

EXECUTIVE SUMMARY

i) Background and Objectives

The potential availability of land and water combined with new knowledge and production technology has stimulated recent interest in growing cotton in northern Australia. Since the mid 1990s research and development and, in some cases, test farming have been undertaken near Broome and the Fitzroy River, at the Ord River Irrigation Area (ORIA) in Western Australia, at Katherine and Douglas-Daly in the Northern Territory and near Richmond and Bowen in northern Queensland. When the Cooperative Research Centre (Australian Cotton CRC) commenced in July 1999, it was thought it had an important role in coordinating and focusing these activities toward sustainable development objectives. The Australian Cotton CRC established a new program, 'Growth into northern Australia', with strong linkages to the other Cotton CRC programs in established growing areas. The philosophy of the Australian Cotton CRC in northern Australia is to assist to develop region-specific production systems, which are economically viable, but minimise chemical inputs and environmental impacts. The Cotton CRC will collaborate with other agencies in each region and ensure conservation of native fauna and flora is accommodated in development and management plans.

There is currently no commercial cotton production in northern Australia. The failure of the previous attempt at the commercial production in the ORIA during the early 1970s, due to uncontrollable insect problems, and the cessation of cotton farming in the Bowen region at about the same time for economic reasons, should serve as cautionary reminders for future attempts.

General Aims of the Scoping Study.

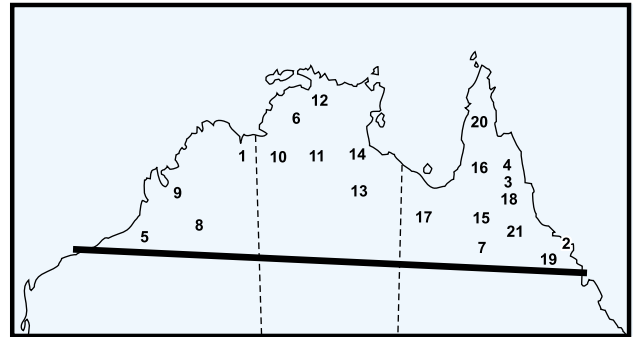
Work on the scoping study started in early 2000 to provide a reference document to assist with research planning in northern Australia. The scoping study has the following aim:

To detail the status of current and past research activities and important production and environmental issues faced by each region in northern Australia that are relevant to cotton production.

ii) The Study Region

The study region, defined as the area north of the line from 21°S on the east coast to 20°S on the west coast, is immense and represents about 30% of the land area of Australia (Map I). The potential land and water resources of the selected region for the scoping study are large. The Gulf of Carpentaria and the Timor Sea drainage divisions alone account for 43% of Australia's annual surface water run-off compared with 6% for the Murray-Darling. Groundwater resources are also significant.

MAP I: The study region is north of the line and numbers are the location of the 21 catchments/regions reviewed.



iii) Methodology

The scoping study reviews issues relating to cotton development in 21 catchments/regions across northern Australia (Map I). These catchments/regions can be categorised in terms of their irrigation development status and whether cotton is being researched (Table I).

Issues relating to Broome, the ORIA, the Katherine-Daly Basin and Richmond are considered in greatest detail, as these are the current sites for research into cotton (Map I, Table I). For each site a review is made of past cotton production and relevant non-cotton research and development, climatic potential, soil and water resource data, infrastructure, key environmental and community issues, and region specific recommendations made. A further 17 regions/sub-catchments that may have potential to grow cotton are reviewed using the same broad headings but at a level of detail sufficient to flesh out the key issues and provide guidance for future region specific research and development needs. In addition past attempts at large-scale agricultural development in northern Australia are reviewed.

The climatic potential for cotton is reviewed for 19 of the 21 regions shown in Table I. This analysis involves estimation of growing season length, as affected by sowing date and likelihood of rain at harvest, calculating the frequency of frost and sub-optimal temperatures and simulation of potential yields using the OZCOT-APSIM model (Hearn 1994, McCown *et al.* 1996).

iv) Outcomes

Outcomes are grouped in 5 categories:

- Lessons from past R&D aimed at large-scale agricultural development in northern Australia
- Physical resources and climatic suitability
- Cotton R&D issues common throughout northern Australia
- Cotton R&D issues specific to the regions of current Cotton CRC involvement
- A suggested approach to cotton R&D in regions undeveloped for irrigated agriculture.

