

COMPARING MAIZE MANAGEMENT AND COEXISTENCE MEANS BETWEEN GM AND NON GM MAIZE IN TWO FRENCH REGIONS

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Abstract

We compared how coexistence in maize at the farm level was i) envisioned in the east of France where GM have never been really cropped, and ii) managed in the south of France where GM maize was cropped in 2006 and 2007. Surveys in respectively 27 and 23 contrasted farms were made in maize-rich sub-regions with high maize pest pressure. Sampling farms for diversity, we used semi-directive interviews with two different protocols for the 2 regions. After data analysis, we identified factors explaining the choice of GM or NGM maize cropping like: presence of maize specialty crops (no GM), presence of other technical scope of progress for maize yield (no GM), perception of corn borer as a risk (more GM) or return time of maize (more GM when maize is frequent). We also identified the different coexistence means preferred according to the region: buffer zone in the South of France with its large fields and sowing period shifts in the East of France where available sowing days are plenty in the spring. We also found out that the results of the first year of testing the GM crop may be the main factor explaining GM maize adoption or abandonment. We will use these results to build a multi-criteria model of maize allocation in a small region.

Keywords: coexistence, farm level, maize management, GMO

Sub Theme: Farm Management

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 adventitious presence of GMO in conventional harvests (EC, 2003).

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 (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.

Preceding studies have studied the effect of the decisions of grain merchants and farmers on crop production and subsequently on harvest mixture (Coléno *et al.*, 2009; Le Bail, 2003). Coléno *et al.* designed for that purpose a model based on the maximisation of gain expectancy for the farmer.

However, this model only takes into account a simple economical reasoning whereas adoption of GM maize are seen by farmers as answers to organisational or technical constraints (Chevassus-au-

Louis, 2001, Gardner and Nelson, 2007) and/or as new constraints on the production system and on the harvest commercialisation for the farmer.

We studied the (potential) adoption or not of GM maize by farmers to identify its determining factors and its impact on maize management. Our objective was to identify simple indicators, even indirect ones, of GM maize adoption in order to improve this model of farmers' allocation of GM and non GM maize at the landscape level.

We chose to study two regions of France, where maize is one of the main crops and where there is a high pest pressure on maize to compare farmer management of GM and non GM maize coexistence.

Material and methods

Regions surveyed

Two regions were chosen because of the importance of maize crop in the farmer's income in these regions: Midi-Pyrénées in the south of France and Alsace in the East of France. In both regions, the pest pressure (corn-borer and/or western corn rootworm) also insured that GM maize would have a technical interest for farmers.

In Midi-Pyrénées, farmers had been confronted to GM-NGM maize coexistence in 2006 and/or 2007, producing GM, NGM or both maize. In Alsace, no GM maize was sown and our survey identified projected coexistence means in the case of future presence of GM maize in the region.

In both cases, our goal was to survey a maximum diversity of farm types, UAA and maize proportion on the farm.

In Midi-Pyrénées, we used the French Ministry of Agriculture's statistical data (Agreste Midi-Pyrénées, 2009) and governmental data (République Française, 2008) to select diverse systems confronted to high GM maize presence. We thus 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.

In Alsace, 27 farms were selected in two contrasted regions: the plain of Ill, dry and hot with irrigated maize monocropping systems in large farms and the Sundgau, wetter and colder with polycropping and livestock in smaller farms.

Survey and analysis method

The same protocol was not used in the two regions.

In Midi-Pyrénées, our sample was built using the « snowball » method, first finding farmers via the phone directory and then filling out with contacts given by the farmers themselves. Using semi-directive interviews, we thus surveyed 23 farms using the method described in Miles and Huberman (1994). Our questions were about the farm and its management: farm resources, productions on the farm, maize crop management, commercial and advising relations and also farmer's view on the advantages and constraints of GM maize.

In Alsace, we crossed information from the local country elevator, the Chambre d'Agriculture (public advisor) and the French statistical survey of 2000. The survey had two phases implied by the fact that farmers had never sown GM crops. The first time, we surveyed the main components of actual land use and cropping systems in the farms. The second time we presented to farmers different scenarios simulating GM/NGM maize organisation in the landscape of their farm and neighbour's

farms to discuss the feasibility of different coexistence means. Mixture risks were calculated using the first survey data and the gene flow model MAPOD (Angevin *et al.*, 2002).

In both protocols, these interviews were then synthesized and analysed to identify the relations between the data about farm, farm management and the means used or projected of GM and NGM maize coexistence.

