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INTRODUCTION OPEN ACCESS

New ideotypes of oil & protein crops

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Fifty years ago, Donald (1968) introduced the concept of "ideotype" in plant breeding with the following sentence: "*The term "*ideotype*", literally "*a form denoting an idea*", is here proposed for biological models. In its broadest sense, an ideotype is a biological model which is expected to perform or behave in a predictable manner within a defined environment*." While he mainly argued his advocacy on wheat, this concept became very familiar from the beginning of the 1970's in the whole plant breeding domain. It is worth noting that modeling the crop functioning was already present behind the Donald's "ideotype".

The first plant ideotypes were defined with the primary objective to increase the yield potential. For example, the wheat ideotype was designed as having erect leaves to optimize the photosynthesis. However, Donald wrote "*Thus the use of varieties with erect foliage will involve greater attention to weed control by methods other than by competition from the crop*". This shows that the ideotype is highly context dependent. Indeed, today, the ability for a crop to compete with weeds became a breeding target (Van der Meulen and Chauhan, 2017), due to the rejection of chemical herbicides by the public opinion.

In this Special Issue, the term "ideotype" does not focus on yield or photosynthesis optimization through plant architecture, but on the complex profile defined by the wide and more and more diverse set of the breeding targets, including quality traits. The purpose is neither to draw what should be the ideotype of oil and protein crops. Rather, we aimed at explaining some aspects or approaches to take into account regarding the definition of an ideotype.

As a scientific introduction to the topic, Gauffreteau (2018) is explaining how the concept of ideotype could help in building a framework to design a target – actually, a multidimensional target, either phenotypic or genotypic – with the different stakeholders.

The world market for agricultural products has been becoming both global and highly segmented. Thus, while a single type of cellular phone, even under different trademarks, is produced and marketed all over the world, there is an increasing diversity of crop productions to fulfill the needs – or the requirements, which are not obviously the same – of the population and the industry. Tonin *et al.* (2018) discussed how the three main actors (consumers, farmers, food industry) are contributing to define a multivariate ideotype, particularly for the harvest quality traits.

Among the researchers involved in plant breeding, Donald (1968) was probably the first to invoke "model plant" as a tool to trace a road aiming to solve the questions raised by plant biology, physiology and breeding. It's one of the reasons why, in this Special Issue, Jasinski *et al.* (2018) were solicited to explain how the use of *Arabidopsis thaliana* model plant is of interest to explore by which way the alternative resource allocation between oil and protein could be managed by genetic design.

As it has been already the case, from time to time all along the past fifty years in Europe, more and more interest is devoted to leguminous crops. Oil crops like oilseed rape and sunflower can provide protein meal for animal feeding. However, these crops are (mostly for oilseed rape) "chemical nitrogen dependent", and with some dietary limitations for animal feeding when compared to imported (and mostly GMO) soybeans. Increasing the knowledge on the interaction of leguminous plants with the agronomic environment could benefit to projects aiming at limiting greenhouse gas (GHG) emissions in increasing the part of plant protein in human consumption (Springmann *et al.*, 2018). G. Mendel opened the way a couple of centuries ago: *Pisum sativum* is certainly a good model in Western Europe to decipher how it works. Burstin *et al.* (2018) provides explanations regarding the PeaMUST project, which aims to solve some of these challenges.

More as a comment than as a scientific demonstration, we also asked here (Vincourt and Carolo, 2018) whether the Participatory Plant Breeding approaches are modifying the definition and/or the conceptual and practical content of the ideotype. It seemed to us of interest to decipher how, in this field, the interaction between science and society became of upmost importance.

Not all the topics of interest regarding the ideotypes in plant breeding found the opportunity to be discussed in this Issue. For example, it would have been interesting to get the point of view of expert and regulatory organizations such as GEVES in France (https://www.geves.fr/about-us/, French Ministry of Agriculture). Indeed, GEVES is clearly involved,

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including with scientists in plant biology, breeding and agronomy as well as farmers representatives, in the definition of ideotypes for agriculture. Probably because the ideotype is considered as a marketing secret by private seed companies, we did not succeed to include the approach of these stakeholders. Also, because modeling the crop growth and functioning is becoming an accessible dream in the big data world (ex.: Mangin *et al.*, 2017), and because Donald (1968) clearly predicted that modeling could be the way to design future crops, we would have preferred to get the possibility to enhance this way. We however hope that this Issue will provide insights regarding ideotypes: reasoning on "biodiversity" of the plant breeding targets.

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