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Analysing the repartition and coexistence means used in maize in France in 2007

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Abstract

We studied how coexistence was managed in maize in the South of France at the farm level by surveying 23 contrasted farms in a region where nearly half of the maize cropped in 2007 was GM. Using semi-directive interviews, we identified factors explaining the choice of GM or NGM maize cropping like: presence of maize specialty crops, presence of technical scope of progress for maize yield, perception of corn borer as a risk or return time of maize. We will use these results to build a multicriteria model of maize allocation.

Introduction

In the European Union, the principles of the coexistence between GM (Genetically Modified) and non GM (NGM) crops have been defined by several directives and recommendations that, at the agricultural production level, aim at limiting the fortuitous presence of GMO in conventional harvests (EC, 2003a).

Under European regulations a product containing more than 0,9% of one of its ingredients coming from GM material is labelled as GM (EC, 2003b).

Several studies have been done to test the effect of production means and conditions on the level of GMO in a conventional harvest. Several models of gene dissemination at a small landscape scale have been developed (Colbach *et al.*, 2001a,b; Angevin *et al.*, 2002) to measure the probable level of GM presence in the harvest at the plot level according to the landscape and the cropping systems at the plot level simulated (Angevin *et al.*, 2008; Messéan *et al.*, 2006).

Bt maize (resistant to corn borer) is the only GM crop commercially grown in the EU and has already been cropped in France, especially in 2007.

After harvest, the risk of GM-NGM mixture is especially high in maize during drying. Preceding studies have studied the effect of the decisions of grain merchants on crop production and subsequently on harvest mixture (Coléno *et al.*, 2009; Le Bail, 2003).

The answer of farmers to these decisions has been conceptualised with a simple economical model based on the maximisation of gain expectancy for the farmer (Coléno *et al.*, 2009). However, this model only takes into account an economical reasoning whereas adoption of GM maize cannot only be explained by a economical reasoning. GM crops are also an answer to organisational constraints (Chevassus-au-Louis, 2001, Gardner and Nelson, 2007) or to technical constraints. They also bring new constraints on the production system and on the harvest commercialisation for the farmer.

In order to improve this model of farmers' allocation of GM and non GM maize at the landscape level, we studied in real case farms GM maize adoption, the determining factors of its adoption and the cropping systems associated both with GM and NGM maize in these farms.

We chose to study the South-West of France, where maize is one of the main crops and where corn-borer is present with frequently two cycles per year.

We studied how coexistence was managed in maize in the South of France at the farms level in 2006 and 2007.

Material and methods

Region surveyed

We chose the Midi-Pyrénées region (France) because of the importance of maize crop in the farmer's income in this region. The high corn-borer pressure also insured that GM maize would have a technical interest for farmers.

Our goal was to survey a maximum diversity of farms, which had been confronted to GM-NGM maize coexistence in 2006 and/or 2007, producing GM, NGM or both maize.

We thus chose an area where mixed farming production systems could be found, using the French Ministry of Agriculture's statistical data (Agreste Midi-Pyrénées, 2009) and where GM maize represented a high proportion of cropped maize, using governmental data (République Française, 2008).

Two departments represented 73% of GM maize cropped in Midi-Pyrénées in 2007: Haute-Garonne and Tarn-et-Garonne. In the Verdun-sur-Garonne County especially, GM maize had been cropped on 63% of the total maize area in 2007. We chose to survey an area in and around Verdun-sur-Garonne over both Haute-Garonne and Tarn-et-Garonne departments.

The area surveyed covered 6 counties, where GM maize was cropped on 25 to 63% of the total maize crop. However, a little over half of the farms surveyed were situated in the Verdun-sur-Garonne County.

We surveyed 23 contrasted farms near Verdun sur Garonne, where maize is the main crop and nearly half of the maize cropped in 2007 was GM. The farms surveyed were organic or not, producing mainly cash crops or not, with arboriculture, vine, vegetables or cattle.

Survey and analysis method

Our sample was build using the « snowball » method, first finding farmers via the phone directory and then filling out with contacts given by the farmers themselves. These farms were thus first chosen in a general database with no relation to the agricultural sector and there was not the usual bias induced by the use of a database given by grain merchants or technical advisors.

Using semi-directive interviews, we surveyed 23 farms using the method described in Miles and Huberman (1994). We used an interview guideline but let the farmer speak freely and choose the order in which he talked about the different points.

