Note: General Font type: Times New Roman
Format A4; Upper margin 3 cm, other margins 2.5 cm each.
Start the first page with [2 lines free, 12 pt]

FoodMC: a COST Action to promote modeling in food science and industry [font: 15 pt, bold, flush left]

[1 line free, 12 pt]

Alberto Tonda[1]
[1]*UMR 782 GMPA, Université Paris-Saclay and INRA, 1 Av. Lucien Brétignières, 78850, Thiverval-Grignon, France* [font: 12 pt, italics, block]
e-mail address(es) (if desired): alberto.tonda@inra.fr [font: 12 pt, italics, block]
[2 lines free, 12 pt]

Abstract[font: 11 pt, bold]: Methodologies and tools from Maths and Computer Science (MCS) are emerging as key contributors to modernization and optimization of processes in various disciplines: the agri-food sector, however, is not a traditional domain of application for MCS, and at the moment there is no community organized around solving the issues of this field. The COST Action FoodMC brings together scientists and practitioners from MCS and agri-food domains, stimulating the emergence of new research, and structuring a new community to coordinate further investigation efforts. Exploiting approaches originating at different subfields of MCS, from applied mathematical models to knowledge engineering, this COST Action will cover two main topics: understanding and controlling agri-food processes; and eco-design of agri-food products. During its first year of existence, COST Action FoodMC helped fund several international collaborations between European researchers, fostered the drafting of survey papers on food modelling, organized meetings for discussion, and co-funded a training school. [font: 11 pt]
[1 line free, 11 pt]

Key words [font: 11 pt, bold]: European project, COST Action, modelling, food modelling, networking [font: 11 pt]
[2 lines free, 12 pt]

Introduction [font: 13 pt, bold, flush left]

[1 line free, 12 pt]

European Cooperation in Science and Technology (COST) is Europe's longest-running intergovernmental framework for cooperation in science and technology. Founded in 1971, COST holds a successful history of funding science and technology networks for over 40 years, offering scientists the opportunity to embark upon bottom-up, multidisciplinary cooperation across all science and technology domains. Also known as COST Actions, these science and technology networks allow scientists to grow their ideas by sharing them with their peers. This gives impetus to their research, career and innovation. Researchers, engineers and scholars from both public and private sectors can set up their own network in any field of science and technology. [font: 12 pt, no indent]

COST Actions grow throughout a funding period of 4 years. The funding covers networking activities such as meetings (e.g. travel, subsistence, local organiser support), conferences, workshops, short-term scientific missions (STSMs), training schools,

publications and dissemination activities. COST does not fund research itself. [font: 12 pt, indent of first line: 0.8 mm]
[2 lines free, 12 pt]

Challenge [font: 13 pt, bold, flush left]
[1 line free, 12 pt]

Food processing and agricultural products catering companies are one of the major employers and economic forces in the EU, representing both a central component of the agro-food system, and a crucial provider of biomaterials and biofuels. In recent years, this strategic industry has been facing unprecedented challenges, mainly concerning food security and the threat of climate change. Additionally, the production of processed agricultural products needs to adopt and comply with several new regulations, aiming at reducing waste, improving re-utilization of by-products, limiting energy consumption and lowering the overall environmental impact. These demanding objectives can only be achieved through appropriate adaptation and innovation in the food processing activity. Disruptive innovations, however, require considerable economic efforts and the development of new skills not readily available in the agro-food domain, especially in small and medium enterprises (SMEs). A considerable number of unsustainable practices are still in place, due to the high cost of experimenting with new techniques on existing production/supply chains and validating scale-up.

There is evidence that developing Mathematical and Computer Science (MCS) models for the target processes can contribute to solving the issue (Trystram, 2012), allowing even SMEs to optimize resource management and economic outputs, while guaranteeing the current levels of quality and availability of products. The agro-food industry, however, is not a traditional application domain for MCS: at the moment, there is no structured community around this issue, nor a coordinated effort to advance the state of the art; and building adequate mathematical models for specific applications is extremely knowledge and labour intensive. It is the role of academic research to initiate the development of methods, functional models, software or technologies, which will be critical to guide the evolution of the food processing industry with regards to the grand challenges of the future.

MCS researchers and practitioners can also benefit from working on agro-products industry applications, since the field provides considerable challenges to existing methodologies in MCS: uncertainty of the data, multi-scale description of the systems, coupling of models, representation of expert knowledge, etc. As the upcoming challenges for the industry grow more pressing, promoting cooperation between agro-food and applied mathematics becomes more and more urgent. The aim of this COST Action is thus to create a community of scientists and practitioners from the two different domains, stimulating the emergence of new research and ideas tackling these ambitious topics.

