CRDC2202 Final Report “Building profitable farming systems for the future through increasing soil organic carbon and optimising water use efficiency in a changing climate” Dryland Cotton Research Association

Executive Summary:

This project was to develop insight into the future of rainfed cotton systems by developing an understanding of soil carbon and water use efficiency across a number of current rotation options.

The project included:

- a review of work on optimal farming systems and the influence of long-term rotations including cover cropping and the introduction of pulses, cereals and fallow on water use efficiency and profitability
- consultation across the rainfed cropping industry to identify existing innovative tactics currently being used by growers
- the establishment of two legacy sites for demonstration trials to compare current rotations in commercial enterprises with the benefits of carbon accumulation on sustainability and profitability
- Farm walks/field days to support information delivery
- economic analysis, and
- the development of a suite of case studies encompassing innovative farming tactics to deal with climate variability.

There is an appetite for understanding more about soil organic carbon and the benefits of managing a rainfed cropping system to accumulate soil carbon.

Rainfed cotton growers still indicate that they don’t understand how soil organic carbon fits into their farming system and are unsure of how to make evidence based, on-farm decisions specifically around soil organic carbon. Likewise, despite the uptake of technology to monitor soil moisture growers and their advisors are unsure how to use the data to make on-farm decisions. This project was to look at the interaction of soil organic carbon and water use efficiency so this constraint to adoption needs to be addressed.

The rainfed cotton industry could benefit from further investigation in to:

- Economic and sustainability analysis on the use of enhanced efficiency fertilisers in crop rotations to reduce emissions, alongside organic products such as manure pellets.
- Whole farm carbon footprint analysis and measuring biodiversity scores across various dryland regions where local vegetation species can be identified to improve the accuracy of sequestered carbon may be useful to build awareness of the value and stewardship of non-cropped areas.
- Conducting a review of emerging biodiversity score ‘tools’ available and their value in the marketplace is an emerging area of consumer and brand influence.
- Given the low relative carbon/water footprints of dryland cotton - owing to modest nitrogen use and on-farm vegetation, exploratory economic analysis on dryland cotton branding premiums in the marketplace has commercial potential.

- Consumer/brand market research, EU market access, accreditation design parameters, traceability frameworks in a prospective unique supply chain benefit cost study may also be valuable for dryland cotton growers.
- Continued research at the two legacy sites established to consolidate the work already completed over a longer timeframe within varying climatic conditions.
- Develop standardized, simple sustainability metrics
- Investigate standardized testing protocol for dryland cotton systems taking into account carbon fluctuations and rigor around testing
- Review the CRDC data agreement to determine if data from previous projects can be shared for analysis
- Managing systems for soil carbon accumulation in sodic, cracking soils
- Investigate what cover crops have been trialled in horticulture that may be suitable for dryland cotton systems
- Investigate breeding specific cover crops with high biomass, fast growing and persistent traits for increasing soil carbon in dryland cotton systems
- Investigate aggregating soil test and rotation data together from 2019 for at least one site
- Investigate the marketing of rain grown carbon neutral cotton differently to irrigated cotton.

This project, while a good start, requires further investment to realise the full value of the work already completed.

As technology improves and research learnings are ground truth in commercial systems the development of simple to use tools will be critical to facilitate integration of these profitability and sustainability concepts into current rainfed cotton cropping systems.

Public Release Summary:

Rainfed cotton growers have an appetite to better understand the interaction between soil organic carbon and water use efficiency as a way to drive long term profitability and sustainability.

The early on-farm data collected over one growing season and analysed across soil carbon levels, soil moisture dynamics, and cropping system performance demonstrates a clear commitment to sustainable dryland production. While seasonal challenges prevented the establishment of a summer cover crop, the strategic shift towards soil benchmarking and technology integration has provided deep insights into soil health, crop resilience, and resource use efficiency. The results affirm that the current five-year rotational system supports moderate soil organic carbon levels, effective moisture conservation in key zones, and potential for further optimisation through targeted management practices.

Continued investment in soil monitoring, moisture tracking, and adaptive agronomic strategies will ensure the cropping system will remain resilient to seasonal variability and climate pressures. The integration of data-driven insights with practical on-farm management will underpin future improvements in soil health, water-use efficiency, and carbon sequestration potential.

