

CSIRO Submission 14/522

Green Paper on Agricultural Competitiveness

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Executive Summary

CSIRO welcomes the opportunity to respond to the Agricultural Competitiveness Green Paper.

This submission is structured around the categories articulated in the green paper and references the policy ideas proposed in it. CSIRO's response is focused on the dependencies between research, development and extension (RD&E) and agricultural competitiveness. We note that the **policy idea 20** (and its sub-sections) explicitly relates to RD&E and we begin our submission through an RD&E lens. Importantly science, technology and knowledge underpin many other aspects of the Green Paper and its policy ideas. After a general consideration of RD&E matters, we explicitly comment on: **infrastructure (policy ideas 1 and 2), communications (policy idea 3), agricultural education (policy idea 14), drought preparedness (policy idea 16), drought support (policy idea 17), water infrastructure (policy idea 18); rural RDCs (policy idea 21), and biosecurity systems (policy idea 23).**

Australia's rural R, D&E system (policy idea 20)

Science and Technology has played and will continue to play an integral role in maintaining and growing Australia's agricultural competitiveness. While Australian agriculture has had a long history of year on year total factor productivity growth from the 1960's through to the 1990's, there are some signals that this growth has slowed over the last decade or so. Agricultural competitiveness has been a central focus for CSIRO's scientific and industrial research over the last 87 years. In 2014/15, agri-food industries are the primary focus for around \$350 million investment (approximately half from core appropriations to CSIRO and half from competitive industry and government funds). CSIRO's plant, animal, agricultural and environmental science is world class in terms of scientific output and recognition measures.

Australia's rural RD&E system has many strengths and is well recognised globally for the quality of its scientific outputs. Despite these core scientific strengths, it has evolved incrementally over the last 50 years and there has been limited evidence-based analysis of its contemporary functionality and effectiveness. Such analysis could examine the core role for RD&E as a catalyst for industry innovation and as the knowledge provider to the national public/community/policy interest. Without a solid understanding of how the current system is functioning, isolated interventions to improve efficiency and effectiveness could be ineffective at best and damaging at worst.

CSIRO strongly supports some of the proposals under **policy idea 20** – in particular; **20a** - to reflect community (and hence government policy) needs in RD&E priorities, **20d** – to promote the further development (and evolution to reflect the 21st Century technology drivers) of extension services and **20f** - to regularly assess the RD&E system to ensure its relevance and effectiveness. CSIRO stands ready to participate fully and actively in any effort to improve the functionality and effectiveness of Australia's rural RD&E system. CSIRO strongly argues that this should be examined on the basis of evidence and analysis and would be happy to assist with data sources and analytical framing.

The issue of cross-sectoral R&D is a critical one for CSIRO as it goes to the heart of the unique contribution CSIRO makes to Australia's agri-food and fibre sector. CSIRO's National Research Flagships in Agriculture, Biosecurity and Food and Nutrition draw together the relevant science disciplines and partner with industry and government to deliver on both industry and national public interest goals. This commitment to cross-sectoral work in CSIRO is also seen in the high level of involvement CSIRO has in COAG-PISC (now AGSOC) R&D planning and coordination in areas such as plant biosecurity, animal biosecurity, food and nutrition, climate research (adaptation and mitigation), water use and soils.

Given this background, CSIRO would urge caution with respect to the policy idea, **20b – to establishing a new body, or tasking existing research bodies, to coordinate cross-sector research**. Tasking existing bodies to ensure our rural innovation system effectively and efficiently supports industry innovation and community interests is likely to be a more effective response to this objective than establishing a new body with the transaction costs that entails.

Looking forward, an effective RD&E system for Australia would reflect an appropriately balanced set of drivers from three sources, namely:

- (a) Industry drivers (the RDC model helps here, and Australia needs to grow direct private sector investment where possible);
- (b) Public interest drivers (competitive Government funding helps, as does Government guidance to RDCs); and
- (c) Science drivers, including a longer term understanding of global and national science trends and a commitment to fostering longer term scientific capabilities and infrastructure in the national interest.

An effective RD&E system is not enough on its own – it needs to be richly and deeply embedded in an effective innovation system that includes linkages to other industry, policy, institutional and market drivers for effective innovation. The emergence of initiatives such as the industry growth centres appears to be driven by a desire to improve this connectivity between R&D and industry innovation and competitiveness.

RDC administration (policy idea 21)

CSIRO strongly supports the RDC model because of the very significant benefits that come from linking research to industry knowledge and priorities. These are however challenges that could be addressed under **policy idea 21 - administrative changes to the RDC model to increase transparency and reduce costs**. Firstly, a move to a common contracting template (or small set of templates for different types of work) that were consistent with relevant Australian Government policies, protect legitimate industry interests in commercial outcomes and science agency interests in effective publicly funded science would deliver significant benefits over the current situation in which 15 RDCs have 15 different templates for research contracts. Secondly, there would be longer-term benefits from greater transparency in recognition and sharing of the full costs of research and some policy guidance on the level of leverage of taxpayer funds into RDC projects that is desirable / acceptable.