TABLE I: Irrigable areas reviewed and their development status. * = site of cotton R&D in 2000.

DEVELOPMENT STATUS	MAP REFERENCE	CATCHMENT OR REGION	Town (s)	DRAINAGE AREA
1. Existing (non cotton) irrigated cropping and / or potential for expansion	1*	Ord River Irrigation Area	Kununurra	Timor Sea
	2	Bowen/lower Burdekin	Bowen, Ayr	Coral Sea
	3	Atherton, Mareeba - Dimbulah	Mareeba	Coral Sea
	4	Lakeland Downs	Laura/Mareeba	Coral Sea
2. New areas under development or evaluation	5*	La Grange Sub-basin	Broome	Indian Ocean
	6*	Daly Basin	Katherine	Timor Sea
	7*	Flinders	Richmond	Gulf
3. Undeveloped for large scale irrigated cropping	8	Fitzroy River	Fitzroy Crossing, Derby	Indian Ocean
	9	Lennard River	Derby	Indian Ocean
	10	Bains/Victoria rivers	Timber Creek, Kununurra	Timor Sea
	11	Sturt Plateau	Larrimah, Daly Waters	Timor Sea, Gulf
	12	Adelaide River, Marrakai Plain	Darwin, Adelaide River	Timor Sea
	13	Barkley Tableland	Tennant Creek Brunette Downs	Gulf
	14	Roper River/north?western Gulf	Roper Bar, Boroloola	Gulf
	15	Gilbert/Einasleigh	Einasleigh, Georgetown	Gulf
	16	Mitchell/Lynd	Kowanyarma, Parmaville	Gulf
	17	Cloncurry/Corella/Leichhardt/Gregory	Cloncurry	Gulf
	18	Upper Herbert	Mt Garnet, Ravenshoe	Coral Sea
	19	Bowen/Broken	Collinsville	Coral Sea
20	Cape York(e.g., Kendal, Holroyd, Edward, Archer, Colman, Watson rivers)	Coen, Weipa, Pormpuraaw, Aurukun	Gulf/Coral Sea	
21	Upper Burdekin	Charters Towers	Coral Sea	

Lessons from past R&D aimed at large-scale agricultural development in northern Australia

- A systems approach is required with clearly defined goals understood and accepted by all participating organisations.
- Agricultural researchers alone cannot be expected to provide an adequate basis for commercial success as small-plot research is quickly subject to diminishing returns and resources are then best allocated to large-scale trials or pilot farms for limited periods.
- Infrastructure issues must be addressed and action taken by the time commercial development starts. However, during the large-scale trial phase lack of infrastructure will impact on costs and such costs must be borne as part of the evaluation.
- Large-scale trials can provide data for environmental impact assessment, the development of guidelines for sustainable management practices and best practices for management of chemicals and other inputs.
- Ease of importation of production technology and skills are important factors in the feasibility assessment and industry establishment phase. (e.g., sugar at the ORIA).
- More successes with annual cropping have been with dry rather than wet season production (e.g.,

annual horticulture). Successful perennial crops are also harvested during the dry season.

- The variable climate necessitates a modelling approach to research outcomes, i.e., three year studies may not be representative of the seasonal range.
- Lack of capital combined with too rapid movement to commercial production (without adequate research) has resulted in many failures.
- Failed developments have provided initial capital (land) for subsequent successful industries, (e.g., Ord Stage I, Lakeland Downs).
- NT-Kenaf is a good model for a fibre crop R&D feasibility study.

