



Australia's National
Science Agency

CSIRO submission to consultation on Next Phase of the Future Drought Fund

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Executive Summary

CSIRO, Australia's National Science Agency, welcomes the opportunity to contribute to the Department of Agriculture, Fisheries and Forestry's consultation on the next phase of the Future Drought Fund (FDF). In this submission, CSIRO addresses relevant consultation questions and specific information requests received from DAFF, based on our involvement and expertise in the FDF's activities and other relevant experience.

CSIRO is involved in the delivery of several FDF programs as part of a broader effort on drought resilience through the Drought Resilience Mission¹. The Mission operates at three inter-connected levels: on-farm, regionally and at the policy level; and is undertaking a broad range of activities that support governments in responding to and preparing for drought. Projects of relevance to this submission include:

- **My Climate View (previously known as the Climate Services for Agriculture online platform):** A farmer and advisor facing digital product that allows a comparison of aspects of historical and future climate for a range of commodities that allow farmers to prepare for a variable and changing climate (supported by the FDF delivered in partnership with the Bureau of Meteorology)².
- **Drought Early Warning System:** An early warning system for drought, established by DAFF and delivered in partnership with CSIRO and the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). The system links weather data and forecasts to crop, pasture, and farm profit models to predict farm business outcomes. A prototype has been developed with data presented for the next 12 months and is updated monthly for the Australian agricultural zone on a 5 km by 5 km grid.
- **Independent Assessment of Regional Drought Resilience Plans (RDR) plans:** In partnership with the FDF and States and Territories Regional Drought Resilience Planning (RDRP) program team and coordinators, CSIRO is providing independent review and feedback on each of the expected 73 RDR plans. CSIRO has so far reviewed 22 RDR plans and has produced a synthesis report outlining lessons learned from reviewing the first 15 RDR plans, which includes useful insights for planning and implementation of future RDR plans.
- **Cultural Indicators of Drought Resilience:** Co-development and co-design of approaches with Aboriginal and Torres Strait Island communities to identify cultural indicators of drought based on traditional knowledge. This pilot study is being undertaken in partnership with Traditional Owners in several case study locations.
- Over the last two years, the Drought Resilience Mission has also internally funded research relevant to "*transformational change and monitoring*" and "*evaluation and learning*"

¹ CSIRO. (2021). Drought resilience. <https://www.csiro.au/en/about/challenges-missions/Drought-Resilience>

² CSIRO. (2023). Innovative climate tool expands to support more farmers. <https://www.csiro.au/en/news/All/News/2023/July/My-Climate-View>

This submission emphasises the importance of:

- Integrating other programs to support the effective development and implementation of RDR plans.
- Establishing appropriate ways to co-design approaches to building drought resilience with First Nations communities that are specific to their needs.
- Prioritising and supporting transformational change needed at the individual, community, and regional levels.
- Finding ways to build capacity in resilience thinking, principles and practices.

Introduction

CSIRO welcomes the opportunity to provide input to the Future Drought Fund (FDF) consultation into the 2024-28 Funding and Investment Plans of the Future Drought Fund.

CSIRO provides independent advice based on its research and contributes to solving issues of national significance. As such, CSIRO recognises the importance of providing feedback requested on the draft Drought Resilience Funding Plan 2024 to 2028 (Funding Plan), and the consultation draft of the FDF Investment Strategy 2024 to 2028 (Investment Strategy). CSIRO previously provided a submission to the Productivity Commission's Inquiry into the Australian Government's FDF (submission Number 8. CSIRO Ref 23/808)³.

CSIRO was also involved in the recent in-person public consultations held in Townsville and Canberra, organised by DAFF and members of the FDF Consultative Committee seeking feedback on how drought resilience funding under the FDF should be prioritised and invested from 2024 to 2028. This submission provides input where CSIRO can add value based on our expertise and research and addresses the findings and information requests sought by the Consultative Committee representatives at the Public Consultation sessions relevant to CSIRO's involvement in the FDF's activities.

CSIRO would welcome the opportunity to discuss any points outlined in this submission in further detail with DAFF.

³ Productivity Commission. (2023). Submission 8: CSIRO submission to inquiry into the Australian Government's Future Drought Fund. https://www.pc.gov.au/__data/assets/pdf_file/0019/356023/sub008-future-drought-fund.pdf

CSIRO response to the Questions

1. Proposed key features of new programs

a. Does the draft funding plan provide an appropriate framework to guide spending on drought resilience initiatives?

Nil response.

b. Which current FDF programs should be retained?

Which current FDF programs could be integrated with existing programs or built upon to drive efficiency or to maximise impact?

CSIRO is involved in the delivery of some of the FDF programs so will not make comment on what programs should or should not be retained. Our comments will be confined to integration across existing or new programs to maximise impact.

From a resilience thinking and practice perspective⁴, the FDF's primary focus areas of agriculture, rural and regional communities and environments are considered as coupled human-environment or social-ecological systems. The social in social-ecological systems, encompasses the economic subsystem. This aligns with findings in the resilience literature^{4,5} which emphasises the importance of taking an integrated approach to building resilience, rather than developing economic, environmental, or social resilience separately, or focussing only on some subsystems, which can lead to missing significant vulnerabilities and resilience conferred from relationships among these subsystems.

From this perspective, drought resilience programs and long-term investment could be guided by an integrated assessment of the current state and trajectory of resilience to drought of agriculture, rural communities, and landscapes as social-ecological systems. Such resilience assessments conducted at an appropriate level, for example, on distinct agricultural, rural/regional communities and landscapes as social-ecological systems, can guide what aspects and properties of the system are needed to *maintain*, *modify*, and *transform* to build and sustain resilience⁶. This is consistent with the FDF funding plan's recognition that building drought resilience may require farmers and communities to make incremental, transitional, and transformational changes. Such an integrated approach could also help to avoid unhelpful distinctions between environmental, economic, and social resilience. Instead, it offers an opportunity to tackle drought vulnerabilities and explore resilience options that emerge from the socio-cultural, economic, and environmental dimensions and their interactions.

⁴ Walker, B. & Salt, D. 2012. Resilience thinking: sustaining ecosystems and people in a changing world, Island press.

⁵ Holling, C.S. and Gunderson, L.H., 2002. Resilience and adaptive cycles. In: Panarchy: Understanding Transformations in Human and Natural Systems, 25-62.

⁶ Maru, Y., O'Connell, D., Grigg, N., Abel, N., Cowie, A., Stone-Jovicich, S., Butler, J., Wise, R., Walker, B. & Million, A. 2017. Making 'resilience', 'adaptation' and 'transformation' real for the design of sustainable development projects: piloting the Resilience, Adaptation Pathways and Transformation Assessment (RAPTA) framework in Ethiopia. May 2017. CSIRO, Australia.