Our questions were about the farm and its management: farm resources (Usable Arable Area -UAA-, soils, distances between farm and plots, equipment, labour), productions on the farm (crops, livestock, production's importance in the final income...), maize crop management (cropping system, crop localization, crop rotations, pests presence and management, coexistence means used...), commercial and advising relations and also farmer's view on the advantages and constraints of GM maize.

These interviews were then synthesized and analysed to identify the relations between the data about farm, farm management and the presence of GM maize or not on the farm as well as the coexistence means used.

Results and discussion

Global sample analysis

Global structure

The 23 farms surveyed represent a very diverse sample: 15 combinations of production were found from the cereals and oleo-proteinaceous crop producer (5 farms) to the cereal/duck/seeds/fruit producer (1 farm).

On this sample, we found cereals in each farm since it was one of the necessary conditions for the sample (presence of maize). Livestock farming was present in 6 farms (cattle, chicken, and duck), seeds in 7 farms, orchards in 8 farms and vegetables in 3 farms.

In 7 of the 23 farms, the farmer had another activity (primary or secondary) in relation with agriculture (6 farms) or not (2 cases on one farm).

Farm size varied from 33ha to 280ha with 1 to 4 individuals working on the farm.

Maize was cropped on 7.6% to 80% of the UAA (Table 1).

Maize area in % of the UAA	<11%	11-25%	25-50%	>50%
Number of	4	1	13	5

farms				
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Table1. Proportion of maize cropped on the farm

Maize was the main income source for 13 farms.

The majority of the farms had a much aggregated field pattern with the most distant plot less than 5km away in 12 of the 20 farms where this data was available.

Maize management

The sowing date was more or less stable between farms: it is highly dependent on the rain in April and May, which is frequent. Sowing date varies between the beginning of April and the end of May depending on the year and the rain pattern.

Except in organic farms, maize is treated with one systematic herbicide before maize germination. This treatment is completed when necessary or systematically with another herbicide depending on the farm.

Nitrogen doses varied considerably between farms from 80 to 300kg N/ha but could not be related to another factor (Figure 1). As shown on Figure 1, no clear relation can be found between nitrogen input and maize yield. The lone point corresponding to a 40q/ha yield with a 215kgN/ha input represents the maize seed producing farm.

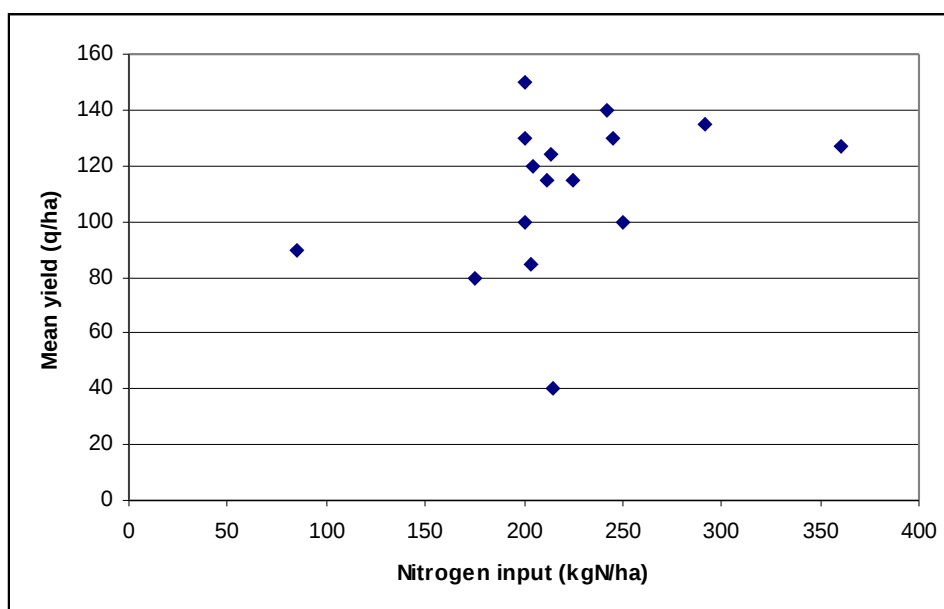


Figure 1. Mean maize yield according to total nitrogen input in the 16 farms where both data were available.

Corn-borer and sesamia were perceived as a risk for maize yield in 12 of the 19 farms where this data was available but only 8 of those 12 farmers treated their maize crop with a pesticide. The helicopter treatment was given up from 2006 by those who did it.

