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iCROPM 2020: Crop Modeling for the Future

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Abstract

During the past decade, the interest in using crop models for research, education, extension, outreach and in the private sector has rapidly increased. The iCROPM 2020 Symposium entitled 'Crop Modeling for the Future', held in February 2020, therefore, provided a great opportunity for over 400 scientists from 50 different countries to exchange information on crop model development, evaluation with experimental data and implementation. A key outcome was the understanding that crop models simulate the dynamics of the soil-plant-atmosphere continuum. Thus, the models can be used for a quantitative and multi-criteria assessment of cropping system functioning, agronomic performance and environmental impact. This should result in more practical applications that can provide actionable information for stakeholders.

The field of crop modelling is relatively new in the agricultural science discipline compared to plant breeding, soil physics and soil chemistry, and originated approximately five decades ago. Some refer to the publication by De Wit (1965) on modelling photosynthesis as one of the groundbreaking studies on crop modelling in Europe, resulting in the SUCROS and WOFOST style models that are still being used today (Bouman *et al.*, 1996). In the USA, the first crop models were based on a systems approach for understanding and improving crop management, with the GOSSYM-COMAX for cotton irrigation and nitrogen management as one of the early success stories (McKinion *et al.*, 1989). A more detailed review of the history of agricultural system models can be found in Jones *et al.* (2017).

During the time when the first crop simulation models were developed, there was not much scope for presenting modelling studies at scientific meetings and publishing modelling results in society and other scientific journals. Therefore, the Biological Systems Simulation Group (BSSG) was established in the USA during the 1970s, mainly for an informal exchange on the development and application of simulation models in agriculture. All presentations were published as extended summaries in proceedings, but there was, however, limited international participation. Due to lack of interest and limited funding for travel, the BSSG meetings were, after more than 40 successful meetings, discontinued. At the same time, the agricultural societies became more receptive to presentations and especially publications on crop modelling that included studies on crop model development, improvement and evaluation, and applications to address real-world problems.

One groundbreaking symposium entitled 'Modelling Cropping Systems: Science, Software and Application' was held in Florence, Italy in 2003 and was sponsored by the European Society of Agronomy. The outcomes of this symposium resulted in a special publication on crop models that had been developed by the main modelling groups across the globe (van Ittersum and Donatelli, 2003). As of today, many of these papers are still very highly cited. During the 1990s and 2000s, most of the crop modelling activities and associated presentations occurred during the annual meetings of the European Society of Agronomy, the annual international meetings of the American Society of Agronomy-Crop Science Society of America-Soil Science Society of America, and the annual meetings of the American Society of Agricultural and Biological Engineers. The Agricultural Intercomparison and Improvement Project (AgMIP; www.AgMIP.org) and the Modelling Agriculture with Climate Change for Food Security (MACSUR; https://macsur.eu/) project in Europe also facilitated international meetings among agricultural modellers, but focused on climate change impact and adaptation in agriculture and issues related to food security.

The iCROPM 2016 International Crop Modeling Symposium held in Berlin, Germany in March 2016 provided a new opportunity for crop modellers to interact informally and to exchange information. One of the main goals of iCROPM 2016 was to discuss the underlying science for crop model development and improvement, the collection and application of experimental data for model evaluation, the advancement of crop model applications at different temporal and spatial scales, and new software development associated with crop modelling. The iCROPM 2016 Symposium was very successful and attracted many young scientists from across the globe. Some of the main presentations of the iCROPM 2016 Symposium were published as scientific papers in two special issues (Nendel *et al.*, 2018; Thorburn *et al.*, 2018). Some of the key challenges to crop modelling that were identified during the symposium included data and especially Big Data, innovation in modelling and models, credibility of models, capacity building and training, the overall goal of model applications, and community challenges, such as the involvement of young modellers and gender issues.

The success of the iCROPM 2016 Symposium resulted in the Second International Crop Modeling Symposium. The iCROPM 2020 Symposium, entitled *Crop Modeling for the Future*, was held from 3 to 5 February 2020 at the Le Corum Conference Center in Montpellier, France. Following the iCROPM 2020 Symposium, the AgMIP crop modelling teams for maize, maize evapotranspiration, soybean, wheat, low input farming systems, global gridded crop modelling, crop model calibration, ozone impact, and extreme events met for 2 days at Agropolis International in Montpellier, France. Unfortunately, it was one of the last 'in-person' conferences that was held in 2020 prior to the termination of all travel and cancellation of in-person meetings due to the Covid-19 pandemic. In fact, several scientists from China had to cancel their participation at the last minute. Nevertheless, the iCROPM 2020 Symposium brought together over 400 scientists representing 50 countries, including many young scientists. One of the main goals of the iCROPM 2020 Symposium was to facilitate an informal exchange on the improvement and application of crop simulation models. The symposium included six oral sessions that covered topics such as improvement of crop models, crop modelling for ecological intensification, linking crop/plant models and genetics, linking crop models to data streams in the digital age, crop modelling for impact and risk assessment, and methods and software to support modelling activities. There were two plenary sessions that facilitated speed talks on the main crop modelling and software platforms. For a more informal interaction among the participants, there were also six poster sessions with the posters on display for 3 days during the entire symposium. A key outcome of the iCROPM 2020 Symposium was that we now must clearly consider that crop models are in reality soil-plant-atmosphere models in which the cycles of water, carbon, nitrogen and sometimes other nutrients are simulated as the daily or sub-daily interactions of the soil-plant-atmosphere continuum. Using the crop models will then allow for a quantitative and multi-criteria assessment of cropping system functioning, agronomic performance and environmental impact.

This issue of *The Journal of Agricultural Science Cambridge* (Volume 158, issue 10) is dedicated to the iCROPM 2020 Symposium. It includes six papers that are based on both oral and poster presentations from the symposium, including the final keynote presentation. One of the main goals of this issue is to not necessarily highlight invited presentations that are normally presented by senior and well-established scientists, but rather to provide opportunities for young scientists to publish either their oral or poster presentation.

The paper by Gurkan *et al.* (2020) discusses a crop modelling study on the potential impact of climate change on sunflower production in Turkey for both rainfed and irrigated conditions. The paper by Sampaio *et al.* (2020) presents a crop modelling study on the evaluation of different planting dates and plant densities for soybean grown in Brazil. The paper by Bracho-Mujica *et al.* (2020) addresses the issue of input data requirements for crop models with emphasis on weather data and the study evaluated different solutions for scaling. The paper by Khafajeh *et al.* (2020) applies a crop simulation model for greenhouse conditions linked to fuzzy control, a somewhat new and challenging application for crop models that are normally developed for field conditions. The paper by Habte *et al.* (2020) compares two different crop models for the simulation of rainfed sorghum production in Ethiopia with emphasis on yield gap analysis.

Finally, the paper by Vasco Silva and Giller (2020) provides a general perspective on what crop modelling until now has been able to accomplish and presents a thorough review of the limitations of crop growth modelling. Based on the challenges that are identified by Vasco Silva and Giller (2020) and a comprehensive review of the abstracts of the conference contributions, it is clear that there will be new opportunities for model improvement to address food and nutrition security in a changing climate. It is expected that this will result in more practical applications covering a broader range of relevant topics that are based on scientifically robust crop models and evaluated with comprehensive data, ultimately resulting in actionable information for stakeholders.

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