It is important to highlight what may be lost from not having an integrated approach and where environmental, economic, or social resilience are considered separately:

- *Potential and connectedness* which are core drivers of the resilience of a social-ecological system⁵ with significant social components, could be lost if a program focuses only on environment and economic resilience. *Potential* refers to accumulated capital and capacities and *connectedness* to interactions that control the cohesion of a system.
- Human and social capital and several social attributes that contribute to social resilience are central to absorptive, adaptive, and transformative capacities of a social-ecological system. The *connectedness* of social to the ecological system is mediated by networks and institutions that govern human and human-environmental interactions⁷.

Given the holistic view that the RDR plans could provide, it is important to consider integrating other programs to support the effective development and implementation of RDR plans. There has been some level of integration between the programs within the Better Prepared Communities theme, which has likely improved the effectiveness of drought resilience plans. The RDR plans provide a good focus to bring people together to address issues. The diverse programs existing within the FDF could help to realise the plans' assessment of what is needed in the regions, providing resources and capacity to implement context-relevant projects and actions identified in the plans. For example, regions have identified mental health and social well-being as essential contributors to building resilience, which could be fostered in the Helping Regional Communities Prepare for Drought initiative, as well as networking efforts resulting from the Networks to Build Drought Resilience initiative.

2. Proposed Investment Streams – Place-based action and partnerships

Hubs

a. How should the Hubs' role be better defined to deliver more impact for their regions? Are the proposed funding options for the Hubs appropriate?

The Hubs, their nodes and networks can provide platforms that facilitate partnerships and place-based innovations to maintain relevance and assist with shortening and filling the innovation-adoption gap. These networks can offer effective pathways for integration and adoption of context-relevant innovative tools, processes and outcomes arising from other FDF programs, that further support place-based innovation and capacity building.

The Hubs could also act as a centre for capacity building, needed for governing the update, implementation and tracking of progress of the Regional Drought Plans across all states and territories. Building on the capacity and capability of the Hubs would be an effective way to accelerate the uptake of new knowledge, practices, tools, and innovations developed by the FDF

⁷ Abel, N., Cumming, D.H. and Anderies, J.M., 2006. Collapse and reorganization in social-ecological systems: questions, some ideas, and policy implications. *Ecology and society*, 11(1).

and other partners, such as CSIRO's Drought Resilience Mission². Engagement between many of the hubs with the Climate Services for Agriculture program could also be built upon³.

Regional Resilience Plans

b. What implementation pathways and governance options are the most appropriate ways of actioning regional plans?

On 8 Nov 2023, at the FDF Consultation meeting on the 2024-28 Funding and Investment Plans in Canberra, CSIRO was asked to provide feedback on the following in this submission:

- Governance options and implementation pathways for the RDR plans (addressed here in Question 2b and in Appendix 1);
- The need for prioritising transformational change for building drought resilience (addressed in Question 5b and in Appendix 2); and
- On the importance of the Theory of Change (ToC) for the FDF 2024-28 Funding and Investment Plans (addressed as part of a response to Question 6a).

In early 2022, the then Australian Government Department of Agriculture, Water, and the Environment (DAWE) commissioned CSIRO to conduct independent reviews of RDR plans developed under the FDF Regional Drought Resilience Planning (RDRP) program. The reviews are intended to provide independent, expert feedback to:

1. Help regions enhance the quality of their RDR plans, and;
2. Provide assessments and feedback to the Federal Department and the State and Territory managers on the quality of the plans under the RDRP program.

In August 2023, CSIRO conducted a synthesis of the reviews of the initial 15 RDR plans developed during the foundational year of the RDRP program, focusing on different processes used to develop each plan and its contents, including prioritised areas and proposed actions.

Feedback provided in this section is based on CSIRO's synthesis review and on independent reviews of RDR plans since August 2023.

The RDRP program provides an opportunity for collaboration and partnership of diverse groups of regional and community organisations and representatives of different groups of stakeholders to plan for integrated social, economic, and environmental resilience. As a process, developing plans through partnerships and multistakeholder engagement, is important for social learning and developing community resilience capacities. As a product, the plans, building on drought impact or vulnerability assessments, guide investment and actions informed by evidence, needs and priorities relevant to regional stakeholders. There are several steps and actions to consider to ensure effective implementation of these plans:

1. Establish adaptive governance arrangements for plan completion and implementation.
2. Specify, prioritise and sequence actions in the plan, to make them ready for implementation and add more innovative and transformative actions.
3. Consider the use of FDF funding for implementation to put the plan in motion.
4. Prioritise and support building capacities for resilience planning.
5. Map farm and non-farm stakeholders and engage with those missed in the first round.
6. Establish baseline information and state of resilience in the region.

7. Start implementing no-regrets actions while completing and updating plans for implementation.
8. Attend to region specific needs.

Further details on each of these steps and actions are outlined in Appendix 1.

3. Proposed Investment Streams - Information, skills and capacity building

Farm Business Resilience

- a. **Should a future iteration of the FBR program be more focussed on specific learning areas or target particular cohorts of farmers (e.g., young farmers, remotely located farmers, smaller landholders and/or those operating on marginal land)?**

Nil response.

- b. **How should public and private good be balanced in a future iteration of the FBR program? Should the program require farmer co-contributions?**

There is a case for partnering with businesses for drought-related issues that are not entirely public or private goods, or when it is deemed a joint activity and can generate both private and public good. Co-contribution can be sought when an activity has public good or public demonstration opportunities, but mainly generates private good. Partnering with Research Development Corporations may be a way of achieving both public and private good outcomes.

My Climate View

- c. **Should the FDF provide training on how best to use and interpret information from existing climate tools, including but not limited to 'My Climate View'? If so, who could benefit most from such training?**

The engagement activities undertaken as part of the development of My Climate View have demonstrated that:

- farmers often work with a range of advisors when considering their future planning (including use of climate information) and
- that not all advisors are confident in the use and interpretation of climate tools and data.

This has led to the development of train the trainer courses targeted to those in an advisory role with content covering both general information about weather and climate projections as well as training specific to My Climate View.

These experiences support the proposition that the FDF should continue to support training on how to best use and interpret information from existing climate tools. Advisors who interact with many primary producers, interested and motivated producers and those developing regional drought resilience plans could be those who would benefit most from such training.