Biosecurity (policy idea 23):

CSIRO supports an integrated biosecurity strategy comprising technologies and social approaches including strategic surveillance, web based tools for appreciating new biosecurity threats, use of autonomous systems and engagement of individuals, communities, industry and regulators in biosecurity surveillance. In particular we note that smart and effective biosecurity systems are an enabler of agricultural trade between states and internationally through area freedom and certification processes, as well as providing protection of Australia from new incursions. For these reasons, CSIRO strongly supports the propositions put forward under **policy idea 23 – improving biosecurity systems**.

Water and resource Management (policy idea 18):

Integrated water resource assessment for agricultural development is an essential input to **policy area 18a - investment in new dam and infrastructure projects and opportunities to improve water-use efficiency or increase the amount of water available to agriculture through infrastructure projects**.

Drought (policy ideas 16 and 17):

Reliable weather and climate information, and tools which translate this into on-farm decision support have greatly advanced our ability to manage for and deal with drought. Ground-breaking tools of the 1980s and 1990s are set for a step-change in effectiveness with improvements in weather and climate prediction and the arrival of broadband and related digital services for Australia's rural sector.

Science and technology has also delivered great improvements in on-farm systems and equipment which make the most of available water and reduce waste. Tools such as Yield Prophet® are particularly relevant to ***policy option 16 b and c – improve multi-peril insurance products and improved climate information and farm level decision tools.***

Education, skills and training, and labour (policy idea 14):

Currently Australia's innovation and education systems are somewhat disconnected, with skills development effort not necessarily grounded in areas where there are opportunities for industry innovation or where there are clear skills gaps. This is relevant to ***policy idea 14—strengthening agricultural education.*** CSIRO and other publicly funded research agencies could better incorporate students in their mix of programs and in build industry-relevant skills through the new industry growth centres and SME engagement to help address this disconnect. Advances are being made in remote delivery of education and have great future potential for agricultural skills development and rural education.

Infrastructure and communications (policy ideas 1, 2 and 3):

Logistics research delivers dividends for infrastructure development, as demonstrated in recent studies in Northern Australia. Initiatives like the TRANSIT project which informs investment in infrastructure are assisting efficient investment of public funds and delivering benefits to rural industries. Similarly agricultural resource assessments and dam investigations show where dams might be constructed, their proximity to agricultural land and their economic feasibility. This information can optimise infrastructure investment to catalyse industry development in both established and greenfields agricultural areas.

Recent years have seen great progress in access to reliable and affordable communications systems - an important issue for regional communities as described in ***policy idea 3 enhancing communications.*** Remote health delivery initiatives have shown great results as have other innovations in communication. Access to social infrastructure is also important issue and work is underway in CSIRO to boost telecommunication and remote service delivery. Realising the possibilities that the roll out of Australia's next generation broadband network and adoption of smart digital services present to help the rural sector meet its productivity and sustainability challenges.

Summary - policy ideas where CSIRO has an explicit response

Number	Policy idea	Summary of CSIRO response
1 and 2	<p>The Government is committed to working towards filling Australia's infrastructure gaps to meet the infrastructure needs of the 21st century.</p> <p>The Government is committed to upgrading existing infrastructure across Australia and reducing transport costs.</p>	<p>CSIRO notes the important role for science to inform major infrastructure decisions. The TRANSIT model has demonstrated this in regard to transport infrastructure. Water resource and agriculture assessments have most recently been comprehensively demonstrated in the Flinders and Gilbert Agricultural Resource Assessment (FGARA).</p>
3	<p>The Government is committed to ensuring that farmers and regional communities have access to reliable and affordable communications systems. Views are sought on areas of focus for future government and commercial investment in communications infrastructure and options to assist farmers and regional communities to use the communications infrastructure currently being deployed.</p>	<p>CSIRO strongly supports this recommendation. Digital agriculture is imminent and will integrate proximal and remote sensing, big data analytics, automation and robotics. Advances in communication infrastructure will be essential to taking advantage of these developments for lifting agricultural productivity and competitiveness.</p>
4a	Working with states and territories Removing excessive native vegetation laws	<p>CSIRO suggests land clearing considerations take account of interactions between native vegetation, hydrology, carbon and ecosystem services.</p>
4c	Improving the efficiency of the native title system	<p>Analysis by CSIRO and JCU in northern Australia has identified opportunities to address common land tenure barriers.</p>
5a	Limiting the adverse impacts of mining on the agriculture sector	<p>Initiatives like the Gas Industry Social and Environmental Research Alliance (GISERA) can help minimise the downside and develop upside impacts where resource extraction and agriculture co-exist.</p>
13	Improving the transparency of foreign investment	<p>Investment requires understanding the potential risks and benefits of investment and precompetitive research can inform this.</p>
14	Strengthening agricultural education.	<p>CSIRO sees a role for itself in strengthening education through students and SME engagement</p>
14c	Agricultural education: creating national agricultural tertiary centres of excellence in regional areas for education, training, research and extension	<p>CSIRO sees value in this suggestion and would build links to such regional centres of excellence within its available resources.</p>
16b	Drought preparedness: improve multi-peril crop insurance products	<p>CSIRO's science in climate information and on-farm decision support can underpin drought preparedness.</p>
16c	improved climate information and farm level decision tools	
17b	Drought support: provision of additional assistance for prolonged and severe drought that is beyond any capacity of farmers to prepare for, such as a one in 75-year drought.	<p>CSIRO notes that the notion of a "one in 75 year" drought becomes problematic given the likelihood of shifting baselines under climate change.</p>
18a	Improving water infrastructure: investment in new dam and infrastructure projects and opportunities to improve water-use efficiency or increase the amount of water available to agriculture through infrastructure projects.	<p>CSIRO notes the critical role of science investigations including agricultural resource assessments to identify feasibility of water infrastructure developments and management regimes.</p>

