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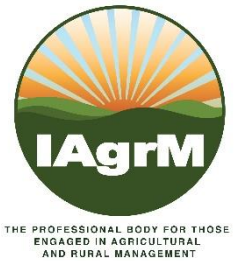

Briefing 3050

Fulfilling the opportunity to transform knowledge generation in agriculture ... By transforming the science of agriculture

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Summary

"I'm not yet convinced that the opportunity here has been fully fleshed out, and we don't yet have a road map that pulls together these strands into a unified vision to maximise progress in productivity for the farming industry"

This paper is by Daniel Kindred, ADAS and can be found here:
https://www.linkedin.com/pulse/fulfilling-opportunity-transform-knowledge-generation-daniel-kindred/

Inspired by my first Oxford Farming Conference I'm incredibly excited by what Michael Gove called the 4th Agricultural Revolution, driven by the powerful new opportunities from new technologies in data science, artificial intelligence, sensors & precision farming, genetics and new farming systems, combined with renewed control of our Agricultural Policy.

However, I'm not yet convinced that the opportunity here has been fully fleshed out, and we don't yet have a road map that pulls together these strands into a unified vision to maximise progress in productivity for the farming industry.

Sir Mark Walport, CEO of UKRI, recognised that farming has progressed by centuries of research, measurement and innovation by farmers, with farmers using Science as a daily part of their jobs. Yet when asked about the current constraints to agricultural productivity benefitting from scientific innovations, he talked of difficulties in translation from the lab in to industry, or diffusing new knowledge into practice. Sir Mark highlighted some great examples of current UKRI funded work, including Ji Zhou's CropQuant sensor from the Earlham Institute and Designing Future Wheatfrom Rothamsted Research & John Innes Centre. Melanie Welham demonstrated a range of other relevant BBSRC projects in the OFC Innovation Hub. But for a very large proportion of BBSRC-funded work the only real avenue for translation into industry is via genetics and breeding. Very little of the current UKRI programme is aimed at better understanding the variability inherent in farmed systems or helping farmers make better decisions on-farm. The top-down model of knowledge transfer ignores the crucial importance of knowledge exchange from the farmer & practitioner to the scientist – this bottom-up communication is fundamental to understanding the real constraints to productivity on-farm, and to identifying the problems & questions that are both worthy of scientific inquiry and that really matter on-farm.

Very much of the knowledge that really matters in farming is totally invisible to science, as it exists in farmers and practitioners heads, not in scientific papers. This has been recognised by the many recent initiatives embracing peer to peer learning, including AHDB Monitor Farms, Innovative Farmers Field Labs & ADAS Yield Enhancement Network (YEN). It is also evident in the huge amounts of relevant information shared by farmers on social media, via Twitter and discussion forums like The Farming Forum.

Performance varies hugely in agriculture at all scales; within and between fields, farms, regions and years, yet there is curiously little scientific endeavour to understand this variability. The number and complexity of decisions faced by farmers is vast; if you multiply the combinations of decisions taken by UK arable farmers (eg what species, variety, sowing date, seed rate, cultivation system, manure applications, products rates and timings for fertilisers, pesticides etc) with the possible soil and climatic environments encountered there are 10^30 (trillions of trillions!) decision x environment combinations! Clearly not all the interactions here are important, but many of them are, and we need ways to identify them. No-one currently takes responsibility for the science of decision-making in farming – I believe it is here that lie the biggest opportunities from the 4th agricultural revolution.

We have many specialisms and specialists in agriculture and agricultural science (eg soil scientist, pathologist, entomologist, physiologist, nutrition). The conventional job of the scientist is to reduce the system to a scale and simplicity that enables a testable hypothesis. The job of the farmer and agronomist by contrast is to put all the components of the farm system together to achieve maximal performance, profitability and sustainability across multiple objectives. We see that the best farmers in the UK are evidently better at this than any researchers, so science and industry's best route to progress must be to work with the best farmers.

Some great presentations were given at the World of Innovation session at OFC. Prof Cristobal Uauy from JIC demonstrated the power of gene editing for crop breeding; it offers the potential for farmers and breeders to target specific traits for specific environments and management systems. AHDB Strategic Farmer Brian Barker demonstrated the enthusiasm of farmers to innovate, measure, test, experiment, engage, collaborate, improve understanding and communicate; Brian said he wants a scientist on every farm. Kate Pressland demonstrated the fantastic Innovative Farmers Field Labs that enable small groups of farmers to work with researchers to tackle specific questions, but highlighted the challenges of funding the scaling of this approach. OFC Chairman Tom Allen-Stevens asked how the current gulf between science and practice can be bridged. Whilst all the right warm words were spoken about science-industry collaboration, I believe the major opportunity was missed; that of progressing science as well as farming. This comes from the opportunities that Dr Matthew Smith of Microsoft described earlier about artificial intelligence helping to improve productivity within farms and supply chains. I believe that the unprecedented amounts of data that can now be generated and shared on-farm, combined with social media and new tools for collaborative working, provides an enormous opportunity for a new science in agriculture that could transform the way we generate, distil and share knowledge in agriculture. We call this Agronomics.