Economic analysis against a benchmark five year rotation showed the largest gains in soil carbon accumulation are observed in a millet/cotton rotation. However, this rotation produced a negative marginal return on capital from carbon farming. The remaining two new crop rotations showed both improved sustainability and economic returns when compared with the baseline rotation. The marginal rate of return from entering a carbon farming commitment in

these scenarios was overwhelmingly positive, whereby premiums from high-value crops such as cotton and chickpeas easily outweighed certification and audit costs.

However, the two cropping rotations commenced the gross margin analysis as more favourable than the baseline rotation. A number of limitations exist in the study, and findings remain early stage and should be viewed in that context.

Future work should focus on better understanding farming input assumptions into the decision support models used, sensitivity testing to determine the robustness of practice changes, and investigating the role of native vegetation in offsetting GHG emissions from cropping inputs.

Three case studies using real gross margin and input data for cropping systems in the Namoi Valley, Darling Downs and the Northern Territory.

The general results are:

- Each system had a positive net present value (NPV) and internal rate of return (IRR) from changing from a baseline practice to a carbon-focussed rotation whilst participating in an ERF carbon project
- Financial results were highly sensitive to long-term increases in cropping yields, and moderately sensitive to soil carbon sequestration
- Changes in the discount rate and future ACCU prices were found to have more limited impacts on the financial results
- All three case study farms were found to be either carbon neutral or net carbon sinks, owing to sequestration from non-cropped area

The project has identified a number of key areas that require further investigation to develop simple, easy to use tools for growers to make evidence based and timely on-farm decisions around soil organic carbon accumulation considerations.

Objectives:

The key objectives of this project were:

- Facilitate collaboration to review previous work completed on soil organic carbon in rainfed cropping systems.
- Consult effectively with growers and advisors on the systems and rotations currently being used in commercial businesses
- Establish two legacy sites for benchmarking key attributes and long-term work on the correlation between soil organic carbon and water use efficiency.
- Complete economic analysis of a cross section of farming systems
- Complete economic analysis on three representative cropping systems with a view to soil organic carbon accumulation and carbon neutral farming practices.

Background:

Many projects have examined the various components of sustainable farming systems based on profitability and water use efficiency. The components of the optimal farming system are ever evolving and changing in a future where warmer temperatures, lower, but more intense rainfall, herbicide resistance, changing pests and diseases spectrum and nutritional requirements are playing an increased role in how the optimal farming system for the future looks.

This project will develop a picture for the future of how rainfed cotton systems might look through developing an understanding of factors such as soil carbon and water use efficiency throughout the rotation and how manipulation of that system will build carbon levels through sustainable farming practices.

Research Activities:

The activities of the project include:

- Review of work to date on optimal farming systems components including cover cropping, water use efficiency and measuring soil carbon and determining which system may hold benefits for the future.
- Case study/s of grower/s using innovative farming system practices for soil carbon sequestration
- Demonstration trials to test innovative farming systems tactics
- Economic analysis of the profitability and water use efficiency of potential systems and tactics
- Recommendations for future resilient farming systems extended through field days, demonstrations and industry forums

Outputs:

The project has developed the following outputs:

- March 2022 Think Tank Summary Report
- January 2023 Opportunities to sequester carbon in dryland cropping rotations. An economic review of costs and benefits. AgEcon
- April 2025 Soil carbon project potential and measuring agronomic benefits. AgEcon
- April 2025 Podcast Soil carbon project potential and measuring agronomic benefits. AgEcon
- April 2025 Soil health, cropping systems and technology integration for sustainable dryland cotton production. Outlook Ag

Impacts:

This project is an initial investment into an emerging issue for rainfed cotton growers.

It has achieved, through effective collaboration:

- the synthesis of current research learnings, on-farm observations and innovative tactics to manage rainfed systems sustainably
- a better understanding of the current thinking and the knowledge gaps that exist
- preliminary analysis of the economic and financial benefits of three contrasting rotational systems in regard to soil organic carbon accumulation.
- a greater awareness of the benefits that could be realised through marketing a carbon neutral farming system

Key Publications:

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