Number	Policy idea	Summary of CSIRO response
20 20a 20b 20d 20f	<p>Collaboration, cross-sector and transformational research and extension have been identified as current gaps in Australia's RD&E system. The Government is interested in ways to promote better rural RD&E coordination, reduce duplication, and facilitate the development of private markets in extension services.</p> <ul style="list-style-type: none"> - update rural RD&E priorities to reflect community needs - establishing a new body, or tasking existing research bodies, to coordinate cross-sector research - promoting the development of extension services - to regularly assess the RD&E system to ensure its relevance and effectiveness. 	<p>CSIRO commends the attention given to the RD&E system as a foundation for agricultural competitiveness. CSIRO notes a number of challenges emerging to the efficiency and effectiveness of Australia's RD&E system and wider industry innovation system and suggests that a comprehensive, evidence-based study of the functionality of the system be undertaken.</p> <p>CSIRO plays a strong cross-sectoral research role currently and suggests that tasking existing cross-sectoral research capacity and experience is preferable to setting up new institutions in an already complex R&D system.</p> <p>CSIRO supports regular assessment of the RD&E system to ensure relevance and updating of RD&E priorities to reflect community needs.</p>
21a	<p>RD&E funding to RDCs should drive tangible outcomes for farmers to improve farm profits by targeting priority areas and minimising research overheads</p> <ul style="list-style-type: none"> - administrative changes to the RDC model to increase transparency and reduce costs, including giving RDCs a targeted set of objectives 	<p>CSIRO strongly supports the RDC model and notes its effectiveness in linking research to industry insights and priorities. CSIRO suggests efficiencies and effectiveness of the RDC model could be improved via a common contracting template and more transparency in the RDC co-funding arrangements including guidance on levels of taxpayer co-investment and recognition of full research costs.</p>
23a 23b 23c	<p>Australia's biosecurity system protects our native flora and fauna and underpins our agricultural exports. To ensure that it remains robust and resilient to new and emerging pests and diseases, stakeholders suggested the need for;</p> <ul style="list-style-type: none"> - improved information and intelligence gathering tools, supported by increased investment in high-risk areas and priority pests and diseases - enhanced onshore monitoring, including by developing reporting tools and establishing a public Biosecurity Information System to share information - collaborating with industry associations to extend traceability systems to better facilitate responses to outbreaks and expand market access. 	<p>CSIRO supports these policy options and notes its active program of research to help advance the efficiency and effectiveness of biosecurity systems.</p>
24	<p>Strengthening Australia's overseas market efforts.</p>	<p>CSIRO suggests Australia has great opportunities to integrate across agricultural value chains for export. In doing so it is important that the focus is broader than agricultural commodities and targets high value exports from Australia's agricultural base.</p>

CSIRO's response to the policy ideas in the Green Paper on Agricultural Competitiveness

Research Development and Extension (policy ideas 20 and 21)

Australia's rural R&D system: Science and Technology has played and will continue to play an integral role in maintaining and growing Australia's agricultural competitiveness. CSIRO explored this history at length in the submission on the Agricultural Competitiveness Issues Paperⁱ.

Some more contemporary CSIRO-led examples include delivery of \$5 billion net present value from increased yield and regional adaptation in the Australian cotton industry through breeding and crop management programsⁱⁱ major lifts in productivity through breeding and novel feeds in aquacultureⁱⁱⁱ and the de-risking of broad acre enterprises through research based decision support tools^{iv}.

Agriculture in Australia has had a long history of year on year total factor productivity growth of around 1 - 2%, driven by breed development, water, pest and fertiliser management, implementation of new farming systems and structural change in farm businesses^v. Since the 1990's however, the productivity growth story is less clear and while climate factors complicate interpretation, there are valid concerns that technical productivity growth may be slowing^{vi}.

