frontiers in Agronomy

FIELD GRAND CHALLENGE
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Agronomy: The Science of Food Production

John R. Porter[1,2]*

[1] Faculty of Science, University of Copenhagen, Frederiksberg, Denmark, [2] Fondation Agropolis, Montpellier, France

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THE FUNDAMENTALS

"Agronomy *is the applied science of crop and plant production for food, fiber, and energy. It is intrinsically multi-disciplinary – it encompasses plant genetics, plant and crop physiology, climate and meteorology and soil science and expresses these interactions in terms of interactions between genotype x environment x management x technology (GEMT), of which it is possible to coalesce M and T to give GEM. Agronomists need to have knowledge of biology, chemistry, ecology, soil and earth sciences, pathology, weed science and genetics. In addition to understanding interrelationships among biotic and abiotic ecosystem components, agronomy focuses on ways to predict the responses of food producing systems by using models and other tools, such as statistical analysis, that had their birth within agronomy. Finally agronomy tries to improve the systems that humans use to produce food, feed, fuel, and fiber. A distinctive feature of agronomy is that it is both a science and an accredited profession."* In the current context, the above elements describe the original and fundamental elements of agronomy (Porter, 2011; Porter et al., 2012).

Agronomy is always faced with the GEM equation that stresses the interactions between its individual components. Most recent plant science has been poor at dealing with interactions, especially those where changes in scale are needed, as is the case in agronomy—from leaf to individual plant to population. The fields in which crops are grown are the only meaningful sites for the integration of otherwise reductionist plant sciences. Reductionism needs to be balanced by *integration-ism*.

Other issues for agronomy include variation in field agronomic management that can change according to the weather and the scale of variation in weather that is relevant to crop exposure to extreme events, such as high temperatures at flowering or pest or pathogen infections. Variation in farmers' financial situation and risk aversion affects how closely they try to manage for attainable yield. Access to rural infrastructure and markets is part of this consideration. Agronomy has a role not only in lifting yields but also in reducing costs and improving efficiencies and conserving the natural resource base for production. In developing agronomy we must investigate regional patterns in the relative contributions of G, E, and M to yields. The case can be made that agronomists are inevitably broader in their thinking than breeders, soil scientists or pathologists

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Davey Jones,
Bangor University, United Kingdom

***Correspondence:**
John R. Porter
jrp@plen.ku.dk

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in the sense that agronomists either as scientists or practitioner have to pull everything together for the farmer. The key spatial scale for an agronomist ranges from a square meter of crop to the field; agronomy's hierarchical stretch goes from the individual plant organ via the individual plant to the plant population and, perhaps, plant community. The agronomic temporal scale ranges mainly from a day to a year and there is nothing so practical as a good idea.

THE FUTURE

What can be the ways in which a journal devoted to agronomy can develop in the future? My personal list would include looking at how the efficiencies of crop resource use (water, nutrients, and radiation) interact with each other; remembering that agronomy is a profession and a science, I would welcome articles that addressed how agronomists are and might be trained in the future; I think it would be interesting to see if and how women and men see differently the use of agronomy, particularly in less economically developed countries and, of course the role that agronomy can play in relation to the impacts, adaption to and mitigation of climate change. I was heavily involved in several IPCC reports in the sections that dealt with food and agriculture. It occurs to me now that the direction of research travel is away from a sole focus on crop production and toward food systems. I think studies of how agronomy fits into food systems that include food processing, food consumption, and food waste, i.e., the whole food cycle, and circular food systems will become very important in the future. What does agronomy look like for systems that produce enough, waste less, recycle more, save more—instead of produce more, waste more, recycle less, and save less?

I hope colleagues will use, but not overuse, models of different kinds at different spatial and temporal scales. Simulation models can be almost magical when used properly; improperly they can be the most useless application of curve-fitting. By this I mean that comparisons of observed vs. simulated results of experiments in which the oft-heard conclusion is "the model generally was able to reproduce the observed results" are of very little value. What is of value is identifying where models have not reproduced observed results and *why?* Dig deeper. What one does in developing a simulation model is to write a series of symbols that describe crop growth and development (Hay and Porter, 2006) translated into strictly defined "computer" words and a language that a computer can understand. At its absolute best—a model then passes back to us ideas and conclusions that we had not thought of in terms of the growth and development of a crop. So a very defined, unambiguous, and restricted conversation with a machine based on electrical impulses can make us think of new things. I think that is beautiful. My own experience of this occurred in the mid-1990s when my mathematical colleague Mikhail Semenov and I discovered the importance of changes in climate variability, as opposed to changes in mean climate, for the coefficient of yield of wheat crops. We also examined the interaction between changes in variability and average climate. This discovery played an important role in the IPCC 3rd Assessment Report.

What I want to see in our journal are excellent papers that have passed rigorous examination and that are then openly released to the scientific community. This means that the best experiments will be multi-year and multi-location; they will have well-described statistics and methods, they will contribute new thinking and knowledge and they will be relevant to the challenges from such issues as global heating and the UN sustainable development goals. If we can produce papers with these goals then we will be successful. Agronomy can be seen as an applied or practical science, so please think large and wide and deep about the subject of this journal—Frontiers in Agronomy. We need to move the frontiers of our subject throughout the whole world and into the future. Humanity needs us to do this.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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