- d. **Should the long-term goal for CSA be providing adaptation information to better support practice change in response to climate projections?**

Adaptations to farming systems are driven by multiple factors, climate being just one of them. Currently My Climate View seeks to provide information to farmers and their advisors about how climate projections will impact key aspects of growing and producing the commodities of interest to them. Based on that information and their other circumstances they can decide if they need to explore adaptations.

Determining the adaptations that are relevant to their locality and circumstances is likely better-established outside of the My Climate View tool. The Climate Services for Agriculture program could work with Drought Hubs and advisors to determine how this information is best provided. There are many adaptations being developed inside and outside of FDF funded activities. A key role of a knowledge management component of the enabling activities of the FDF (Question 6) could be curating and making available those adaptation options.

4. Proposed Investment Streams – Agricultural landscapes management

- a. Should the FDF prioritise natural capital management projects through discrete programs (such as a new Drought Resilience Soils and Landscapes program) or should NRM continue to be embedded throughout most streams of investment? Or both?**

Nil response.

- b. How can First Nations communities be supported so that their knowledge and practices to care for country can be maintained for the benefit of their communities and land?**

Aboriginal and Torres Strait Islander Peoples have unique ecological knowledge of the land and water systems across Australia that are central to understanding the impacts of drought across the landscape and innovations to build drought resilience. There are also specific risks and capacity needs of Indigenous communities that require attention and focus to build drought resilience. Given the value of Indigenous knowledge, it will be important for the FDF program to consider appropriate protections for this knowledge. This includes compliance with the Indigenous Cultural and Intellectual Property principles aligned with the Nagoya Protocol and the United Nations Declaration on the Rights of Indigenous Peoples. It will also be important to monitor the progress of building drought resilience, specifically related to the risks and needs of Indigenous communities.

CSIRO's Our Knowledge, Our Way Guidelines⁸ showcases innovative ways in which Indigenous people are working with, and strengthening, their knowledge to build sustainable futures through their land and sea country. Over 100 Aboriginal and Torres Strait Islander people and organisations, including partners, co-authors, case-study providers, and reviewers, contributed to the development of the Best Practice Guidelines.

One example of this approach in the context of building drought resilience is the Drought Resilience Mission's Cultural Indicators of Drought project that aims to address the challenge of understanding drought in a different way to the usual western science-based understanding of drought based on rainfall deficit that then leads to production deficits and socio-economic

⁸ CSIRO. (2021). Our Knowledge, Our Way Guidelines. <https://www.csiro.au/en/research/indigenous-science/Indigenous-knowledge/Our-Knowledge-Our-Way>

consequences. This project aims to start to fill this gap through the co-design and testing of culturally appropriate baseline data and indicators that are place-based and relevant to understanding drought resilience from a cultural lens.

The co-design nature of this project means that the outputs are not predefined. It is through engagement with Traditional Owners (who want to work with us) that the focus and creation and publication of knowledge is defined and agreed together. A key learning from the CSIRO Cultural Indicator of Drought Resilience project was recognising the time it can take to build the relationships and trust of Traditional Owners to engage in these conversations. These activities are likely to be most successful if they are Indigenous-led, supported by Indigenous scientists and capability.

DAFF staff members are engaged as part of the project's External Reference Panel and through participation in project team meetings. The project team has also presented at the DAFF internal Community of Practice. These connections are critical to avoid duplication of effort and to facilitate collaboration to achieve a beneficial outcome for Indigenous communities. CSIRO is offering to support development of this critical area for the FDF to achieve a successful outcome and in partnership with other providers. For example, University of Canberra is a critical partner in the Cultural Indicators of Drought project and is providing the Indigenous Science leadership. By working together, we are building capability and capacity of both organisations.

The FDF could consider taking a similar approach when designing an engagement process and program relevant to addressing First Nations priorities.

5. Proposed Investment Streams – Innovation and transformation

a. Should the FDF focus on innovation or broader extension and adoption of tried and tested practices to enable change at scale in Australia? Or both?

The FDF should focus on both innovation and broader extension and adoption of tried and tested practices.

The FDF is set up to provide improved resilience to future droughts, not just the next one. This will necessitate both efforts to increase the adoption of practices with evidence of success and the development of innovations to promote future practices and options that can provide benefits and further resilience to drought.

Some of the transitions and transformations sought from the FDF plan will not necessarily come from already proven but not widely adopted practices. New innovations could be developed in partnership with end users to ensure solutions remain fit for purpose and to accelerate their adoption.

b. Should transformational change and partnerships that facilitate it be prioritised by the FDF? What incentives or programs would best support transformational change?

It will be important to prioritise and support the transformational change needed at the individual, community, sector, and regional levels. Transformation involves fundamental changes in structural, functional, relational, and cognitive aspects of socio-technical-ecological systems, to establish new patterns of resilient and sustainable interactions and outcomes.

Taking a broad view of resilience, supports effective and ethical transformation. Resilience emphasises developing a variety of capacities, including for transformation. These capacities include:

- Anticipatory capacity to prevent, prepare and reduce impacts of droughts and related stresses and shocks.
- Absorptive capacity for maintaining the system.
- Adaptive capacity for modifying the systems, when needed.
- Transformative capacity for systemic change when maintaining and modifying existing system are untenable.

In addition to having these capacities, developing a new configuration of networks, institutions, and governance to support and implement efficient, effective, and ethical transformations, could be considered. Further details regarding the need and nature of transformational change in the Australian agricultural context is provided in Appendix 2.

It will be important to maintain understanding and support for different types of farming and rural systems transformations for FDF future programs for various reasons:

1. Building drought resilience is not only about maintaining the current systems; when necessary, it is also about transforming them. Supporting farmers to exit farming well, could assist with transformational change.
2. It will be important to consider the impact that exits could have on others in the rural community and the viability of the settlement (towns or regions), especially if an exit also involves moving away from the community.
3. It is important to consider what options exist or are emerging for individuals, communities, sectors or even regions to transform, that will build resilience to drought and other stresses and shocks. Therefore, identifying existing and emerging options for transformation and enabling the generation of new options will be important.
4. While there are urgencies, transitions need time, and enabling conditions have to be in place starting from now for transformation to happen in the future. Preparatory activities may include:
 - Understanding the drivers and dynamics of exit from and entry to farming and other non-farm livelihood activities, sectors, and systems in rural drought-affected regions. This could help to understand whether there are established or emerging patterns of transition that may be by choice or/and necessity and could lead to transformational change.
 - Reviewing current support systems, including financial counselling to farmers and other business owners affected by drought and climate extremes, to determine whether they are discussing options for transition/ transformation.
 - Exploring possible options for farmers, farm employees, and other non-farm rural businesses to transition or transform to, that can build drought resilience of the communities and the regions and what can be done to expand those options.