CSIRO's relevance to agricultural competitiveness: Agricultural competitiveness has been a central focus for CSIRO's scientific and industrial research over the last 87 years. CSIRO started as CSIR in 1927 and at the outset 97% of its activities were focused on the big development and competitiveness issues facing Australia's agricultural industries. In 2014/15, agri-food industries are still the primary focus for around \$350 million p.a. investment (approximately half from core appropriations to CSIRO and half from competitive industry and government funds). Significant additional investments around the environment (climate, oceans, land and water) support these agri-industry R&D investments. CSIRO's plant, animal, agricultural and environmental science is world class in terms of scientific output and recognition measures^{vii}.

Functionality of the rural R, D&E system: Australia's rural RD&E system has many strengths and is well recognised globally for the quality of its scientific outputs. For example, Australia publishes about 3.6% of the world's agricultural science papers and these are cited 30% more than the global average on a like for like basis^{viii}. CSIRO conducts about 20% of Australia's agricultural R&D and it is in the top 0.1 percent of the global field in the Web of Science subject matter fields of plant & animal science and agricultural science. CSIRO is also the strongest institution nationally in terms of scientific outputs in related fields such as soil science. There are a number of Australian Universities that are also strong in the plant & animal, agricultural and soil sciences – and taken as a whole Australia has a globally significant public sector agricultural science capacity.

Despite these core scientific strengths, Australia's rural R&D system has evolved incrementally over the last 50 years and there has been limited evidence-based analysis of its contemporary functionality and effectiveness. Such analysis could examine the core role for RD&E to serve as a catalyst for industry innovation and as the knowledge provider to the national public/community/policy interest. . A current concern is that the rural RD&E system is being optimised to suit narrow interests with extensive leverage and re-leverage of the national pool of resources There is no comprehensive understanding of how the different industry, public interest and science drivers are balanced to deliver maximum benefit in terms of rural industry innovation and community benefit. Without a solid understanding of how the current system

is functioning, isolated interventions to improve efficiency and effectiveness could be ineffective at best and damaging at worst.

Some current issues in rural RD&E include:

- achieving balance in the R&D effort, given the propensity for individual investors to seek to increase their control of the system via financial leverage mechanisms;
- a generally weak private sector dimension to agricultural research in Australia;
- a RDC levy system which provides a conduit for tens of thousands of small farm businesses to contribute to R&D that would not otherwise be possible (a positive), but which for much of the RDC research portfolio is typically in the 20-40% range of full cost and the balance is leveraged or cross-subsidised taxpayer investment (potentially a negative long-term).
- growing cross-subsidisation of agricultural research from the education system which is rarely fully transparent. While this may be seen as drawing more funds into the sector, the long term consequences for the functionality of the RD&E system are unknown.

Consequently, CSIRO strongly supports some of the proposals under **policy idea 20** – in particular; **20a** - to reflect community (and hence government policy) needs in RD&E priorities, **20d** – to promote the further development (and evolution to reflect the 21st Century technology drivers) of extension services and **20f** - to regularly assess the RD&E system to ensure its relevance and effectiveness. CSIRO stands ready to participate fully and actively in any effort to improve the functionality and effectiveness of Australia's rural RD&E system. CSIRO strongly argues that this should include evidence-based examination and would be happy to assist with data sources and analytical framing.

The issue of cross-sectoral R&D has appropriately received attention in the Green Paper. This issue is a critical one for CSIRO as it goes to the heart of the unique contribution CSIRO makes to Australia's agri-food and fibre sector. CSIRO's National Research Flagships draw together all the relevant science disciplines and partner with industry and government to deliver on both industry and national public interest goals. For instance, CSIRO's recently expanded Agriculture Flagship is cross-sectoral at its core, with a \$220M p.a. total investment (half CSIRO core appropriations and half competitive funds from industry and government) covering soils, water, NRM, climate adaptation and mitigation, productivity and sustainability for the crop, forage, livestock, aquaculture and horticulture industries. CSIRO's Biosecurity Flagship represents a critical cross-sectoral investment over \$40 Million p.a. in biosecurity for Australia's livestock and cropping industries together with an important role in protection of Australia's natural biological heritage. The Food and Nutrition Flagship also is inherently cross sectoral, with around \$70 Million p.a. invested in pursuit of innovation and value addition post farm gate and the development of novel bio-products that can help diversify Australia's agricultural industries (Figure 1).

A recent review of CSIRO's Science Excellence indicates a high degree of connectivity in the Australian agricultural science community that can be harnessed to achieve further gains in this area of cross-sectoral connections.

