of $\Delta F_t$, corresponding to the optimal hedging ratio are not statistically significant for wheat and corn. In other words, organic wheat cannot be cross hedged using the European futures contract on conventional wheat (EBM) and organic corn cannot be cross hedged using the European futures contract on conventional corn (EMA).

***Table 4** - OLS regression results*

| | **Estimate for wheat** | **Std. Error for wheat** | **Estimate for corn** | **Std. Error for corn** |
|---|---|---|---|---|
| Intercept | -0.02 | 0.26 | -0.02 | 0.26 |
| $\Delta F_t$ | -0.05 | 0.04 | 0.05 | 0.03 |
| $\Delta F_{t-1}$ | -0.08 | 0.05 | 0.11* | 0.04 |
| $\Delta F_{t-2}$ | -0.02 | 0.06 | 0.11* | 0.05 |
| $\Delta F_{t-3}$ | 0.02 | 0.07 | 0.05 | 0.06 |
| $\Delta F_{t-4}$ | 0.06 | 0.07 | 0.07 | 0.06 |
| $\Delta F_{t-5}$ | -0.01 | 0.07 | 0.07 | 0.07 |
| $\Delta F_{t-6}$ | 0.07 | 0.07 | 0.06 | 0.06 |
| $\Delta F_{t-7}$ | 0.03 | 0.06 | 0.04 | 0.06 |
| $\Delta F_{t-8}$ | -0.04 | 0.05 | 0.11 . | 0.06 |
| $\Delta F_{t-9}$ | 0.004 | 0.04 | 0.08 | 0.05 |
| $\Delta F_{t-10}$ | | | 0.02 | 0.04 |
| $\Delta S_{t-1}$ | -0.94*** | 0.05 | -1.00*** | 0.05 |
| $\Delta S_{t-2}$ | -0.95 *** | 0.07 | -0.82*** | 0.08 |
| $\Delta S_{t-3}$ | -0.80 *** | 0.09 | -0.63*** | 0.09 |
| $\Delta S_{t-4}$ | -0.66 *** | 0.09 | -0.59*** | 0.09 |
| $\Delta S_{t-5}$ | -0.58*** | 0.09 | -0.57*** | 0.09 |
| $\Delta S_{t-6}$ | -0.42*** | 0.09 | -0.49*** | 0.09 |
| $\Delta S_{t-7}$ | -0.32*** | 0.08 | -0.44*** | 0.09 |
| $\Delta S_{t-8}$ | -0.21** | 0.07 | -0.36*** | 0.09 |
| $\Delta S_{t-9}$ | -0.07 | 0.05 | -0.18* | 0.08 |
| $\Delta S_{t-10}$ | | | -0.09 . | 0.05 |

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' '.' 0.1
Multiple R-squared: 0.517, Adjusted R-squared: 0.4917 for wheat ; Multiple R-squared: 0.5217, Adjusted R-squared: 0.4938 for corn

In theory, cross-hedging is possible when the correlation between the two assets is significantly different from zero. For example, it was possible to cross hedge the French oleic sunflower with Euronext's rapeseed futures contract, even though the two commodities are different. Why is it not possible for the case of organic wheat and corn? It has been shown that the demand for organic products is elastic, therefore when the price of organic products decrease, people tend to switch from conventional to organic products (Gschwandtner, 2014; Lin et al., 2009). But the products analyzed in this study are not finished products, meaning that they are not sold to the final consumers directly. They are instead purchased by industrials to be transformed and they are not able to substitute organic products by conventional ones. A baker for example cannot sell an organic baguette using conventional wheat. As a matter of fact, the baker has to have special set up for the organic products so that it does not enter into contact with organic wheat. In addition, one difference between the two markets that can be looked at is the fact that the organic market for French cereals in general remains a small national market, while the conventional one is much more developed and export oriented making it more prone to be impacted by international news. In fact, for organic cereals, Europe (hence France) is an importer, but for conventional wheat, 13.9 millions of tons were exported in 2020/2021 for a production of 29.2 millions of tons, and for corn 4.5 millions of tons were exported for a 13.6 millions of tons produced.

## Conclusion

The organic markets for wheat and corn offer higher but also more stable prices to the producers as seen with the high premiums that cover the additional production costs, as well as the historical volatilities that are higher for conventional wheat 84.9% of the time, and higher 59% of the time for conventional corn. It is also reassuring in one way for converted farmers to know that the organic markets for milling wheat and corn are still disconnected from the futures market, and that cross hedging is not possible. This is positive for them because it means that the chances of having volatility spillovers are still low, and the organic market is still independent. Hence escaping volatility is a valid motivation for conversion to organic pricing. But financial markets, although demonized by some farmers, are not necessarily harmful to them. They enable them to fix a selling price in advance through financial instruments like futures contracts, and they also enable price discovery, meaning more transparency of prices. With organic markets, since they are over-the-counter markets, prices are less transparent. This situation however won't last forever. If the exodus continues, the organic market might as well just become like the conventional market, especially with the current "conventionalization" of the organic industry (Obach, 2007). Indeed, organic methods are becoming more and more like conventional ones in Europe, with larger farms, both in terms of land size and in terms of labor (Konstantinidis, 2012). With an increased institutionalization (Piriou, 2002), and a surge of third party certification that can be inaccessible to small farms (Nelson et al., 2015), organic products can become standardized hence more easily tradable in a financial commodity market and the premium can be reduced. As stated by a grain elevator interviewed for a different "organic farming is good, but a market will remain a market. The day where there will be too much organic farming, it will be the same as conventional farming" (see appendix for verbatim reports).

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# Appendix: verbatim reports (translated from French)

- **Verbatim 1 (grain farmer 1):** "For organic farming, it's booming, and no one has succeeded yet. People who go organically are people sometimes who want to get out of the cooperative a little, who want to be autonomous, and therefore in the organic market there may be something to do, it is why we would like to convert. Price volatility is not real there, it is still supply and demand, so we are really in something that seems realistic. Today soybeans are being used excessively, prices have fallen and you tell yourself: yes it makes sense, at least something that I can control, that I can see, it's not someone in Chicago behind his computer doing what he wants, that's why we would like to go into organic farming maybe and try to become a real player again in our profession, that's what would interest us tomorrow."

- **Verbatim 2 (grain farmer 1)**: "You have the forward price, but you see it is also a little… especially those who go organic, they are a little fed up you see, because we never talk in forward prices. You see, we never know where we are, they (the cooperative) say yes there will potentially be… for example, they give you more money afterwards they tell you there will be surcharges on top of that. We'll give you a little more money, and you never know in the end how much they're buying a ton from you, and in the end, you never know how much you gain (… ) finally, there are many who have been fed up and in particular this is an argument they have, those who have converted to organic."

- Verbatim 3 (grain farmer 2): "I converted to organic farming last year, I will be an organic farmer on April 6th, I would have completed the conversion period, and I was a bit frustrated with grain prices and our way of producing, that's why I switched to organic farming."

- **Verbatim 4 (grain farmer 2):** "What I see in organic farming is farmers regaining their freedom."

- **Verbatim 5 (grain elevator):** "Organic farming is good, but a market will remain a market. The day where there will be too much organic farming, it will be the same as conventional farming. Yes the stress of markets… It's good because of the opinion people have on organic farming today, and since organic wheat costs 500 euros per ton and that the price is always the same, yes indeed, it's not stressful. But the day where there will be too much organic farming and that we'll have to export organic products, I can tell you that organic products will be very close in terms of prices to conventional farming."