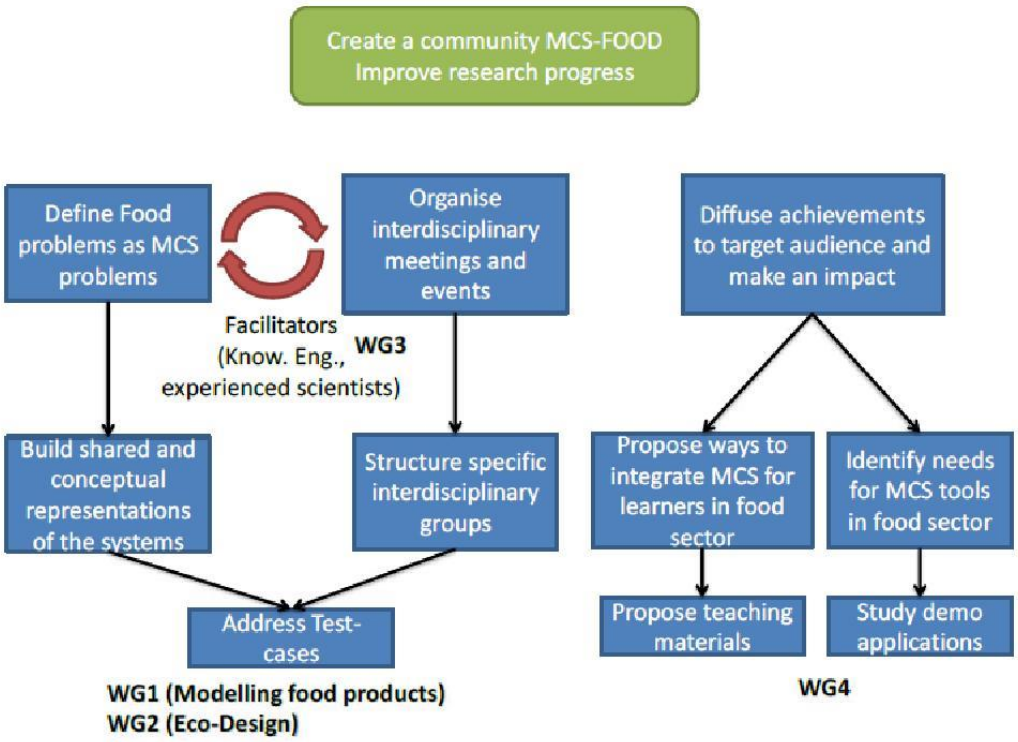
The development of novel mathematical and computer models, following the complex systems and knowledge engineering paradigms, has been slowly gaining support in the agro-food community over the last two decades (Van Mil, 2014 and Perrot, 2016). Existing projects, however, are scattered and uncoordinated, focusing more on the solutions to specific issues than on an organized collection of demands and techniques in the field: for these reasons, major methodological breakthroughs, even stemming from applications, are still extremely rare. Although food production is a major industry in most countries, the number of publications dedicated to the treatment of food industry problems by means of innovative MCS modelling is well below that of other types of industries. Coordinating the currently divided research efforts is crucial to avoid re-discoveries and dispersion of useful data, and at

the same time promoting the sharing of theoretical and experimental results. Moreover, the application domain of agro-food products is rich and multi-faceted, and research efforts so far have not been balanced over all aspects. As a result, several features of the considered challenges are not well understood, while the expertise around others should be further developed. Significant progress in the domain can be obtained by providing a roadmap with well-defined MCS problems, addressing critical issues in food processing, in particular food security and sustainability. This issue calls for the close collaboration of domain specialists with mathematicians and computer scientists. [font: 12 pt]
[1 line free, 12 pt]

Action organization [font: 13 pt, bold, flush left]
[1 line free, 12 pt]

Please avoid typing errors [font: 12 pt, bold, italic, flush left]
FoodMC officially started on \textbf{April 11, 2016} and currently includes researchers from 27 different European nations and partner countries (Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyrprus, Denmark, Finland, France, Former Yugoslav Republic of Macedonia, Germany, Greece, Ireland, Italy, Lithuania, Luxembourg, Malta, The Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovenia, Spain, Switzerland, Turkey, and the United Kingdom).

The Action is divided into four Working Groups (WGs), organized as in Figure 1. Each WG is going to focus on a specific aspect of the network, ranging from exploring suitable real-world case studies, to discussing industrials' and practitioners' needs for efficient modelling tools, to gathering and sharing information.Twenty years ago, IOBC published a document that can be considered as one of the cornerstones of Integrated Production in Europe. Key element in this collection of documents is the Declaration of Ovrannaz. It was established by a group of entomologists that met in the Switzerland to discuss the principles of Integrated Plant protection [font: 12 pt, block]
[2 lines free, 12 pt]



[1 line free, 12 pt]

Figure 1. Organization of the Working Groups in the Action. [font: 12 pt]
[2 lines free, 12 pt]

WG 1: Modelling food products and processes [font: 12 pt, bold, italic, flush left]
This group is focused on MCS solutions for modelling food properties and food processes. As the domain is very large, the group will identify the opportunities susceptible to lead to breakthroughs and to meet stakeholders' needs, and will focus the work on the description of benchmark case-studies.