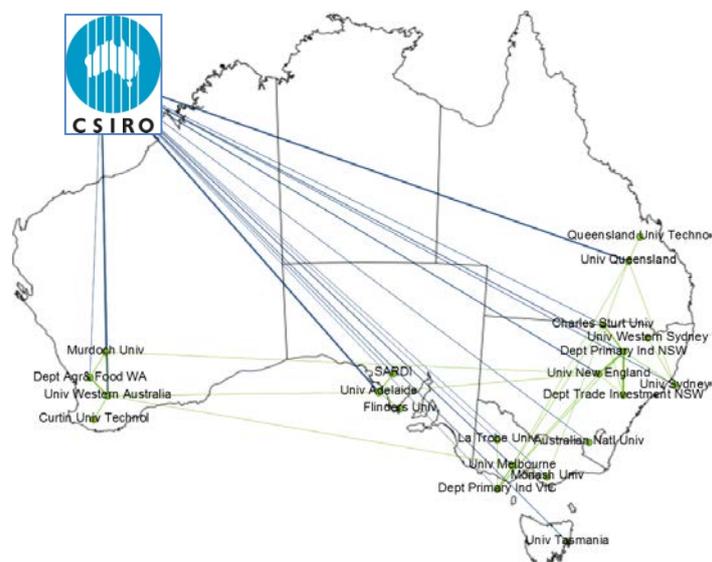


Figure 1 - the major contributors to Australia's research in Agricultural Sciences, along with their interconnections; (for clarity, only institutions with the largest outputs and most frequent connections are shown). CSIRO's role as a national connector is immediately clear. While some members of the Group of Eight are also of substantial importance, so too are some state government Departments of Primary Industry

Data Source: Australia Web of Science Access Database (May 2014); Articles, Reviews & Proceedings Papers, 2009-2013, Filters: >120 total connections, >16 individual edges.

CSIRO's commitment to cross-sectoral work aligns with the unique breadth and diversity in scientific skills resident in CSIRO and our ability to draw together large, mission focused teams for the long term national interest, as required under the Science and Industry Research Act of 1949 which still governs CSIRO's role in the national innovation system. A contemporary reflection of this commitment is the high level of involvement CSIRO has in the COAG-PISC (now AGSOC) R&D planning and coordination in areas such as Plant Biosecurity, Animal Biosecurity, Food & Nutrition, Climate Research (Adaptation and Mitigation), Water Use and, Soils. Given this background, CSIRO would urge caution with respect to the policy idea, **20b – to establishing a new body, or tasking existing research bodies, to coordinate cross-sector research.** Australia has a history of incrementally establishing new bodies to address issues without a complete understanding of the system-wide consequences. This can lead to increased transaction costs and greater fragmentation of effort – potentially compromising the greater “coordination” intended. Care is also needed in defining the “coordination” problem being solved. Ultimately the goal is a rural innovation system to effectively and efficiently support industry innovation and community interests – so all new propositions need to be critically analysed through this lens.

Rural RD&E – looking forward: An effective RD&E system for Australia would reflect an appropriately balanced set of drivers from three sources, namely:

- (a) Industry drivers (the RDC model helps here, and Australia needs to grow direct private sector investment where possible);
- (b) Public interest drivers (competitive Government funding helps here as does Government guidance to RDCs); and
- (c) Science drivers, including a longer term understanding of global and national science trends and a commitment to fostering longer term scientific capabilities and infrastructure in the national interest.

We currently have no systematic analysis of the current balance in Australia's rural RD&E drivers (i.e. amongst industry, government/community and science drivers).

An effective RD&E system is not sufficient– it needs to be richly and deeply embedded in an effective innovation system that includes linkages to other industry, policy, institutional and market drivers for effective innovation. These issues of innovation system function were also explored at length in CSIRO’s submission to the Agricultural Competitiveness Issues paper^{ix}.

Since the release of the Issues Paper, the emergence of initiatives such as the **Industry Growth Centres**^x appears to be driven by a desire to improve this connectivity between R&D and industry innovation and competitiveness. The RDCs play part of this role for the agriculture sector with largely (but not entirely) an on-farm focus but there may be lessons to draw upon from the growth centre initiative.

RDC administration (policy idea 21)

CSIRO strongly supports the RDC model because of the very significant benefits that come from linking research to industry knowledge and priorities. CSIRO sees this benefit every day - not just in project selection and planning but in project implementation whereby researchers, innovative farmers, industry public and private sector advisors and agri-industry companies work together in the spirit of collective enquiry. As outlined in various submission including that to the Senate Inquiry into the innovation system^{xi}, CSIRO notes three factors in the success of this model:

1. The Rural Development Corporations provide a mechanism that consolidates industry requirements for R&D into an integrated portfolio, with this research directed towards the needs of producers.
2. The research has relatively stable funding through a well-articulated mix of Government funding and industry levies.
3. Significant sector specific capability is maintained in organisations, including CSIRO, who have developed and maintained long term relationships with suppliers and key industry bodies.

While making it clear that CSIRO unambiguously supports the RDC model, we would also raise two long running challenges which could be addressed under **policy idea 21 - administrative changes to the RDC model to increase transparency and reduce costs**.