I'm not convinced that we need a scientist on every farm, but I am convinced that every problem, issue and opportunity that the industry faces can be best addressed from the bottom-up, with farmers, industry, researchers and policy-makers working together in co-ordinated open networks embracing the scientific method. For each issue, a shared conceptual framework is required, setting out how scientists & farmers understand the problem, what's already known and what are the knowledge gaps. The conceptual framework defines the important metrics to measure. Brian Barker demonstrates that interested farmers are willing to make & share measurements of their crops, soils and environments, as well as their management. The YEN demonstrates a model for how farmer-generated data can be shared for the common good, enabling benchmarking of >50 crop performance variates for farmers, and data analytics across >200 farmers to generate insights. Sharing data at large scale and utilising AI tools should help us find associations to identify the important decisions (from the 1030 decision combinations) for any measurable target. Big data can allow both the initial testing of hypotheses and the generation of new hypotheses. These hypotheses can now be tested at the most appropriate scale. Conventionally, science has been restricted to lab, greenhouse or plot trials, but the coming ubiquity of precision farming technologies (especially GPS, yield mapping & remote sensing) now allows farmers & scientists to test decisions at field scales through tramline comparisons. Inherent spatial variation within fields means that to draw robust

conclusions from such trials much care is needed in design, management and analysis. Within its Agronomics initiative, ADAS has developed protocols and software to assist with this, and working with British Geological Survey new statistics have been developed to quantify uncertainties and test significance in tramline comparisons. Co-ordinated farmer-led experimentation also has the benefit of scalability; rather than 1, 2 or a few experiments covering limited soil types, geographies and climates, we can work with 10s of farmers to see effects of decisions across a wide range of conditions. With BASF Real Results we support trials with 50 farmers and in the YEN Yield Testing EIP-agri project we are helping farmers conduct 48 trials across 6 Farmer Innovation Groups. We are already demonstrating that it is possible to generate new knowledge, insights and science from farmer-centric approaches. But we've only just started and the opportunity for progress from #citizenscience in agriculture is incredibly exciting.

Sir Mark Walport called for greater diffusion from science to farming. We need much much more than passive diffusion in one direction. We need scientists to fully embrace the exciting new opportunities to ask and answer the old and new questions in agriculture. We need farmers to engage with scientists, offer ideas, make measurements and share their data, and to respect the scientific method.

Sir Mark mentioned the concept of What Works centres which take responsibility for finding and agreeing 'what works' in a given sector (eg healthcare for NICE) and crucially also what doesn't work. The concept of a What Works for Agriculture is a fantastic idea that AHDB and NFU are actively pursuing... but it would be a travesty if this adopted the conventional top-down approach of committees of experts deciding what is best practice - farming systems and environments are too diverse, innovations and practices too dynamic and expertise too widely spread for this to be successful.

I think there is opportunity now to be much more radical, grasping the opportunity to reimagine research & innovation support for productivity alongside the new Agriculture Policy. We could be much more democratic in our approach to deciding what research is needed and who conducts it, recognising that good ideas can come from farmers and industry as easily as from scientists, and embedding farmers and industry in proposals from their initiation through to completion. Why shouldn't farmers decide collectively on what research goes forward, using a crowd-funding approach with credits proportional to their BPS payment or AHDB levy? Why shouldn't farmer-generated data be as important an information source to the science of agriculture as lab, glasshouse, animal and field trials are currently? Why shouldn't farmers who actively engage in knowledge generation be paid for their time, given that they are contributing a public good? This would all need large investment in new digital and social infrastructures, but now is the time to invest in such approaches that could deliver raised productivity. There are many organisations primed to respond to the challenge, including the Agritech Innovation centres Agrimetrics, Agri-EPIcentre, CHAP & CIEL, software & data companies like Map of Ag,Breedr & Rezare and organisations like Innovative Farmers, AHDB and Agritech East. Dr Clive Black highlighted the need to support human capital on-farm and through the industry, bringing research & knowledge will require facilitation, for which there is a crucial role of advisors, both independent and from the supply industry.

We have set out some of our vision in the publications below. But our thinking is continually developing. If you can see ways of helping to achieve this transformation then please do get in touch.

Marchant, B., Rudolph, S., Roques, S., Kindred, D., Gillingham, V., Welham, S., Coleman, C., Sylvester-Bradley, R. (2018). "Establishing the precision and robustness of farmers' crop experiments". Field Crops Research 230. 31-45

Sylvester-Bradley, R., Kindred, D., and Berry, P (2018) Agronōmics: eliciting food security from big data, big ideas and small farms. 14th International Conference on Precision Agriculture, Montreal, Canada, June 2018.

Kindred, D., Clarke, S. Roques, S., Hatley, D., Marchant., B, Sylvester-Bradley, R. (2018) Supporting and Analysing On-Farm Nitrogen Tramline Trials So Farmers, Industry, Agronomists and Scientists Can LearN Together. 14th International Conference on Precision Agriculture, Montreal, Canada, June 2018.

Sylvester-Bradley, R., D. Kindred, B. P. Marchant, S. Rudolph, S. Roques, A. Calatayud, S. Clarke and V. Gillingham (2017). "Agronomics: transforming crop science through digital technologies." Advances in Animal Biosciences: Precision Agriculture (ECPA) 2017 8(2): 728-733.

Kindred, D. and Sylvester-Bradley, R., Clarke, S.,, Roques, S., Smillie, I., & Berry, P. (2016) Agronomics; an arena for synergy between the science and practice of crop production. International Farming Systems Association Conference July 2016.

Sylvester-Bradley, R. and Kindred, D. (2014). The Yield Enhancement Network: Philosophy and results from the first season. Aspects of Applied Biology 125, Agronomic Decision Making in an Uncertain Climate, 53-62.

Alan Spedding, 08 January 2019

RuSource briefings provide concise information on current farming and rural issues for rural professionals. They are circulated weekly by email and produced by Alan Spedding in association with the Arthur Rank Centre, the national focus for the rural church. Previous briefings are archived on the Food and Farming Futures website. You can locate them by searching for the title you are looking for or simply the Briefing number: https://www.foodandfarmingfutures.co.uk

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