

Public–private roles beyond crop yields

Feeding 10 billion people by 2050 requires coordinated efforts between the public and private sectors to improve agricultural productivity. Reduced funding experienced by public sector crop breeding programmes in recent years could jeopardize these efforts.

Increasing yields has been the primary motivation of global grain production during the past 60 years. There are increasingly complex challenges in sustaining agricultural food production — land scarcity, climate change, soil fertility loss, yield plateaus in grain crops and compromised nutrition quality of crops. Technological advance and innovation are crucial, but fundamental questions around funding crop research may compromise efforts.

Technological innovation has been essential in boosting global crop yields. The Green Revolution of the 1950s and 1960s expedited the development of high-yield cereal varieties, improved irrigation methods, chemical fertilizers and agrochemicals, and new cultivation methods. Agricultural biotechnology, using a range of tools such as marker-assisted selection and genetic engineering, has brought the potential to speed up the conventional crop and animal selection and breeding process, and helped to improve crop management. A new age of agriculture is now upon us — with artificial intelligence, machine learning and more tools to enable precision — and it may well have the potential to transform the global food system for human and planetary health¹.

But as crop yields are already starting to plateau globally — for instance, winter wheat yields reached a plateau in many west European high-yield countries between 1991 and 2000^{2,3} — the urgency for transformation should not distract us from the sticky issue of funding. To sustain further yield gains will likely require fine-tuning many different factors in the field: better understanding of genetic potential, improving soil quality, relaxing biotechnology regulation and improving the sustainability of cropping systems. The skills, knowledge and resources to

make headway, especially given the variety of circumstances and needs of the farming community, must come from both the public and private sectors. The nature of funding in recent times has weakened the public sector's capacity in this regard.

Public funding in food and agricultural research and development (R&D) has been decreasing in many countries. In the US, public agricultural R&D fell from US\$6.0 billion to around US\$4.5 billion between 2003 and 2013^{4,5}. This has significantly impacted research programmes in many public institutions. For example, plant breeding in the land-grant institutions has significantly downsized in the past 20 years and many crops have been dropped from programmes due to lack of state support and federal funding. In a recent survey, the estimated mean full-time equivalent (FTE) of current breeding programme leaders declined by 21%, and the estimated mean FTE of technical support staff members had declined by 18% in the past 5 years in the US public institutions⁶. The same trends do not prevail in the private sector.

Private spending on agricultural R&D globally rose from US\$5.1 billion to US\$15.6 billion per year between 1990 and 2014⁷. In the US, private sector funding has risen rapidly — real (inflation-adjusted) private R&D in the sector has increased by over 60% between 2008 and 2013, with R&D by seed companies being the largest and most rapidly expanding components⁸. Private R&D for agricultural inputs had surpassed total public R&D by 2010⁷. The private sector has now already played an important role in developing technologies to raise agricultural productivity⁸.

These funding patterns have implications for the complex challenges we face in sustainable food production. Universities and public institutions traditionally

conduct fundamental research that tends to build slowly towards major agricultural innovations; the private sector favours applied crop technologies that are likely to make business-sense, to be marketable and profitable. In applied research carried out by the public sector, crop breeding, for example, is characterized by low-value, long-term programmes that may have high social returns but low profitability, and researchers often work directly with underserved communities. In addition, the education and training responsibilities public institutions carry have been reduced, and this could well bring a significant shortage of well-trained professionals to the industry. The trend towards decreased investments in public sector breeding programmes could potentially affect the sustainability of the agriculture system.

Governments, academic research institutes and commercial entities must work together, identifying roles, responsibilities, measures and funding that build resilience into public sector applied crop research programmes — and that inherently take the long-term, social view of food systems. □

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