1. A move to a common contracting template (or small set of templates for different types of work) that were consistent with relevant Australian Government policies, protect legitimate industry interests in commercial outcomes and science agency interests in effective publicly funded science would deliver very significant benefits over the current situation in which 15 RDCs have 15 different templates for research contracts. This has been unsuccessfully attempted previously through a PISC process and would benefit from a strong imperative from the Government as investor.
2. A second issue concerning funding models is increasingly generating inefficiencies in the RDC system. RDCs have prefer to be the “marginal funder” - leveraging core funding of institutions like Universities, State Government Departments and CSIRO. This is leading to confusion and inefficiency over recognition of research costs by RDCs. Some institutions can cross-subsidise some costs from other activities – while others cannot. The long-term consequences of RDCs funding only marginal costs of the research work they are directing are unknown – and may lead to long term loss of key capabilities and institutional capacity in the rural R&D system. While RDCs will legitimately pursue their leverage strategies, there would be longer-term benefits of greater transparency in recognition and sharing of the full costs of research and some policy guidance on the level of leverage of taxpayer funds into RDC projects that is desirable / acceptable.

Biosecurity (policy idea 23)

CSIRO supports an integrated biosecurity strategy comprising technologies and social approaches including strategic surveillance, web based tools for appreciating new biosecurity threats, use of autonomous systems and engagement of individuals, communities, industry and regulators in biosecurity surveillance. In particular we note that smart and effective biosecurity systems are an enabler of agricultural trade between states and internationally through area freedom and certification processes, as well as providing protection of Australia from new incursions. For these reasons, CSIRO strongly supports the propositions put forward under **policy idea 23 – improving biosecurity systems**. CSIRO's Biosecurity Flagship is drawing upon the full breadth of sciences within and beyond CSIRO to develop innovations that can transform the efficiency and effectiveness of Australia's biosecurity systems. CSIRO is willing to engage positively with the intent of **policy idea 23**. In addition, wherever major new agricultural developments or shifts in land use are contemplated we suggest that biosecurity risks are included in a comprehensive impact assessment which can guide the most sustainable options.

A recent report Australia's Biosecurity Futures^{xii} uses strategic foresight to identify the major biosecurity trends and risks that Australia may need to respond to over the next 20-30 years, within a global context. The report has identified five biosecurity megatrends that all point towards a shift in the types of biosecurity risks we are likely to face in the future and the way that these risks will need to be managed.

Water and Resource Management (policy idea 18)

For much of Australia where agricultural development has a long history we understand the landscape, its productivity and agricultural potential. However in less developed areas, like Northern Australia, we do not have sufficient information to make infrastructure investment decisions because we don't know what type and volume of agricultural production is possible or, hence, the type, volume and destination of products requiring transport and processing. For example, information about where a dam might best be built, whether it will hold water and its proximity to agricultural land can all inform investment decision makers. The recent Flinders and Gilbert Agricultural Resource Assessment (FGARA) project^{xiii} provides such information for two of Australia's northern catchments and identifies tens of thousands of hectares of irrigation potential and millions of hectares of dryland agriculture potential. This assessment differs from previous assessments of agricultural development or resources in two main ways:

- Where previous assessments have focused on single development activities or assets – without analysing the interactions between them – this Assessment considers the opportunities presented by the simultaneous pursuit of multiple development activities and assets. By this means, the Assessment uses a whole-of-region (rather than an asset-by-asset) approach to consider development.
- The novel methods developed for the Assessment provide a blueprint for rapidly assessing future land and water developments, particularly in northern Australia.

The Assessment has been designed to build a knowledge base to inform future development decisions, importantly, the Assessment does not recommend one development over another but leaves decision makers to use the information as one input to their decision making process.

There is potential for further agricultural resource assessments to inform potential development of other less developed catchments, particularly in the north. CSIRO's DamSite model provides a unique method for rapidly identifying water storage opportunities at large and small scale, in and off stream and in regulated and unregulated catchments. This scientific capability of water resource assessment for agricultural development is an essential input to **policy area 18a - investment in new dam and infrastructure projects**.

Drought (policy ideas 16 and 17)

As a land of droughts and flooding rains, Australia is used to but not necessarily well adapted for drought conditions. Science and technology have contributed to advances in coping with drought by better forecasting weather and climate, understanding the farming system implications of climate variability to support decision making and technologies for making the most of scarce water resources. While progress in this area since the 1980s has been great, there are gains yet to be realised from improved forecasting and linkage of forecasts to on farm decision support systems. There have been great advances in recent years in extreme weather prediction: both nationally and internationally - and there is potential to use international drought forecasting to plant strategically in light of global markets driven by droughts in other countries.

