

INTRODUCTION – DOSSIER

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RAPSEED: SOME EXAMPLES OF CURRENT FRENCH RESEARCH
COLZA : QUELQUES EXEMPLES DE RECHERCHE EN FRANCE

CETIOM's involvement in rapeseed research

Created in 1957, CETIOM is the research and development organization for France's vegetable oils and proteins sectors and its hemp industry.

The main objective of the organization is to improve the economic competitiveness and sustainable production of oilseeds, protein crops and industrial hemp at all stages, from production to their use as processed products. The main crops concerned are rapeseed, sunflowers, soybeans, linseeds, peas, fava beans, lupines and industrial hemp. Operating at the research and development frontier, CETIOM, via its experts and its experimentation network, brings together more than 600 trials per year. It works with organizations concerned with the development of oilseeds, protein crops and industrial hemp as well as with industrial agricultural supplies and processing. It also works in partnership with public research institutions.

CETIOM is involved in several international research programs and hosts two major international organizations: the International Consultative Group Research on Rapeseed (GCIRC) and the International Sunflower Association (ISA).

The main activities in research on rapeseed (winter almost exclusively) are presented here. They can be classified into four major themes.

1 Consolidate expertise to the public debate and organize bio-monitoring

Developing and sustaining the oilseed sector requires an understanding of markets and consumer expectations. Attaining this goal necessitates identifying the strategic decision makers and developing among policy-makers a shared vision. To this end, CETIOM has put in place a monitoring system and developed strategic foresight capabilities.

CETIOM participates in work on honeybees. Rapeseed is a major crop for production of nectar and pollen, much visited by pollinating insects. Technical practices on this culture are therefore likely to have an impact on the activity and population levels. The studies focus on both internal parameters to the colonies (brood areas, mortality...) on the pollinating activity and matrix samples (pollen traps, fresh nectar). The studies are carried out in field conditions and implement innovative techniques (RFID chips for identification of bees for precise monitoring of their activity: entrance out of the hive, flight duration, mortality, etc.). These devices are also used to study the impact of potentially harmful agricultural practices (insecticide treatments on seed or on the crop) on life traits of bees.

2 Assess inputs by developing agro-ecological approaches

CETIOM is committed to supporting plant breeding programs and itself conducts a variety of evaluation trials addressing many criteria: crop protection, agronomy and ecophysiology, quality. Each time, the environmental impacts are quantified.

Support for plant breeding

CETIOM has a well-established tradition of partnership with public research bodies and with seed companies. Current projects focus on plasticity and recovery of nitrogen, the optimal exploitation of genetic resources and resistance to diseases and broomrape for rape. Through an analysis of genotype-environment interactions, the collected data are published each year (mail, web site update, technical meetings).

Each year, CETIOM's support for plant improvement is also achieved through regular funding of doctoral theses.

An example of this is the partnership program, RAPSODYN, coordinated by INRA Rennes (UMR Environment Institute of Genetics and Plant Protection), which tries to create better varieties of rapeseed using nitrogen while optimizing their content and oil yield. The approaches are multidisciplinary and work streams range across bio-informatics, genomics, phenotyping, ecophysiology and modeling.

Agronomic evaluation of varieties

Network trials evaluate varieties not only on yield but also on agronomic criteria of quality or resistance to pests. This enables CETIOM to provide a wide range of information for an optimal use of varieties in cropping systems. Each year CETIOM coordinates with its partners a network assessment of rape varieties that covers both the material available to producers as well as the varieties included in official trials for registration. Each time, qualitative data complement the agronomic evaluations and performance. These data are now valued as part of the modeling of interactions between varieties and environments.

Plant protection: analytical approach and sustainable approach

The approach looks for effective means of achieving economic and environmentally friendly crop protection. To attain this goal, CETIOM research seeks to improve understanding of rapeseed pests: identification and inventory of insects and pathogens, monitoring and predicting the risk of harmful attacks, as well as protection strategies. In cooperation with the chemical's companies, CETIOM contributes to evaluating the effectiveness of active ingredients. The data obtained facilitate model development (risk prediction, protective strategy).

Sclerotinia remains in our context, the most critical pathogen, unlike phoma where genetic resistance is present and implemented already.

On sclerotinia, if we are still looking for genetic variability, the most appropriate solution to date appears to be the fungicide approach (treatment at mid-flowering, when petals fall).

Among the most critical pests, we can identify: beetles, stem weevils or terminal bud weevils. These insects are the subject of most of our investment: better knowledge of biology, harmfulness, monitoring and risk analysis. Assessments of insecticide efficiencies also enable better adjusted protection strategies in a framework of sustainable agriculture that respects pollinators.

Our monitoring device focusses on emerging pests, including clubroot and broomrape rooter present on the Atlantic coast, with expansion spots being regularly detected in other regions.

CETIOM also conducts studies to develop molecular tools for identifying and quantifying various soil pests (this is the case for hernia) or for identifying pathotypes of broomrape present in French soils. These approaches also concern insects.

Regarding weeds management, and beyond the assessing the effectiveness of active ingredients, CETIOM has been developing for several years a range of integrated approaches that take account of the cropping system and rotation. Alternative techniques (hoeing or hoeing combine with herbicides) are promoted. Monitoring the risk of resistance development is also taken into account.