FDF's potential role could include:

1. Supporting transdisciplinary research that establishes the current state of science, policy and practices on farming and rural systems transition/transformation related to drought and assesses what needs transition/transform to build resilience to future drought and other unspecified stresses and shocks.
2. Assessing what options exist, are emerging or can be generated for individuals, rural communities, or sectors who are planning to transition and transform to and exploring public-private partnerships to make these options real and available.

3. Considering ways to create an enabling environment for transition/transformation, including by assessing, modifying and/or developing new regulations, rules, policies, and incentives that support change to build drought resilience.

Or should the FDF continue to also build incremental change – that eventually leads to transformation – and focus on the preconditions (knowledge, skills, and support etc) that enable individuals and communities to make transformational changes?

It is possible that additive incremental changes (adaptation) can eventually lead to transformational change⁹ when directed and used at a greater scale¹⁰. In agreement, some farmers who took part in the CSIRO study (Maru et al. unpublished) also noted that they are making incremental adaptations that may cumulatively result in transformational change in the future. Supporting such incremental changes could be considered if they are assessed to contribute to building rural communities and farming systems' resilience to drought and other interacting stresses and shocks.

The literature on transformation highlights three challenges focusing and relying on cumulative incremental adaptation¹¹:

1. Incremental changes take time to lead to the transformation of the rural system in time for the fundamental changes needed to build resilience.
2. Incremental changes may be non-linear and inadequate to produce the desired transformation that assists with building resilience.
3. Additive incremental actions run the risk of path-dependent decisions that lock farming and rural systems into sub-optimal and unsustainable trajectories.

Therefore, it will be important for the FDF program to consider supporting both radical change and incremental change-based transitions and transformation. However, what radical change and incremental change to support has to be informed by an assessment and a robust theory of change whether they will contribute to a timely building of the resilience of rural systems to drought and other related stresses and shocks.

While there is urgency for transformation, this does not mean everything has to change simultaneously. Decisions around changes required should be based on assessment and deliberation. There are approaches that can assist with such assessment and deliberation. CSIRO developed the Resilience, Adaption, Pathways and Transformation Approach (RAPTA)¹² to operationalise *persistence*, *adaptation* and *transformation* as related concepts that describe the type and extent of change required in a system to build resilience to stresses and shocks and deliver sustainable services and values. The RAPTA approach promotes a systems perspective to:

⁹ Kirkegaard, J. A. (2019). "Incremental transformation: Success from farming system synergy." *Outlook on Agriculture* 48(2): 105-112.

¹⁰ Kates, R.W., Travis, W.R. and Wilbanks, T.J., 2012. Transformational adaptation when incremental adaptations to climate change are insufficient. *Proceedings of the National Academy of Sciences*, 109(19), pp.7156-7161.

¹¹ Vermeulen, S.J., Dinesh, D., Howden, S.M., Cramer, L. and Thornton, P.K., 2018. Transformation in practice: a review of empirical cases of transformational adaptation in agriculture under climate change. *Frontiers in Sustainable Food Systems*, 2, p.65.

¹² O'Connell, D., Maru, Y., Grigg, N., Walker, B., Abel, N., Wise, R., Cowie, A., Butler, J., Stone-Jovicich, S., Stafford-Smith, M. and Ruhweza, A., 2019. Resilience, Adaptation Pathways and Transformation Approach: A guide for designing, implementing and assessing interventions for sustainable futures (version 2).

1. Understand the system structures and feedback loops that cause vulnerability to drought and other interacting extreme events and shocks.
2. Investigate current resilience conferring system properties and rural communities' initiatives.
3. Explore plausible future scenarios, opportunities, and risks.
4. Collectively assess the nature and type of change required. The assessment may find maintaining some aspects, modifying others and/or even completely, transforming or bringing new aspects to the rural system are needed to build a resilient and prosperous future.
5. Work collectively and innovatively on multiple options and complementary transition pathways and programs to implement these changes required.

Given future uncertainties, establishing adaptive governance and continuous monitoring, evaluation and learning will guide the development and implementation of transition pathways and enable revision and changes to pathways as more is known and conditions change. The RAPTA has been widely applied nationally and internationally. Applications include:

- Profiling Australia's vulnerability
- Informing national strategies for disaster resilience¹³
- Informing transition plans for Queensland regional communities¹⁴
- Designing Global Environmental Facility funded projects for resilient and sustainable agriculture and food systems in Sub-Saharan Africa¹⁵.

c. What Drought Resilience Innovation Challenges could be targeted in the proposed new innovation pilot program?

The FDF program constitutes a significant shift from focusing on providing short-term drought relief to building long-term resilience. Some innovation challenges that could be considered for the new innovation pilot program that could support this shift are:

- A challenge for irrigated agriculture, which may be amenable to multiple solutions, is the development and implementation of more flexible responses to seasonal variation in available water at a farm and higher levels of scale.
- Develop and implement ways of piloting the transition to more transformative approaches at a regional scale consistent with regional drought resilience planning goals.
- Develop and implement ways of integrating Indigenous and western knowledge that build drought resilience through productive, environmentally sensitive interventions that benefit both Indigenous and non-Indigenous stakeholders.
- Understand and remove barriers to adoption of digital technologies that if more widely adopted could increase drought resilience.

¹³ Australian Government, Department of Home Affairs. 2018. Profiling Australia's Vulnerability: the interconnected causes and cascading effects of systemic disaster risk

¹⁴ CSIRO, JCU, USQ and TEG. November 2019 Goondiwindi: A living transitions roadmap, CSIRO, Australia.

¹⁵ Maru, Y., O'Connell, D., Grigg, N., Abel, N., Cowie, A., Stone-Jovich, S., Butler, J., Wise, R., Walker, B. & Million, A. 2017. Making 'resilience', 'adaptation' and 'transformation' real for the design of sustainable development projects: piloting the Resilience, Adaptation Pathways and Transformation Assessment (RAPTA) framework in Ethiopia. May 2017. CSIRO, Australia.

To give the areas chosen for the Drought Resilience Challenges a good chance to succeed in building long term resilience they may be characterised by:

- a broad definition of innovation “as a process and an outcome that happens when a new idea, technology, product, business model, management practice, policy, regulation or a combination of these are put into economic, social or environmental use and generate value”¹⁶.
- partnerships among the different stakeholders to develop and adopt fit-for-purpose and for context innovations¹⁷ instead of linear and sequenced invention and then persuasion of targeted beneficiaries to adopt innovation.
- innovations that are not just developed for efficiency, which can reduce redundancy, response diversity and modularity required for building resilience.