Yield Prophet^{®xiv} is an example of a leading online crop production model that provides grain growers and consultants with paddock-specific yield forecasts as well as crop growth and resource information. Using the grower's own soil test data, it estimates the probabilities of a specific paddock obtaining a range of yields. By matching crop inputs with the attainable yield in a given season, growers may avoid over- or under-investing in their crop. All major varieties of wheat, barley and sorghum are supported as well as, to a lesser extent, canola and oats. Building on recent advances in seasonal forecasting and satellite monitoring there is potential for CSIRO and the Bureau of Meteorology to take this type of decision support to a new level of accuracy. Tools such as Yield Prophet[®] are relevant to ***policy option 16 b and c – improve multi-peril insurance products and improved climate information and farm level decision tools.***

CSIRO notes that the notion of a “one in 75 year” drought becomes problematic given the likelihood of shifting baselines under climate change, which is relevant to ***Policy idea 17b provision of additional assistance for prolonged and severe drought that is beyond any capacity of farmers to prepare for, such as a one in 75-year drought.***

Education, skills and training, and labour (policy idea 14)

Currently Australia's innovation system and education are somewhat disconnected, with skills development effort not necessarily grounded in areas where there are opportunities for industry innovation, or where there are clear skills gaps. This is relevant to ***policy idea 14 strengthening agricultural education.*** CSIRO and other publicly funded research agencies have a role in incorporating students in their mix of programs. There is also potential for industry-relevant skills development through industry growth centres and SME engagement activities to ensure skills are developed in areas of industry need.

CSIRO has been working to bring expert educators into the classrooms and homes of students across Australia. The National Museum of Australia (NMA) and the Murray-Darling Basin Authority are using CSIRO Telepresence robots and software to teach students around Australia about water. CSIRO has also partnered with Australian company 3P Learning to provide Science, Technology, Engineering and Mathematics (STEM) lessons in a 3D simulation of the real world. STEM education is crucial to the next generation of productivity improvements in Agriculture, allowing farmers to understand when and how to adopt new advances and optimise farming practices.

CSIRO is currently working with the Department of Communications to integrate their panoramic telepresence system with 3P Learning's virtual world. It will enable students to jump from an exploration of STEM lessons in a virtual world to a live panoramic information session with a trained guide in the real environment.

These technologies could be further applied and adapted to educate students in the function of factories, machinery, greenhouses and farms. All these technologies require high speed broadband to function effectively. Increasing bandwidth increases the opportunities.

This substantial start in remote education could be further enhanced through research into:

- the use of panoramic video in confined spaces,
- greater coupling between video and virtual representations of the environment,
- better collaboration methods between students and educators in telepresence environments.

CSIRO sees value in **Policy idea 14 c: creating national agricultural tertiary centres of excellence in regional areas for education, training, research and extension** and is willing to build links to such regional centres of excellence as far as possible within its available resources.

Infrastructure and Communications (policy ideas 1, 2 and 3)

Over 50 million tonnes of agricultural and horticultural output is transported between farms, storage, processors and to markets each year. Australian agriculture is characterized by long supply chains where the distance between production, processing and markets often exceeds 1000 km. For most products, distance to final export customers exceeds 5000 km.

Despite the longevity, scale and importance of Australia's agricultural and horticultural industries, supply chains have a high level of vulnerability to supply chain shocks. Year-round access, particularly in the north, is not always possible due to a sparse road network that is regularly inaccessible in the wet. Matching the industry's resilience to climatic variability with resilience to changes in markets and supply chains requires careful planning and investment. A range of possible future scenarios is being developed by the industry and state and federal governments (e.g. new processing and storage facilities; mosaic agriculture; diversification and sustainable development pathways). Understanding what those scenarios may mean for supply chain flows and transport will be critical to optimising investment in and operation of the industry's transport and processing infrastructure and is relevant to **policy idea 1 building new transport infrastructure**. The expansion of mining and energy developments into rural areas creates opportunities to leverage infrastructure which may not be realised without well planned logistics development.

To provide a holistic view of the costs and benefits infrastructure investments and policy changes in agriculture supply chains, CSIRO developed a TRANsport Network Strategic Investment Tool (TRANSIT)^{xv}. TRANSIT was initially co-funded by the Office of Northern Australia, NT Government, WA Government and Queensland Government in 2012, and built for the northern livestock industry. It has provided advice on small- and large-scale investments in the agriculture supply chain, and the benefits to enterprises, including:

- Analysing the impact of road, where the financial benefits to individual agriculture enterprises and to the industry as a whole are quantified (e.g. upgrade of Roma-Clermont road; sealing Hann Highway)
- Optimising the use of road versus rail transport, and their integration, at different locations
- Introducing or consolidating processing and storage facilities at optimal locations (e.g. locating new abattoirs and grain silos)
- Testing potential outcomes for changes in policy: alignment of driver and animal welfare stops; truck limitations for road classes (e.g. removal of tick-clearing regulations for cattle transported directly to abattoirs)
- Selecting infrastructure investment and regulatory-change opportunities that maximise transport cost reductions for a limited investment budget.

TRANSIT optimises transport operation and investment for tens of thousands of enterprises and hundreds of thousands of vehicle trips between them and their markets. Its capacity has been extended from northern Australia to now include livestock transport for all of Australia.

