Blurring divides between basic and applied

Basic and applied research too often remain divided in agriculture. With stagnating and, in some cases, declining research funding, the innovation we need in agriculture for food systems transformation calls for greater connection and communication between the two.

Basic research is conducted to gain a more complete understanding of a subject without specific applications in mind. The goals are to obtain new observations and knowledge of the foundations of phenomena. By contrast, applied research aims to gain knowledge in order to meet a specific, recognized need. For example, according to the National Science Foundation, basic research may include activities with broad or general applications, such as the study of how plant genomes change, but should exclude research directed towards a specific application or requirement, such as the optimization of the genome of a specific crop species. In the agricultural research and development (R&D) system, Huffman and Evenson[1] developed a structural representation to define the R&D fields, which include the general sciences, the pre-technology sciences and technology invention. General sciences include chemistry, mathematics and biology. Pre-technology sciences include plant and animal genetics, soil physics and chemistry, and plant and animal pathology. Technology invention includes plant and animal breeding, agronomy and veterinary medicine.

Agriculture is now facing growing challenges, such as increasing crop production while improving efficiency under various soil, water and climate condition constraints. Innovation to address these challenges cannot be achieved by basic or applied science alone, as the growing integration of and iteration between the two has made clear. For example, comprehensive basic knowledge of genes and their regulatory pathways has facilitated improved breeding efficiency, and the science applied within the crop field easily integrates knowledge from plant molecular biology and tools such as phenomics, genomics and informatics. Similarly, the efficiency of field-based soil management approaches has been improved by developing a fundamental understanding of rhizosphere biogeochemical processes and knowledge of molecular-scale biogeochemical processes. In practice, we have innovated and progressed by working with the blurred line between basic and applied research.

In agriculture, although funding agencies and universities still commonly use the terms 'basic' and 'applied' to categorize research disciplines, the combined term 'basic and applied agricultural research' is increasingly used when referring to agricultural R&D activities. It has become common understanding over time that although agricultural research is application-oriented, the creation of scientific knowledge at the bench and its application should go hand in hand. Traditional basic research is becoming more application-oriented, and the progress of traditional applied research is increasingly driven by breakthroughs in basic research. The advent of CRISPR–Cas9 gene editing is a successful example of a discovery from basic biology being applied to biotechnology and medicine[2]; the development of the Cas9 endonuclease for genome editing resulted from more than a decade of basic research on the biological function of CRISPR. Now that research activities have outgrown their original definitions, simply categorizing research into basic and applied is no longer meaningful. In response, translational research is a growing trend. In the crop context, this refers to a systematic effort to convert basic research knowledge into practical applications[3]. However, this type of translational research is still lacking — although considerable progress has been made in basic plant science in recent decades, relatively few new ideas have been tested in an applied context[3].

Basic research is, in the main, publicly funded. In the United States, public investment in agricultural research has declined, while applied research has seen a sharp increase[4]. Meanwhile, private-sector funding has also increased over time, favouring applied research. Overall, this change may leave less room for basic agricultural research. However, important agricultural innovations can come from a better understanding of the basic biology of plants and animals[5], and advances in basic science are needed to provide new ways to address future challenges in the agricultural sector. The disproportionate focus on short-term economical returns could jeopardize agricultural innovation in the long run. Under declining and stagnant funding conditions, the best approach to advance agricultural research is to promote efficient connection and communication between basic and applied science.

Agriculture is a broad, multidisciplinary field, and dividing research into basic and applied can over-simplify the research objectives and impede cross-disciplinary collaboration. Funding agencies, research institutions and the scientific community need to increase interactions between basic and applied research to ensure sustainable development and the implementation of agricultural innovations. ❐

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