Agronomy, physiology and nutrition

Research in agronomy addresses the farming of rape: improving early growth through the preparation of the seedbed, sowing date and equipment (precision driller). Innovative approaches are being evaluated thought networks of farmers: techniques for frost-free pulses (in the same sowing bed) and their benefits focus on the supply of nitrogen to the crop, as well as on crop protection (reduction in attractiveness to pests).

Regarding plant nutrition, nitrogen requirements have been recently updated in order to improve the decision making tool for fertilization (*i.e.*, CETIOM method takes into account the quantity of nitrogen absorbed at the end of winter). This method is applied at the field level, as well as via satellites (*e.g.*, Farmstar).

Phosphate nutrition is also a new area of research due to a declining practice among producers: it aims to clarify the benefits and limitations of localized P fertilization.

As for soil, CETIOM undertakes scientific monitoring in order to better understand the relationship between ecological functions and ecosystem services attributable to microbiology biodiversity.

A performance prediction model on rapeseed (Azodyn) used at the plot level, capitalizes on knowledge of this culture and integrates genotypic effects for different applications: yield prediction, identification of limiting factors, tests technical traits, opportunities for virtual experiments to be associated with real experiments.

3 Optimization of the cropping system

Set up new agricultural production systems

The purpose of this thematic research is to develop new and more sustainable cropping systems, for both conventional and organic farming. These include strategies for diversification of well-established systems (base on rape/wheat/barley) by introducing legumes or others alternative crops. The work will also contribute to the analysis of ecosystem benefits provided by the service plants in a covered rapeseed-legume. It also aims to make cropping systems more efficient in their use of pesticides.

The development of organic agriculture cropping systems includes the characterization and evaluation oilseed crop introductions. Annual analytical tests are conducted on rapeseed in order to optimize practice (experiments of association with legumes frost-shattered...) and for supporting the development of local industries.

Improved environmental assessments, impact of new practices and technologies

French agriculture seeks to be part of a sustainable agriculture respectful of the environment. To facilitate this, CETIOM assists in the development of reliable, relevant and measurable multi-criteria indicators. More specifically, and considering the fraction of the rapeseed production recovered in the form of bio-fuels, the work focuses on four environmental issues: fossil fuel consumption, emissions of greenhouse gases (GHG), water quality and biodiversity. Among GHG the emissions of N₂O from crops is specifically studied in three areas:

- developing reliable simulation tools for N₂O emissions under French conditions;
- establishing a database for those emissions (mainly for rapeseed) through a network of experiments;
- looking for new practices to safely reduce emissions.

4 Management of the product quality

Our expertise in the technological process allows us to carry out experiments or to be partners in research programs seeking to promote the use of oilseeds (oils, cake...).

Animal feed: cake from rapeseed constitute a competitive alternative to traditional raw materials used in animal feed, particularly those based on imported soybeans. Research areas deal with both product knowledge, but also the optimization of technological processes (alternative to hexane, microwave cooking...) to maintain the quality of the meal (protein digestibility, co-products, micronutrients of interest...). Inquiries (seeds and oil cakes) are conducted annually to know about of product quality.

Food: the development of products beneficial to health is a fundamental trend in the consumption habits of the French. Our research focuses on the balance between the supply of seeds and consumer needs (for example, the production of oils rich in omega-3 and micronutrients).

Biofuels: in the field of biodiesel, our work focuses on production processes, including improving the energy balance of the crushing. The objective is to develop new processes that are both more economical and more environmentally friendly.

Plant chemistry: questions from industry are increasing on this point each year. The aim is to create from oils chemicals that could substitute for petroleum products. Whether traditional chemical pathways or new industrial biotechnology routes (enzymatic synthesis, bioconversion, fermentation...) are used, this chemistry could give rise to the obtention of many types of high value-added products (lubricants, paints, inks, bioplastics...). The erucic rapeseed is a good candidate for such approaches.

In order to support improvements in analysis, CETIOM is also involved in standardization methods (AFNOR, ISO...) in the area of oilseeds and fats.

More information on this research program can be obtained via CETIOM's activity report available on our web site at: <http://www.cetiom.fr/le-cetiom/nos-actions/rappor-dactivite/rappor-dactivite-2014/>.

5 OCL's dossier

The papers presented in this issue of OCL seek to provide illustrative examples of the research conducted on rapeseed in France by CETIOM or by its partners.

The first article focuses on agronomic innovations in the growing of rape. The authors illustrate the positive effects of growing rapeseed alongside legumes (sensitive to frost) and highlight a bonus for nitrogen availability (+30 kg of nitrogen N on average, which will be deducted from nitrogen fertilization at spring). Ground cover is increased, leading to reduced weed pressure. Moreover the association of the two crops works as a lure for insects (beetles and terminal bud weevils).

The article on the erucic rapeseed is an example of the genetic diversity of this species and illustrate the value of erucic acid for industrial uses. The paper presents an analysis of the genetic determinism of this character and potential areas for improvement but also the variation factors explaining the variability of the erucic acid content of the oil.

The nutritional benefits of canola oil "00" are particularly well illustrated through the article on the effect on aging of diets enriched in C18:3. This article reports the essential beneficial results of rapeseed oil as demonstrated by the medical community through the linolénage project. This work is supported by the French Oilseed Interprofessional Organization (ONIDOL).

Finally technological improvements in the industrial process by which seeds are dehulled has allowed new uses in animal feed meal. New techniques have lowered the proportion of cellulose meal and increased the protein content, thereby extending its uses beyond monogastric animals.

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