TRANSIT is also useful for comparing policy scenarios in line with **policy idea 2 Improving existing infrastructure and transport regulation**. For example the tool can be used to answer questions like “how much money is saved by moving tick clearing lines?” “What are the financial implications of changing rest periods?” etc.

There is an opportunity to inform management of and investment in agricultural and horticultural supply chains across all of Australia, for existing and potential future industries, by adding new modules to TRANSIT. This is a task that can be completed with a high degree of certainty.

Recent years have seen great progress to in access to reliable and affordable communications systems - an important issue for regional communities as outlined in **policy idea 3 enhancing communications**. Remote health delivery initiatives have shown great results as have other innovations in communication. Access to social infrastructure is also important issue and work is underway in CSIRO to boost telecommunication and remote service delivery, including:

- Extending mobile phone coverage and eliminating “black spots” in northern Australia critical for business and the community,
- Developing “smart” radio technologies allowing the use of small, efficient and inexpensive towers to provide better coverage.
- Deploying our Remote-I solution in northern WA, Queensland and the Torres Strait to close the gap in eye care services,^{xvi}
- Developing new service delivery models based around NGARA telecommunications technology, targeting remote aboriginal communities, and focused on health, education, training, employment and business development,^{xvii}
- Realising the possibilities that the roll out of Australia’s next generation broadband network and adoption of smart digital services present to help the rural sector meet its productivity and sustainability challenges.^{xviii}

Working with States and Territories (policy idea 4 and 5)

Complex land tenure, including issues of native title has been recognised as an impediment to development of northern Australia. CSIRO and JCU prepared a report for the Northern Australia Ministerial Forum on this issue^{xix} - while not a national review, the work outlines potential interventions for northern Australia to simplify tenure arrangements and address stakeholder concerns which may be relevant to **policy idea 4c Improving the efficiency of the native title system**.

The study worked with stakeholders who encouraged governments to:

- increase consistency and reduce complexity through improved tenure arrangements,
- Improve development assessment, and
- Improve landscape-scale planning.

These interventions may address common barriers to investment, including:

- deficiencies in specific aspects of the tenure information base including registration of interests and accessibility of this information to investors;

- diversity of tenures and land and water entitlements including the different conditions of use on similar tenures across jurisdictions;
- inefficiencies in development assessment processes, particularly for major projects, exacerbates tenure-related problems;
- under-resourced negotiation and tenure-resolution mechanisms; and
- legal and other conditions that limit Indigenous and other land owners ability to leverage their land assets for capital and development purposes without affecting existing rights.

When considering any changes to land clearing provisions as suggested in **policy idea 4a removing excessive native vegetation laws** it is important to understand the interaction of native vegetation on hydrology, carbon in the landscape, biodiversity and ecosystem services.

Policy idea 5 suggests **limiting the adverse impacts of mining on the agriculture sector**. Where mining and resource extraction extend into agricultural areas there are social, economic and environmental implications. At a broad scale there is a role for integrated assessment of the overlapping energy-water-land requirements for such expansion. More locally, for developed areas of Australia the actual production potential of agriculture is, or can be, understood. Initiatives like the Gas Industry Social and Environmental Research Alliance (GISERA) are quantifying what happens when energy developments and agriculture intersect above and below ground. This can help minimise the downside and actively develop the upside impacts – for example by identifying productive agricultural uses for waste water from gas extraction^{xx}.

Foreign investment (policy idea 13)

Greenfields development of agriculture requires investment of around \$10,000 per hectare. Regardless of whether capital is sourced domestically or from internationally, investment requires an understanding of the potential risks and benefits. The FGARA and DamSite studies show, at large scale, the development potential of greenfields locations – which is considerable^{xxi}. They outline the risks and opportunities, and are designed to increase investor confidence. Similar studies in additional regions or catchments could facilitate agricultural investment. This work is relevant to all the policy options flagged under item **policy option 13**, in particular the suggestion to **appoint a senior investment specialist for agribusiness and food to help facilitate proposed investments that contribute to industry growth**.

Accessing International Markets (policy idea 24)

Australia's competitive advantage is its extensive agricultural base and resulting biomass that is exported for national income. But this should be value-added wherever it can be done competitively to generate additional domestic employment and higher export income. Our highly populated and low labour cost regional neighbours will be in ever decreasing biomass per capita in decades ahead as a result of population increases and development incursions into rural areas. Australia will be in surplus biomass per capita for some time to come and can be a supplier to the high end of the regional food (deli) and industrial (renewable chemicals and polymers) if we get in with the right products early enough through leveraging our current (and perhaps fleeting) technological advantages.

Australia has enormous opportunities to integrate across agricultural value chains, from production through to export product - whether for food or industrial (bio products) outcomes. In doing so it is crucial that Australia does not just focus on agricultural commodities. The need for value addition cannot be under represented - and we should target high value exports from Australia's agricultural base.

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