Physical resources and climatic suitability

Physical resources

Outside the ORIA, the Katherine-Daly Basin and the established cropping areas in north Queensland (Table I) soil surveying and land resource assessment at too large a scale for irrigation development without further surveying. Moreover, with the exception of established irrigation areas in north Queensland and the ORIA (under review), water-licensing arrangements have not been determined. In some areas (e.g., Cape York) there is insufficient data to calculate these flows. This is because all watercourses are strongly seasonal and there

is considerable between and within season variability in stream flow. In many areas (notably Cape York, the Katherine-Daly Basin and Sturt Plateau) the interaction between surface and groundwater systems requires further research.

With the exception of some of the established cropping areas in north Queensland the majority of the arable soils are similar. That is, red and yellow earths and poorly drained cracking clays all having moderate to low inherent fertility, which implies similar issues for crop nutrition, soil surface management and irrigation distribution system. Areas where inherent salinity occurs can be broadly identified from information currently available.

Climatic suitability

Climatic analyses suggested that cotton could be grown in all 21 regions reviewed in this study (Map I, Table I), provided that water and arable soil are available. However, these analyses found several limitations in the tools used to assess the climatic potential of northern Australia for cotton:

1. The current tools cannot predict the effect of rainfall or temperature on lint quality, which is an important component of economic return in an environment where rainfall is strongly seasonal.
2. The effect of mid-season temperatures between 11°C and 0°C on cotton yield is unknown. Hence it was not possible to determine the geographic range of potential winter growing areas.
3. A lack of long-term climatic records in many areas.

Resource development and land tenure

Many areas that are undeveloped for irrigated farming are leasehold and require a change to land title before irrigated cropping could occur. This will affect the timeframe for the development of irrigated agriculture (if it occurs). Moreover, land title is still being resolved in much of northern Australia.

Cotton R&D issues common throughout northern Australia

A sustainable production system with minimal chemical usage

This is a common objective to all potential growing areas and with local tailoring will have the following R&D outcomes:

- A pest management system that incorporates integrated pest management, area wide pest management, 2-gene Bt registration and associated resistance management strategy.
- Disease management/prevention strategies (Alternaria, cotton rust, Fusarium)
- Incorporation of physiological understanding of plant compensation from insect damage into insect pest management practices.
- Irrigation practices and distribution systems that maximise water use efficiency and minimise environmental impacts.

- Integrated weed management practices that minimise the use of residual herbicides and chemicals, which pose a higher risk to the wider environment.
- Rotations and cover crops incorporating tillage and soil surface management practices that are compatible with pest management strategies, maintain soil structure and prevent erosion and run-off.
- Selection of varieties adapted to the environment and compatible with the management systems.

The impact of summer and winter cropping on *Helicoverpa armigera* migration

There is a potential for a mixture of winter and summer cropping within close proximity, particularly in north Queensland, which may create an opportunity for migration of *Helicoverpa armigera* between growing seasons, thus increasing the risk of resistance to insecticides and the Bt proteins.

Cotton R&D issues specific to regions of current Cotton CRC involvement

Western Australia – Ord River and Broome

There is a significant commitment by many organisations to cotton R&D in the Kimberley region of WA. Both the west Kimberley and Ord River appear to have considerable potential as cotton growing regions.

Future commercial development at the Ord River will depend greatly on the outcomes of the current feasibility assessment for Stage II (33,000 ha) conducted under the Memorandum of Understanding (MOU) between Wesfarmers/Marubeni and the WA Government. The outcomes of R&D conducted in the Ord River Irrigation Area could be extrapolated to nearby clay soil areas with similar climates, e.g., Bains River (NT) and Fitzroy River (WA).

In the west Kimberley more than 20,000 ha could be grown using groundwater reserves south of Broome without any additional water from the Fitzroy River. Future commercial development in the west Kimberley will also depend on the outcomes of feasibility assessments under the MOU with the WA Government and land tenure resolution.

Given the significant in-kind contribution to the Cotton CRC efforts in WA by collaborating member and non-member organisations, and the coordinated approach to irrigation development via the Western Australian Government's MOU's, a greater contribution by the Cotton CRC in WA is well justified.