This WG will produce a state-of-the-art review of food products and food process modelling, an overview of the scientific challenges and finally identify stakeholders concerns. WG 1 will provide guidelines for research at both the fundamental and the applicative level. The WG members will be in charge of identifying modelling approaches with a potential high impact on food sector activities, and define benchmark case-studies that will be addressed during Action workshops and STSMs. Finally, this WG will promote the use of MCS solutions in the food sector through the creation of training schools. [font: 12 pt, indent of first line: 0.8 mm]
[1 line free, 12 pt]

WG 2: Eco-design of food processes [font: 12 pt, bold, italic, flush left]
This group will describe the kind of systems to be addressed by eco-design, the appropriate MCS techniques and tools to be used, it will propose illustrative/pedagogical case-studies and define the boundaries of this interdisciplinary research, that will lead to the delivery of suitable methods and tools in the future.

Mirroring the actions on WG 1, WG 2 will describe the state of the art for modelling in eco-design, addressing the complex network of interactions linking the agro-food activities together, which grows more intricate with system size (local, regional, international). To do

so, the WG will collect and integrate inputs from involved stakeholders and specialists from different disciplines, through dedicated meetings, workshops and STSM. Finally, it will identify a few representative case studies that the scientific community could efficiently address. [font: 12 pt, indent of first line: 0.8 mm]
[1 line free, 12 pt]

WG 3: Eco-design of food processes [font: 12 pt, bold, italic, flush left]
The WG has the objective to promote the development of computer applications, allowing a larger audience of users to exploit scientific results. Expert knowledge, experimental data and mathematical models will be used to answer the users' needs.

WG 3 will address the problem of the low delivery of operational tools based on food science research results. Existing applications, such as web semantic applications, knowledge-based systems, simulation tools, will be adapted to the food sector. The WG will identify the main needs of the users that can benefit the most from the development of such tools. A limited number of case-studies will be identified and addressed during the Action, through specific workshops and STSMs, from the second year. At the end of the Action, results will be disseminated to interested users through a comprehensive report, and a training school will be organized with the gathered materials.

WG 4: Knowledge acquisition and diffusion [font: 12 pt, bold, italic, flush left]
The WG's objective is to promote dissemination of the Action results, via the design and maintenance of the Action website. More than a support to convey related information and deliverables, the Action website will stimulate knowledge transfer. This WG's activity will also favor communication, as successful interdisciplinary research requires a mutual understanding between participants with different backgrounds. Face-to-face meetings of specialists from distant disciplines are generally insufficient to reach this point, because a typical expert relies on a great deal of tacit and implicit knowledge. Shared understanding can be promoted by formalization of tacit knowledge and participatory modelling using, for example, visualization techniques that support acquisition of knowledge. WG members will work with the other WGs leaders to take part into activities that require strong interdisciplinary exchange, and organize the co-construction of knowledge models.
[2 lines free, 12 pt]

Preliminary results and conclusions [font: 13 pt, bold, flush left]
[1 line free, 12 pt]

As of October 2017, FoodMC organized several Working Group meetings (in France, Portugal, and the Former Yugoslav Republic of Macedonia), funded over 10 short-term scientific missions for young and experienced researchers, and co-sponsored the training school on food modelling MSFS (http://www.virprofood.org/msfs2017/). Furthermore, a series of publications on the state of the art in the field are under review, and a series of webinars has been organized and uploaded to the Action's YouTube channel (https://www.youtube.com/playlist?list=PLADEOERvB68u-jE659G0O4pXeFwCnooQp).

While the topic of food modelling has been partially explored in several applied European-level projects, FoodMC aims at creating a European network dedicated to a high-level discussion on the current state and future of food modelling, and its repercussions on supply chains and eco-design of processes. Ideally, this COST Action could be a great think tank to devise and propose new research project, and explore cooperation with private

companies. As it is always possible to join a COST Action in its first years, I encourage the reader to seek further information and, if interested, contact the main proposer or the participants, on the COST Action website (http://www6.inra.fr/FoodMC). [font: 12 pt]
[2 lines free, 12 pt]

References [font: 13 pt, bold, flush left]

[1 line free, 12 pt]

Perrot N.; De Vries H.; Lutton E.; van Mil H.G.; Donner M.; Tonda A.; Martin S.; Alvarez I.; Bourgine P.; van der Linden E.; et al., 2016. Some remarks on computational approaches towards sustainable complex agri-food systems. Trends in Food Science & Technology, 48, 88-101.

Trystram G., 2012. Modelling of food and food processes. Journal of Food Engineering, 110, no. 2, 269-277.

Van Mil H.G.; Foegeding E.A.; Windhab E.J.; Perrot N.; and Van Der Linden E., 2014. A complex system approach to address world challenges in food and agriculture. Trends in Food Science & Technology, 40, no. 1, 20-32.