All maizes were irrigated but several kinds of sprinklers and driplines were found, sometimes on the same farm. Water input usually begins from the ten leaves stage with an input of 30mm per round for the sprinklers for a total of 5 to 8 rounds of irrigation during maize cropping. The usual input of water per round for the dripline is 16mm. However, we had some difficulties in obtaining homogeneous data on this subject and we still need to work on it.

In all cases surveyed where GM maize was cropped in 2006 and/or 2007, GM maize was managed as the non GM maize, except when the corn-borer pesticide was done. It was then stopped on the GM maize.

Maize harvest was mainly done by private firms (14 farms). In 8 farms only, the farmer harvested his maize himself (in one case with the help of neighbours) and in the only case of maize seed production, the seed company harvested the seed itself. Maize monoculture was also the main crop rotation in the sample surveyed (14 farms) but some farmers waited up to 6 years before cropping maize again on a given plot.

Twelve farmers identified localization constraints on the maize. In 6 cases, these constraints were due to the impossibility of difficulty of irrigating some plots.

The only difference in technical management between GM and NGM maize we found in the region was that no insecticide was sprayed on the maize when corn borer had before been perceived as a problem.

Means used to limit GMO/non GMO mixture

In 2007, 14 farms cropped GM maize and one farm cropped GM maize in 2006 but not in 2007. For these 15 farms, GM maize covered 5% to 80% of the maize area.

GM maize covered 80% of the maize area in 7 farms. This 80% coverage was the maximum proportion recommended in the good practices booklet given with each bag of seeds (AGPM, 2006; MAP, 2007).

In only one case, the farmer had no near neighbours cropping maize and thus did not put in place any mean to limit pollen dispersal from the GM maize.

In the other 22 cases surveyed, farmers had a maize plot in an area where both GM and non GM maize coexisted.

In 15 of these cases, buffer zones of non GM maize were put in place around the GM maize. In the case of some of the non GM maize producers, we did not obtain information about the presence or not of buffer zone around the GM maize of their neighbours, so that the number of cases of buffer zones may well be higher than that.

Five farms isolated their maize crop from their neighbours': two farmers isolated their GM maize to keep it from pollinating non GM maize, two farmers isolated their organic maize to keep it from being pollinated by GM maize and one farmer isolated his maize seed production from all maize.

In 6 cases, farmers coordinated themselves to respect a minimum distance or a minimum buffer width between GM and non GM maize (in one out of two cases of organic maize production, in two cases of maize seed production, in one case of duck feed production and in one case of maize production for labelled cattle).

In two cases only, the farmer producing GM maize did not put in place a coexistence mean. In one case, there was no neighbouring non GM maize. In the other, the neighbouring non GM maize was his own and was pop-corn maize, which cannot be pollinated by grain maize.

Other coexistence means were used: in two farms, non GM maize was harvested first so as not to mix harvested grain; in one farm, non GM buffer zones were sown first so that they would be more developed than GM maize; and in one farm GM maize was sown first.

The main coexistence mean used by farmers was thus the buffer zone of non GM maize. These buffer zones were usually 24 rows wide (in 12 cases out of 15) but ranged from 18 to 24 rows. Information and coordination with the neighbours was used mainly in the case of neighbours producing specialty maize.

As for the advantages and constraints of GM maize perceived by the farmers who had cropped them in 2006 and/or 2007, 8 farmers noticed a yield increase between their GM and non GM maize a given year. This yield increase was of less than 15% in 6 cases and of more than 15% in 2 cases. 6 farmers did not notice any difference between GM and non GM maize and one farmer noticed a yield loss of 12% due to a germination problem of the GM seed.

6 farmers noticed a better sanitary state of the GM maize harvest as compared to the non GM maize. In 2 cases, the use of GM maize enabled the farmer to gain flexibility in his work organization.

General synthesis

One of the conclusions of this sample analysis is that no GM maize is found in specialty crops (organic maize, seed maize and duck feed maize). These farmers are contracted to use and produce only non GM maize.

Another conclusion is that corn-borer pressure seems to increase adoption of GM maize: in 12 cases of perceived corn-borer presence, 8 farmers have decided to crop GM maize whereas in 9 cases of perceived corn-borer absence only 5 farmers out of 9 decided to crop GM maize.