6. Proposed Investment Streams – Enabling activities

a. What enabling activities are essential to the success of the FDF and should be directly funded to support FDF programs?

From CSIRO’s experience and involvement in FDF programs and activities, we have identified several key enabling activities that would support improved delivery of the FDF to maximise its impact from investments in its individual programs.

Theory of Change and Monitoring, Evaluation and Learning (MEL) Framework

At the FDF Consultation session on 6 November 2023 in Canberra, the third topic CSIRO was asked to provide feedback on was the importance of the Theory of Change (ToC) for the next round of FDF investment. Here, we outline how well-developed ToC, with MEL, baseline, and end-line data, can assist with robust resilience impact assessment of FDF interventions (i.e., policies, investments, programs, projects).

A well-developed MEL framework can be applied to examine the feasibility and effectiveness of the proposed actions and the extent to which roles and responsibilities have been appropriately assigned, to achieve the outcomes and goals of the FDF. The MEL framework should enable refinements to goals, outcomes, outputs, activities, and inputs in the plan over time. MEL provides an evidence base for active learning and adaptive governance of plan implementation and a well-conceived MEL framework would also assist with generating evidence and information to communicate progress on implementation. An effective MEL framework is underpinned by a ToC that articulates a suite of Indicators to measure progress against a baseline state and a clear plan to collect supporting data and information for evaluation and assessment of progress. Dedicated funding to implementation of MEL will ensure that MEL activities are delivered fit-for-purpose for FDF requirements and can operate at scale and/or across programs to enable effective and efficient evaluation of the FDF, consistent with the ToC.

A well-articulated ToC for an intervention provides an effective impact assessment methodology with adequate rigour and explanation of why and how an intervention could or has

¹⁶ HALL, A. 2007. The origins and implications of using innovation systems perspectives in the design and implementation of agricultural research projects: Some personal observations. *origins*, 2007, 013.

¹⁷ MARU, Y. T. 2018. Summary: Critical reflection on and learning from Agricultural Innovation Systems (AIS) approaches and emerging Agricultural Research for Development (AR4D) practice. *Agricultural Systems*, 165, 354-356.

succeeded/failed to contribute to desired goals¹⁸. A ToC refers to a theory, integrated hypothesis, or explanation of how and why an intervention will activate the desired change bring or contribute to the impact¹⁹. A ToC is, therefore, more than an Impact Pathway, which tells us how the intervention will be or is carried out, usually in the form of inputs-activities-outputs – to deliver different outcomes²⁰.

Depending on the type of intervention, a ToC can have a theory or integrated explanation, for example, based on innovation diffusion, behavioural change, institutional change, or/and resilience theories. A ToC also has assumptions and ways of obtaining evidence to assess whether its proposed mechanisms and assumptions are likely or have delivered outcomes and contribute to impact²¹.

Preparing for a pragmatic impact assessment starts at the inception of an intervention (project, program, policy) by articulating a ToC and MEL for the intervention. The impact assessment can then use the ToC to outline the theories or mechanisms presumed and assumptions that need to hold to deliver outcomes, contribute to impact, and use a qualitative methodology called process tracing. Process tracing is an analytic approach for drawing descriptive and causal inferences from diagnostic pieces of evidence understood as part of a temporal sequence of events or phenomena. Process tracing attempts to identify the intervening causal process, the causal chain and the causal mechanism between an independent variable (or variables) and the outcome of the dependent variable²². The Most Significant Change Stories can also complement a ToC-based process tracing. This qualitative method elicits stakeholders' evaluation of whether or not the interventions are likely or have resulted in the intended outcomes²³.

Depending on the nature of the FDF intervention, other ToC-based but quantitative impact assessment methods can also be used. These include techniques using propensity matching, where ex-post artificial matching of similar cases is used to compare and assess the impact of interventions or difference-in-difference, where using baseline and end-line data on the state of resilience is collected and differences compared²⁴.

An integrated assessment of the system's baseline and endline resilience state may help to evaluate the impact of an FDF Intervention. In assessing baseline and end-line, it is essential to integrate both objective and subjective resilience assessments as individual or community perception and self-evaluation of their resilience have a material impact on their resilience²⁵. Subjective resilience assessment can also provide access to community members' knowledge and experience, which are often missed in objective approaches reliant on definitions, identification of attributes, observations, and expert judgement external to the community whose resilience is

¹⁸ Maru, Y.T., Sparrow, A., Butler, J.R., Banerjee, O., Ison, R., Hall, A. and Carberry, P., 2018. Towards appropriate mainstreaming of "Theory of Change" approaches into agricultural research for development: Challenges and opportunities. *Agricultural Systems*, 165, pp.344-353.

¹⁹ Pawson, R., Tilley, N., 1997. *Realistic Evaluation*. Sage.

²⁰ Weiss, C.H., 1997. Theory-based evaluation: past, present, and future. *N. Dir. Eval.* 1997,41–55.

²¹ Maru, Y., Sparrow, A., Stirzaker, R. and Davies, J., 2018. Integrated agricultural research for development (IAR4D) from a theory of change perspective. *Agricultural Systems*, 165, pp.310-320.

²² Befani, B. and Stedman-Bryce, G., 2017. Process tracing and Bayesian updating for impact evaluation. *Evaluation*, 23(1), pp.42-60.

²³ Davies, R. and Dart, J., 2005. The 'most significant change'(MSC) technique. *A guide to its use*.

²⁴ Béné, C., Chowdhury, F.S., Rashid, M., Dhali, S.A. and Jahan, F., 2017. Squaring the circle: Reconciling the need for rigor with the reality on the ground in resilience impact assessment. *World Development*, 97, pp.212-231.

²⁵ Béné, C., Frankenberger, T., Griffin, T., Langworthy, M., Mueller, M. and Martin, S., 2019. 'Perception matters': New insights into the subjective dimension of resilience in the context of humanitarian and food security crises. *Progress in Development Studies*, 19(3), pp.186-210.

measured²⁶. Models for integrated subjective and objective resilience assessment that can be used to conduct resilience outcome assessment are being developed²⁷.

Data Access and Knowledge Management

The FDF has produced significant data, information, and knowledge in its first four years of operation. A nationally coordinated Knowledge Management Platform is essential to ensure that all products developed through FDF investment are available and accessible to all stakeholders regardless of their location or specific involvement in individual FDF projects. This responsibility is broader than the responsibility of one program, or the Adoption and Innovation Hubs, and requires a dedicated effort to maximise the value of FDF investments to enable dissemination of information and brings together cross-program information and adaptation options, which are important precursors to action.