Results

Global sample analysis

The 50 farms surveyed represent a very diverse sample for productions and certification and covered the regional diversity.

On this sample, we found cereals in each farm since it was one of the necessary conditions for the sample. Livestock farming was present in 17 farms (cattle, chicken and duck), seeds, orchards and vegetables in some farms of Midi-Pyrénées.

In 20 of the 50 farms, the farmer had another activity (primary or secondary).

Farm size varied from 21ha to 280ha with 1 to 4 individuals working on the farm.

Maize was cropped on 7.6% to 90% of the UAA (Table 1).

We compared the relation between maize area and UAA in both regions.

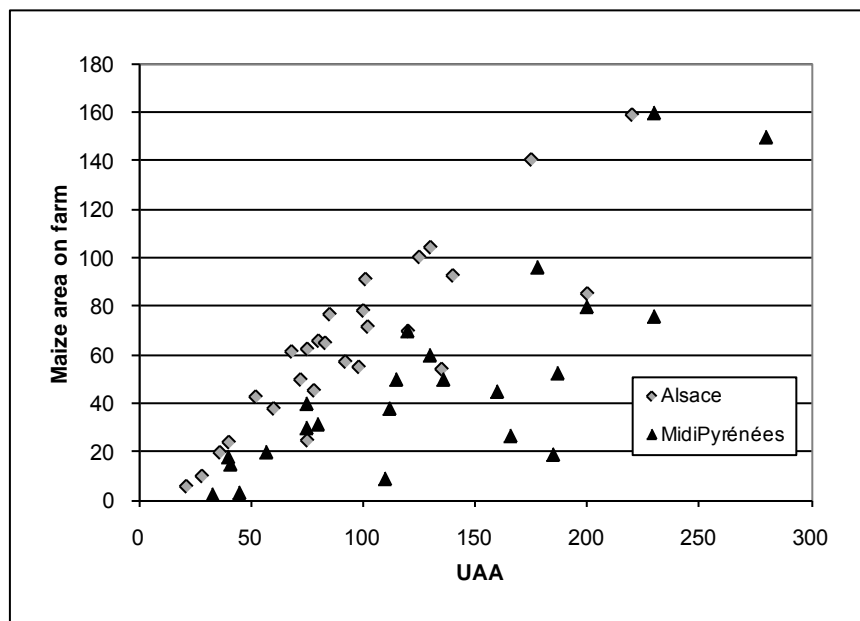


Figure 1. Relationship between maize area and UAA in both regions

Even though in Alsace, maize area seemed linked to total farm area (Figure 1), the same relationship was not clear in Midi Pyrénées. However, maize seemed to be the main income source for 29 farms.

Maize management

In Midi-Pyrénées, the sowing date was more or less stable between farms and highly dependent on the frequent rain in April and May, which is the sowing period. In Alsace the sowing date depends on the sub-region. In Sundgau, the hydromorphic conditions of clay soils delay the sowing to the second decade of April while it is possible to sow 10 days earlier in Plaine of Ill. However, shifting flowering period via sowing dates and maize precocity may be possible in some farms

In Midi-Pyrénées, corn-borer and sesamia were perceived as a risk for maize yield for 12 of the 19 farmers who answered this question but only 8 of those treated their maize crop with a pesticide. We compared the number of varieties used each year in farms with total maize area and with return time of maize on a given plot both in both regions (Figure 2). Varietal choice did not seem linked to either maize area or maize return time on a plot. Thus farmers did not use varietal choice either as a mean of managing pest risk.