Crop rotation including maize and mean maize yield may also have an effect on GM maize adoption (Tables 2 and 3). Farmers with a high perceived presence of corn-borer or with a high corn-borer risk due to crop rotation (Table 2) used GM maize more often to limit this risk.

Crop rotation with maize on the farm	Monoculture	Maize 5 years/cereal	Intermediate	Long rotation
GMO presence	9 farms	2 farms	2 farms	1 farm
GMO absence	1 farm	1 farm	2 farms	4 farms

Table 2. Relation between crop rotation length and GM maize adoption. Intermediate rotation includes 3 years maize/3 years of other crop and maize alternated with another crop (wheat, triticale, soybean or sunflower). Long rotation includes rotation with a minimum of 4 years between 2 maize crops.

Mean maize dry yield	<100q/ha	>100q/ha
GMO presence	0 farm	15 farms
GMO absence	5 farms	2 farms

Table 3. Relation between mean maize yield and GM maize adoption

Table 3 shows that only farmers with a high mean maize yield use GM maize in our sample. Out of the two farmers with a high mean yield and no GM maize, one produces a specialty crop (duck-feed) and another is against GMOs. The other farmers usually combine their high mean yield with a maize monoculture and a high nitrogen input. The only leeway left to increase their yield is to limit the hidden losses due to corn-borer. They are thus more likely to adopt GM maize. These results can be compared to that found on Bt cotton in Africa by Hofs *et al.* (2006). In their study, Hofs *et al.* (2006) found out that using GM crop could be an important component in cropping intensification strategies but that in farms with low or variable yields it did not always bring improvements. In our study, only farmers with an intensification strategy tried GM crops. Another point in this argument is that all 5 farms with a low maize yield and no GMO are also the 5 farms who have less than 20% of their UAA in maize whereas the other farms have at least 28% of their UAA in maize. This points to farms with more diverse crops and/or pastures. The 2 farms with yield

higher than 100q/ha and no GM maize also have 4 and 6 crops other than maize on their farm.

At the end of this survey, we identified 3 kinds of reason given by farmers for cropping GM maize:

- yield increase
- better sanitary state of the harvest
- more flexible work organization.

We also identified 3 kinds of reason for not cropping (again) GM maize:

- technico-economical reasons (no yield increase observed combined with a high seed cost or existence of other levers to increase yield)
- strategical reasons (specialty crops)
- ideological reasons (given alone in only one case in our survey)

In farms where the NGM maize behaved as well or better than the GM maize, farmers will not crop GM maize again. However, in farms where GM maize behaved better than NGM maize (better yield or better sanitary state of the crop), GM maize will be cropped again if authorized.

In 2006 corn-borer (and sesamia) presence was high and GM maize cropped this year may have had a better yield (only one farmer, out of the 7 who tried it this year, did not see a yield increase). However, in 2007, corn-borer presence was much lower and the farmers who cropped GM maize only in 2007 did not see yield increase as much (only 3 farmers, out of 9 who tried it that year, observed a yield increase).

The consequences of testing GM maize in 2006 or 2007 seems high on future GM adoption: 5 out of 9 farmers testing GM maize in 2007 would crop GM maize again if authorized whereas 6 out of 7 farmers testing GM maize in 2006 would crop GM maize again if authorized.

Thus, pest pressure the first year of testing seems to be a determining factor of GM maize adoption as it impacts on the benefits the farmer sees for GM maize cropping. However, even though farmers having cropped GM maize both in 2006 and 2007 may not have seen a yield increase in 2007, they still declared themselves ready to crop GM maize again, surely as a security measure for years with a high corn-borer (or sesamia) presence.

Conclusions

We thus identified factors which could explain the choice of GM or NGM maize cropping like the presence or not of specialty productions related to maize on the farm, the presence or not of technical scope of progress for the maize yield within the farmer's strategy, the perception of corn borer as a risk or not and the return time of maize on a plot, distinguishing 3 kinds of reasons explaining the use or not of GM maize.

Our survey also showed that farmers managed GM and NGM maize in the same way except for GM's specificities: no need for insecticides but coexistence means to limit pollen dispersal to NGM maize.

We will now begin to use these results and others from the MASCOTE project to build a multicriteria model of GM and NGM maize plot allocation in small region taking into account agronomical, economical and legislative criteria.

To build the agronomical part of this model we will compare the data obtained through this survey with those obtained by Duquesne (2005) in Alsace (France) and by the IPTS Study (Messean *et al.*, 2006).

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