The advantage of the FDF funding a central, coordinated approach to Data Access and Knowledge Management is the consistency in approach, a lifespan beyond the term of a single program, ability to bring together FDF program and project outputs, and creation of a national platform that can reach the broad range of stakeholders necessary to create impact. Such a system would also support effective and efficient MEL and better support broad uptake and adoption of tools and products relevant to building drought resilience.

Integration and Synthesis

FDF investment has been delivered through a broad range of programs that operate across different sectors, disciplines and scales. There is no current investment that is targeted towards synthesis and integration of the new knowledge that is being generated. A cost-effective approach to maximise the outcomes of existing investment would be to undertake a series of integration pieces that synthesise this knowledge and facilitate knowledge sharing across economic, social and environmental dimensions, industry sectors and/or scales. Synthesis should be focussed on those issues and scales that operate across multiple Adoption and Innovation Hubs and contemplate the more transformational concepts and opportunities. This approach would build upon the Knowledge Management Platform and create additional value from individual FDF investments.

Furthermore, as elaborated under Question 1 of this submission, resilience challenges and opportunities emerging from the interactions among those economic, social and environmental dimensions are as important as resilience within each dimension. An integrative resilience approach will be important to design and implement programs to ensure system-wide outcomes. Integration could be considered to be a fourth pillar to the three FDF objectives and applied to assess the extent to which critical interactions among the dimensions are considered in the proposed FDF programs.

For synergy, coordination and scaling impact, attention to integration can extend beyond the FDF programs. This may involve mapping and ensuring linkage and alignment between the FDF programs with other related strategies and programs, such as water security investment, climate change mitigation and adaptation strategies, and disaster risk reduction initiatives run by different government and non-government organisations.

²⁶ Jones, L. and d'Errico, M., 2019. Whose resilience matters? Like-for-like comparison of objective and subjective evaluations of resilience. *World Development*, 124, p.104632.

²⁷ Yong, S., Maru, Y.T., Herr, A., Measham, T.G. and Loechel, B., 2022. A method for benchmarking two different resilience assessment methods. *Ecology and Society*, 27(4).

Capacity building

It is important to consider building capacity in resilience thinking, principles and practices to ensure well-informed and appropriate application in governing and implementing the FDF drought resilience programs for impact. Building capacity in resilience thinking, principles and practices can also reduce the misapplication of the concept for valuable activities and initiatives, but that may not confer drought resilience²⁸. This could be offered as adult learning-based training to key people governing and implementing FDF programs, which in turn helps improve resilience thinking, principles, and practices.

Capacities to consider focussing training on include:

- Anticipatory capacity: to help prepare unfolding risks and plausible futures.
- Absorptive capacity: for coping with immediate impacts of stresses and shocks and maintaining the system.
- Adaptive capacity: for modifying the systems when needed.
- Transformative capacity: for systemic change when maintaining and modifying existing systems are untenable.

Exploring a new configuration of networks, institutions, and governance to implement these capacities could also support building resilience.

Building capacity in resilience thinking and practice also requires changing mental models. The shifts include:

- developing a systems perspective to understand better complex problems and opportunities, feedback loops, cross-scale interactions and thresholds;
- considering intentional reserves, buffers and redundancies in a system not as inefficiencies but critical elements of resilience; and
- acknowledging uncertainty and difficulty in precise predictions and shifting focus in preparing for multiple plausible futures.

Enabling policy and institutional changes

Resilience will come not only through technology, innovation, and change in practices but also through change and innovation in policy, rules and regulations. In this regard, the FDF, a significant policy shift from relief to resilience, could help create the enabling conditions for change and innovation in policy and institutions that further complement and implement this shift. These enabling conditions could include:

- Different time allocations needed for different FDF projects – for example, projects for transformational change or projects co-designed with First Nations peoples may require more than the funding time envelopes.
- Assessing how the current set of drought-related policies, strategies, and programs at different scales (federal, state/territory and local) support building drought resilience and what can be done to link, align and create synergy.
- Establishing governance arrangements that enable adaptive and innovative implementation of some of the programs, for example, the Regional Drought Resilience

²⁸ Walker, B. 2020. Resilience: what it is and is not. *Ecology and Society*, 25.

Planning Program – more detail on why and how to establish adaptive governance is given in Appendix 1.

Enabling transformational change

The importance of transformational change and what direct and enabling role the FDF program could play is outlined in Question 5b.

APPENDIX 1: Steps and actions that could be considered when establishing adaptive governance and implementation pathways to actioning regional plans

1. Establish adaptive governance arrangements for plan completion and implementation

An adaptive governance arrangement, encompassing local, regional, and state/federal level of government, for the plans could help to:

- Complete remaining plan components.
- Refine proposed actions and assign roles and responsibilities to different partners and stakeholders.
- Effectively guide plan implementations and make plan updates in anticipation and response to uncertainties and changes.

Adaptive governance of the RDR plans could support the overall policy shift indicated for the FDF program from drought relief to resilience. Therefore, the program could support capacity building in establishing appropriate governance arrangements.

Almost all the plans CSIRO reviewed for the synthesis report demonstrated a high level of collaboration among diverse local, regional, and state-based stakeholder organisations in developing the RDR plans. However, some regions expressed concerns about whether these partnerships would continue once the resources for the planning stage were utilised. With support, the strong collaborations evident in developing the plans could be used to establish enduring partnerships and adaptive governance arrangements for plan implementation. Some plans proposed that partnerships formed for plan development become part of the governance groups for plan implementation, ensuring continuity and maintenance of corporate knowledge in future iterations.

The RDRP program promotes local ownership of the RDR plans, which is crucial for legitimacy as a part of cross-scale governance of the plans. There were concerns with local ownership of plans, with some fearing this could mean devolving sole responsibility to local levels without access to appropriate capacities, resources, and authority to make essential decisions for implementing and updating plans. It is important to have a governance structure that fosters different roles, responsibilities, and resource sharing across scales.

Adaptive governance of the RDR plan could also consider close coordination with other national, state/territory, regional and local mental health programs, climate change adaptation and net zero initiatives and disaster risk reduction schemes operating in rural and regional areas to increase systemic outcomes and to reduce the burden on local organisations and communities.

Other components that could be considered either prior to or during plan implementation are:

- MEL framework.

- Scenarios that provide insights for generating intervention options that are robust under different plausible futures.
- Assessing the extent to which proposed actions and pathways will likely deliver drought resilience.