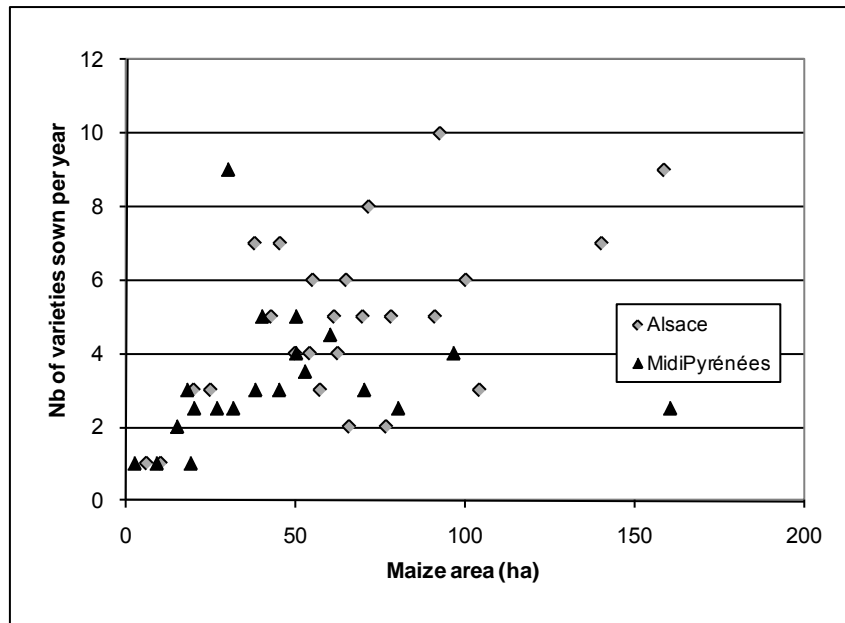


Figure 2. Relationship between the number of varieties sown and maize area in each farm.

In all cases surveyed where GM maize had been cropped, it was managed as the NGM maize, except that pesticide was never used on NGM maize.

Maize harvest was mainly done by private firms (30 farms). In 19 farms only, the farmer harvested his maize himself (in 6 cases with neighbours) and for maize seed production, the seed company itself harvested the seed.

Maize monoculture was also the main crop rotation in the sample surveyed but some farmers waited up to 6 years before cropping maize again on a given plot.

In Midi-Pyrénées, 12 farmers identified localization constraints on the maize, due in 6 cases, to the difficulty of irrigating some plots. In Alsace, the impossibility of putting more profitable crops in some soils increased maize area.

Means used to limit GM/NGM mixture in Midi-Pyrénées

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 neighbour cropping maize and thus did not put in place any coexistence mean. In another, the neighbouring NGM maize was his and was pop-corn maize, which cannot be pollinated by grain maize.

In 15 cases, buffer zones of NGM maize were put in place around the GM maize. In the case of some of the NGM 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 distanced their maize crop from their neighbours': two farmers isolated their GM maize to keep it from pollinating NGM 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 NGM maize.

Other coexistence means were used: in two farms, NGM maize was harvested first so as not to mix harvested grain; in one farm, NGM 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 NGM 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 NGM 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 NGM 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 NGM maize. In 2 cases, the use of GM maize enabled the farmer to gain flexibility in his work organization.

Means projected to limit GM/NGM mixture in Alsace

In Alsace, differences in flowering period of 2-4 days with different precocities have been observed in seed producing maize, according also to sowing date and yearly climate. To limit mixture, GM maize would have to be more precocious, with a lower potential yield. This coexistence mean would be less adapted to the Sundgau region (hydromorphic soils). As for the buffer zones, they could be used in some farms with large and regular fields but in small fields they would use a too great part of the field, rendering the use of GM maize uninteresting. Another coexistence mean discussed with the farmers was the increase of the distance between maize plots but due to the high percentage of maize in the region, this did not seem possible, especially in the Plaine. Co-organization of maize cropping between neighbours seemed to be an answer to these two problems but due to differences in objectives and working habits, it would be hard to set in place.

General synthesis and discussion

Explaining GM maize cropping

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 NGM maize. That is especially the case in Alsace which has been organized as a GM free region for 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 and mean maize yield may also have an effect on GM maize adoption (Tables 1 and 2). Farmers with a high perceived presence of corn-borer or with a high corn-borer risk due to crop rotation (Table 1) used GM maize more often to limit this risk.

Table 1. Relation between crop rotation length and GM maize adoption.

Crop rotation with maize on the farm	Monoculture	Maize 5 years/cereal	Intermediate (3years maize/3 years other crops and maize)	Long rotation (min. 4 years between 2 maize)
GMO presence	9 farms	2 farms	2 farms	1 farm
GMO absence	1 farm	1 farm	2 farms	4 farms

Table 2. Relation between mean maize yield for conventional maize on the farm and GM maize adoption

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

Table 2 shows that only farmers with a high mean conventional maize yield used 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. 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. No comparison of economic return was made between systems.

Coexistence means are different according to regions

In Midi-Pyrénées, the main coexistence mean used was the buffer zone, whereas in Alsace, the main projected coexistence mean was changing the sowing date. This can be explained by the field patterns and the climate of both regions. Thus each region seems to have adapted or be ready to adapt the coexistence means to its own structural characteristics as is recommended in Le Bail *et al.* (2010).

Different reasons to accept or refuse GM maize for farmers

In Midi-Pyrénées, 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)
- strategic 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.

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 pest 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 or were prepared to manage GM and NGM maize using coexistence means adapted to their region.

We are now beginning 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.

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