REVIEW SUMMARY

Cotton Research and Development – Plant pathology investment

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The Australian cotton industry has invested in cotton disease research over a number of decades, building a strong knowledge base and making some significant gains in disease management along the way. Despite these ongoing efforts, disease is still one of the leading limitations in the cotton production system. This review provides an opportunity to review and reflect on the past investments and outputs, identify shortfalls or research gaps and critically review the strategic direction for future of CRDC pathology investments to deliver heightened impact at a field level.

The emergence and dominance of fungal pathogens in cotton is consistent with other areas of agricultural production where the tightening of crop rotation, adoption of agronomic practices to maximise yield and the ongoing evolution of pathogens creates the ideal environment and selection pressure for more virulent pathogen strains. The cotton industry lacks empirical data on this trend, however this review has identified a high level of concern among stakeholders and acknowledges that the risk of pathogens to cotton production is both currently substantial and likely to increase with time.

The cotton industry has a limited tool kit for disease control and disease research should remain a high priority for the CRDC. Unlike many other broadacre production systems there are few effective fungicides for cotton diseases and, although new fungicides may be a possibility, there is limited incentive for registration. There is a track record of genetic gain by breeding for biotic stress resistance for cotton and new sources of resistance exist within germplasm collections. Breeding for new host resistance is important and ongoing. However, there is a long pathway to the delivery of disease-resistant germplasm.

Subsequently, this review recommends that the CRDC adopts a strategic approach to bring together current and future industry knowledge and research for in-field disease management based on:
a) Systems-based disease control packages – with a robust theoretical framework for each disease of interest, clearly identified critical control points and the deployment of near-to-field analysis of disease pressure, soil health and agronomic solutions based on empirical data sets (derived from in-field trials, inclusive of economic impact assessment).

Furthermore, this review also recommends changes to research focus including:
b) Greater emphasis on understanding pathogen behaviour (both the phenotype – ie the virulence and epidemiology of the pathogens causing disease and the genotype - genetics of the pathogens and pathogen populations).
c) Economic assessment of disease and control options – to extend the current knowledge of disease incidence to understand progression to severity and yield loss.
d) Increased adoption of spatial data analytics and advanced modelling capability.
e) Longer term (5 to 8 year) investment framework guided by point a) with clearly defined opportunities for co-investment and co-design and the implementation of an enabled national leadership role.

The cotton industry is strongly supported by a high quality group of people dedicated to Research, Development and Extension. The recommendations in this report will ensure that CRDC co-investment, research effort and industry knowledge is developed within a defined framework targeting economically relevant on-farm impacts and ensuring that the capacity for cotton pathology research remains commensurate with other areas of Agricultural production.

Recommendations

1. That future research investment in surveillance separates investment to align clearly with surveillance outcomes:
   - *Tactical disease management and alerts for known diseases*
   - *Pathogen population monitoring*
   - *Identification and early warning of new disease causal mechanisms*
   - *Biosecurity*

2. That co-investment includes the development of data on the actual economic impact of diseases for cotton across all production areas.

3. That all pathology co-investments should be linked to economic assessment of impact at the design, output delivery and completion stages.

4. Establish collaboration between crop pathology and spatial data analytics and investigate the potential to use remote and/or proximal sensing to target surveys and/or extend survey result.

Recommendations (Continued)

5. Undertake a post-hoc assessment of past data sets to determine if any are suited to data mining, modelling and multivariate analysis. Provide recommendations on structure for future database and data sharing agreements.

6. Co-invest in high quality pathogen genomes, reference isolates, determination of pathogen diversity and some ongoing sequencing of 'interesting' pathotypes. A partnership model is recommended to allow access to core resources within established pathogen genomics groups (and Bioplatforms Australia) and turning out of new capability through shared PhD studentships and/or technical resources. Reference isolates and genomic sequences should be universally available to all researchers.

7. Continue to invest in pathogen surveillance leading to new genomic data and the assessment of the molecular basis for changes in pathogen behaviour.

8. Continue to develop and deploy rapid PCR capability for 'near to field' detection and identification of pathogens.

9. Co-invest in revision of current phenotyping methods and establish and publish clear criteria for nationally accepted methods.

10. Develop clearer relationships between levels of infection disease impacts. Consider AUDC in the context of pathogen load (qPCR assays) and pathogenicity/virulence. Investment in pathology to encourage collaboration with plant physiology to help identify and quantify key points of impact of diseases.

11. That the CRDC co-invests in an economic assessment of RoI for improved genetic resistance for Verticillium and Black Root Rot resistance in cotton.

12. That improved linkages between pathology investment and crop breeding are facilitated through the development of a roadmap to genetic improvement for biotic stress (pending assessment of RoI) and structured interaction (annual meetings, agreed phenotyping, exchange of reference isolates and updates on changes in pathogen population) between pathology research teams and crop breeding staff.

13. Invest in a multiphase development of disease decision support, supporting field trials and extension activities. Starting with Verticillium (both forms), then extending to Black Root Rot and Fusarium design a whole of production cycle theoretical framework for disease impact and control. Undertake an analysis of the evidence base for key points of decision associated with control. Define and test assumptions against the known knowledge base. Define key control points for near-to-field measurement of disease pressure (and other parameters).

14. That CRDC pathology investment moves to a structure of co-investment in research co-ordinated as a national program (minimum time horizon of 5 years) and contracted at the project level. This program should include both an element of investment in national leadership and clearly delineate the individual strengths (and pathosystems of interest) of each State pathology group. Where appropriate a 'lead or support' model should be implemented at the project level.

15. That the CRDC engages with State/Territory Governments of all cotton producing States to secure commitment to co-investment and input to co-design across the national program of research.

16. That the CRDC explores opportunities within State Government research organisations, CSIRO and the tertiary education sector to identify opportunity to co-invest in enduring senior academic leadership and capacity building for cotton pathology research. As part of this process the CRDC should investigate the option of a physical or virtual centre for cotton pathology research.

17. CRDC continues to contribute to collaboration among stakeholders interested in cotton production in NT and North WA to co-develop disease management R,D and E strategies.

18. CRDC strategic R&D planning tools for pathology to be revised to include:

- Each project to have clearly defined outcomes for each category of next or end users.
- Stronger project logic with an increased focus on SMART output and milestone development.
- Outcomes articulated into a single (CRDC cotton pathology) strategic plan for whole of investment

19. Clearly define the near to market and far from market (blue sky) outcomes within future investment portfolio.

20. At the strategic plan level and project level include deliberate elements of co-design with each category of end users.

21. Within the CRDC cotton pathology research community, build a culture and understanding of the role of utility of research outputs in industry innovation. Proposed research activities should include an assessment of utility and a conscious decision should be made to invest not only in the output but also in its utility.

22. Inclusion of milestones relating to specific deliverables for extension material in all CRDC pathology investments

23. Development and delivery of hands on training for extension officers and interested industry participants on a 2 year cycle.