A well-developed MEL framework in each plan (currently missing in many plans) should examine the feasibility and effectiveness of the proposed actions and the extent to which roles and responsibilities have been appropriately assigned, to achieve the outcomes and goals of building regional drought resilience. It should also reflect on the degree and availability of resources required and identify appropriate indicators and data sources for tracking and assessing progress in plan implementation. The MEL framework should enable refinements to goals, outcomes, outputs, activities, and inputs in the plan over time. Without a well-developed MEL, it is difficult to operationalise a plan as a living document that can be adapted as more is learned and circumstances change. A robust MEL framework also embeds recognised moments for reflection and active learning as critical to the plan development and implementation. The MEL provides an evidence base for active learning and adaptive governance of plan implementation. A well-conceived MEL framework would also assist with generating evidence and information to communicate progress on the plan's ongoing development and implementation to stakeholders.

A ToC developed first could further enhance the MEL's quality and overall plan. A ToC for an RDR plan is the causal logic and mechanisms by which proposed actions in a plan if implemented as a set, will build regional drought resilience. It assists with integrating all the components of the plan, from articulating a clear vision to the identification and explicitly stating the mechanisms and pathways presumed to deliver the outcomes and goals of the plan.

2. Specify, prioritise and sequence actions in the plan to make them ready for implementation and add more innovative and transformative actions.

The plans CSIRO reviewed for synthesis had a median of 74 actions per plan, many aspirational and lacking specificity. Most of the proposed priority areas and actions focus on maintaining and enhancing the current farming systems through increasing efficiency (seven plans) and expanding existing water storage and irrigation infrastructures (all plans). Some (seven plans) propose large dams and irrigation infrastructure to secure water for sustaining and expanding agricultural practices. Some plans explored diversifications within farming types and practices and diversification to off-farm activities. However, many plans did not consider supply and value chain resilience. The legitimate focus on farming in some plans seemed to have also overshadowed the need to understand the details of the impact of drought on the livelihoods of non-farming community groups in the region.

Only a few plans seriously explored transitioning to non-agricultural livelihoods less dependent on rainwater availability, such as carbon farming, solar farming, or becoming digital technology testing hubs. These plans are supported by commissioned research identifying what to maintain, modify, and/or transform in the region to build resilience as broad change pathways with corresponding initiatives and actions.

While regions need to explore more new ideas, technologies, business models, and industries for transitions and transformations, the challenges in these change pathways are more than just

technical. Instead, they are cognitive, behavioural, cultural, and structural, including infrastructure, economic and social policies, land-use legislation and other institutions that need to change, facilitated by stakeholders at a scale beyond the farm.

3. Consider the use of FDF funding for implementation to put the plan in motion.

FDF implementation funding could be used to implement the plan, focusing on prioritised actions and on continued work to determine ongoing funding sources for implementation plan actions. Alignment of some of the proposed actions with other government grants, for example, from the National Water Grid Authority, federal and state disaster reduction and climate resilience programs, and mental health programs, could assist additional and ongoing funding for plan actions. Most plans incorporated evidence and information from past and current related initiatives and established linkages and alignment with other plans and policies. These included other FDF programs (e.g. Drought Resilience Leadership and Networking programs) and a variety of other catchment, regional, state, and national programs and strategies, including disaster resilience plans. Further support could help to make these linkages and alignments strategic and effective to increase synergy, reduce duplication of efforts and explore potential funding sources for identified resilience-building activities in the RDR plans.

4. Prioritise and support building capacities for resilience planning

The synthesis has given us insights into the state of drought resilience planning across the country, and in doing so, it has revealed some common challenges or capacity needs critical for ongoing plan updates and implementation. It would be beneficial to build these capacities across regions for the implementation of foundation plans and new plans. Specific components include establishing adaptive governance arrangements, creating a ToC and MEL, resilience assessment, participatory scenarios, adaptive pathways, and exploring more innovative options for transitioning and transforming current farming and rural systems for better preparedness and response to drought and other interacting stresses and shocks.

5. Map farm and non-farm stakeholders and engage with those missed in the first round.

Most plans reported common challenges faced during the engagement that affected participation. These challenges included a short engagement and overall planning timeframe, COVID-related restrictions, meetings, and consultation fatigue, contributing to low attendance at invited community events. In many regions, flood events also made it challenging to undertake active engagements. It will be important to ensure living plans are updated regularly through more active participation of groups, specifically First Nations peoples and other non-farming groups vulnerable to drought impacts. Active participation can be guided by developing or refining stakeholder maps to include non-farming groups affected by drought and considering factors affecting drought vulnerabilities, such as age, gender, disability, disadvantage, language and cultural barriers.

6. Establish baseline information and state of resilience in the region.

All plans included at least a preliminary assessment of the impacts of past droughts and likely future impacts. Some plans even went further in developing drought vulnerability assessments. Those assessments could be upgraded to include a regional resilience assessment. The resilience assessment extends the drought impact and vulnerability assessments in the RDR plans by

explicitly considering the region's absorptive, adaptive, and transformative capacities and different sectors and segments of the communities to drought and other stresses and shocks. Resilience assessment will also identify critical variables, feedback loops, and thresholds of concern that are essential in guiding efforts for building resilience and transformation. The regional resilience could provide evidence for determining what to maintain, modify and/or transform to build the absorptive, adaptive, and transformative capacities, a baseline for MEL to track the progress of activities identified in RDR plans and for other FDF initiatives, and overall regional drought resilience outcomes and goals.

Recent resilience assessment studies have found having a subjective resilience assessment helpful. This is because individual or community perception and self-evaluation of their resilience have a material impact on their resilience²⁹. Subjective resilience assessment can also provide access to community members' knowledge and experience, which are often missed in objective approaches³⁰. Models for integrated subjective and objective resilience assessment are being developed³¹.

7. Start implementing no-regrets actions while completing and updating implementation plans.

It is recognised that there are some plan components to complete. Many of the proposed actions require more specification and assessing if and how much they contribute to building drought resilience. However, it will be important to consider delaying implementing plans until all missing or poorly developed components are completed. It is important to start with some no-regrets activities known to help build resilience. These could include building missing capacities identified above and resilience-building actions aimed at community health, especially mental health and well-being. Examples of actions include:

- Supporting existing public and community gatherings and sports events to increase informal community involvement, interaction, and networking.
- Raising mental and physical health awareness, including advertisements that counter stigma and promote acceptance and early professional help-seeking behaviour.

The plans also emphasise increasing community access to psychosocial and other health services, financial counselling and maintaining green community spaces. Factors such as gender, age, ethnicity, Indigenous status, pre-existing health status, socio-economic disadvantage, level of drought exposure and sensitivity of livelihoods, previous drought experience and financial reserves, and cultural and linguistic barriers to accessing health support, can all contribute to substantial differences in vulnerability to impacts of drought among different groups of rural communities. In building social resilience, having a nuanced understanding of these differential

²⁹ Béné, C., Frankenberger, T., Griffin, T., Langworthy, M., Mueller, M. and Martin, S., 2019. 'Perception matters': New insights into the subjective dimension of resilience in the context of humanitarian and food security crises. *Progress in Development Studies*, 19(3), pp.186-210.

³⁰ Jones, L. and d'Errico, M., 2019. Whose resilience matters? Like-for-like comparison of objective and subjective evaluations of resilience. *World Development*, 124, p.104632.

³¹ Yong, S., Maru, Y.T., Herr, A., Measham, T.G. and Loechel, B., 2022. A method for benchmarking two different resilience assessment methods. *Ecology and Society*, 27(4).

vulnerabilities can assist in tailoring health and other professional support before, during, and after droughts and better meet the specific needs of different community groups.

8. Attend to region-specific needs.

Planning for resilience is a learning process. Regions face different challenges in putting together resilience plans and preparing for implementation. Listening sessions and strengthening other feedback mechanisms would assist the DAFF RDRP program, state and territory program coordinators, and others to be responsive to regions' specific needs for plan implementation.

APPENDIX 2: Transformation Needs in Agriculture and Rural Systems

Agriculture and food systems literature indicates that there are limits to current agricultural and rural adaptation options^{32,33}. It also emphasises the need to transform farming systems to ensure they can continue to deliver products and values in a sustainable, safe, and resilient way with minimal emissions³⁴. The literature underscores that transformations are occurring, especially at farm and farm household levels, shown by the rise in different kinds of farming, scales of farms or exiting farming altogether³⁵. However, there is limited understanding of what is driving these transformations, i.e. whether they are by choice or forced and of their implication on the well-being of farmers and communities, viability of rural settlements, resilience, and sustainability of rural systems.

An unpublished CSIRO study (Maru et al. unpublished)³⁶ shows farmers and farm advisors believe that the current business models are working yet limits to adaptation are inevitable and transformational changes are necessary. The reason for adaptation limits and the need for transformation are not entirely owed to drought risks or climate change. Rather, they are also likely to be related to interacting economic factors (such as input cost, commodity prices, and labour shortages), policy and regulatory requirements, and changing social values.

Transformation may involve an individual, a community or a region, a sector, a value chain, or a system. At the individual farmer level, transformations do happen regularly with farmers selling their land and exiting farming for a variety of reasons. In a study on the impact of exiting farming on the autonomy and well-being of farmers, Peel and colleagues (2019)³⁷ cite 2016 ABS data and note that 15,700 farmers exited farming between the 2011 and 2016 censuses, representing a decline in the number of farmers by 20% since 2006. While retirement can be expected to form a sizable portion of those who exited farming, a study by Wheeler and colleagues (2019)³⁸ shows the drivers for exiting farming among farmers in the Murray-Darling Basin have been climatic (for example, increases in maximum temperature and increased drought risk) and socio-economic factors, such as decreased commodity output prices, increased urbanisation, and higher unemployment. Peel and colleagues (2019)¹⁴ found that 27% of rural residents who exited farming surveyed retired at the time of exit, while the remaining 73% did not retire, with a majority (51%)

³² Dow, K., Berkhout, F., Preston, B.L., Klein, R.J., Midgley, G. and Shaw, M.R., 2013. Limits to adaptation. *Nature Climate Change*, 3(4), pp.305-307.

³³ Alston, M., Clarke, J. and Whittenbury, K., 2018. Limits to adaptation: Reducing irrigation water in the Murray-Darling Basin dairy communities. *Journal of Rural Studies*, 58, pp.93-102.

³⁴ Singh, B.K., Arnold, T., Biermayr-Jenzano, P., Broerse, J., Brunori, G., Caron, P., De Schutter, O., Fan, S., Fanzo, J., Fraser, E. and Gurinovic, M., 2021. Enhancing science-policy interfaces for food systems transformation. *Nature food*, 2(11), pp.838-842.

³⁵ Vermeulen, S.J., Dinesh, D., Howden, S.M., Cramer, L. and Thornton, P.K., 2018. Transformation in practice: a review of empirical cases of transformational adaptation in agriculture under climate change. *Frontiers in Sustainable Food Systems*, 2, p.65

³⁶ Maru, Y.T., Bhaskar, U., Williams, S., Weaver, T., Herr, A., Staines, T. and Fletcher, A. (unpublished) Farmer and farm advisors' perspectives on agricultural adaptation limits and necessity of options for transformation

³⁷ Peel, D., Schirmer, J., Berry, H. and O'Brien, L.V., 2019. Farm exit, wellbeing and autonomy: a quantitative analysis of exited farmers in Australia. *Rural Society*, 28(2), pp.108-126.


³⁸ Wheeler, S.A., Xu, Y. and Zuo, A., 2020. Modelling the climate, water and socio-economic drivers of farmer exit in the Murray-Darling Basin. *Climatic Change*, 158(3), pp.551-574.

transitioning to working for a salary or wages and 12 % establishing non-farm businesses. The retired were reported to be less likely to lose their autonomy and, therefore, had better well-being outcomes than those who transitioned to owning non-farm businesses or working for a salary or wage¹⁴. Those who transitioned to working for a salary or a wage were the most likely to lose autonomy and well-being¹⁴.

Transformations may also be necessary at community, sector, and regional levels. These could include if a community primarily dependent on farming changes to services or mining or farming sector changes from primarily cropping to livestock. Transformations can be intentional or emergent and are not always inherently good³⁹. They may require intervention to guide intentional and emergent transformations to achieve normative goals such as building resilience, delivering better well-being and sustainability outcomes. For example, global economic and trade drivers and dynamics can lead a farming region with some newly in-demand mineral resources to transform to a mining region. In such transformations, interventions to reduce and address adverse impacts of transformations could be considered⁴⁰.

³⁹ Blythe, J., Silver, J., Evans, L., Armitage, D., Bennett, N.J., Moore, M.L., Morrison, T.H. and Brown, K., 2018. The dark side of transformation: latent risks in contemporary sustainability discourse. *Antipode*, 50(5), pp.1206-1223.

⁴⁰ Geels, F. W. (2019). Socio-technical transitions to sustainability: A review of criticisms and elaborations of the Multi-Level Perspective. *Current opinion in environmental sustainability*, 39, 187-201.



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