Northern Territory

During the 1960s cotton was previously researched as a low-input wet season crop. There are several regions in the NT that could potentially grow irrigated cotton although the current R&D at Katherine appears focused toward future land and water developments in the Katherine-Daly regions.

There are no irrigation dams constructed in the NT. The Daly/Katherine, Victoria, Adelaide, Roper and McArthur are the NT catchments most likely to support larger-scale irrigated agriculture using surface water. Annual flows are high compared with south-eastern Australia. Due to seasonality of rainfall any irrigation development using surface water will require harvesting of wet season flows either by dams or off-stream storages. Groundwater is currently used to irrigate crops in the Daly-Katherine area and smaller areas on the Sturt Plateau. The NT government is currently reviewing the ground and surface water reserves for Daly-Katherine Basin, Sturt Plateau, and other catchments.

A comparison of potential cotton production areas indicated a trade-off between the more isolated locations with apparently favourable climates and resource availability (Roper, Bains Rivers) and locations closer to infrastructure with less favourable climates, soil and water resources (Daly Basin, Marrakai Plains). Of these regions the Daly Basin is most advanced in the collection of relevant environmental information prior to land development for agriculture.

Small plot research at Katherine has shown that good yields of transgenic cotton varieties can be achieved in the dry season with minimal pesticide usage. However, further pre-commercial cropping systems research is necessary but this must now proceed at a realistically large (commercial) scale. An R&D plan for the next five years that incorporates necessary land and water resource, infrastructure, cropping systems and environmental protection research needs was released in 2001. This R&D plan distinguishes a research phase from a commercial development phase, which could follow.

The previous Country Liberal Government was drafting legislation to regulate the production of cotton. This legislation was partly in response to a fear of the public perception of cottons' impact on the environment and the concerns of important interest groups for example Amateur Fishermen's Association of the Northern Territory (AFANT) and The Environment Centre NT (ECNT). Following the recent (August 2001) change of government in the NT, Territory Labor's stance on this legislation and Genetically Modified Organisms (GMO) is unclear from policy documents published prior to the election.

North Queensland

Climatic analysis suggests that cotton could be grown during the winter season in the north and coastal areas and during the summer season in the south and inland areas of the region. In all potential growing areas some crop specific research would be required at some time prior to commercial development.

In undeveloped areas the timeframe for cotton development, if it were to proceed, is highly dependent on the status of infrastructure development/availability,

resource surveying, water resource plans and environmental impact assessments. Except for the Flinders (Richmond), Broken (Collinsville) and possibly Gilbert rivers, the development of irrigation infrastructure is likely to have a > 10 year timeframe.

In the established cropping areas (Atherton Tableland, Mareeba-Dimbulah, Lakeland Downs and Bowen/Lower Burdekin areas), cotton would be substituted for other crops and factors such as economic competitiveness with existing crops and access to ginning and other cotton specific infrastructure (picking equipment) will influence whether cotton is grown. Due to a mix of crop species, area wide pest management would be essential in all these regions.

The Flinders River (Richmond) has the largest discharge in north-western Queensland. The clay-textured soils are derived from marine deposits having some accumulation of salt at depth. The extent to which salt is an impediment to crop growth or poses a salinity risk to irrigated agriculture is not known. The Queensland Department of Natural Resources has recently announced that a salinity risk assessment is a requirement prior to development of land for irrigation purposes.

Currently a landholder and Queensland Cotton Corporation Ltd provide most funds for production R&D work at Richmond. A team of locally based research staff is being established. The Cotton CRC funds technical support for entomological and agronomic research at the site. Queensland Cotton funds research and commercial agronomists, and Queensland Department of Primary Industry (DPI) provides professional entomological support.

Many potential growing areas drain into the Coral Sea, which could be an emotive environmental issue for cropping.

A suggested approach to Cotton R&D in regions undeveloped for irrigated agriculture.

In northern Australia there are many potential growing areas where cotton could be the first crop after land clearing (Table I). An R&D plan for cotton in a new irrigation area in northern Australia must aim to answer five broad questions:

1. Where are the best production sites? (e.g., what is the geographic limit of winter cropping in northern Australia? And at the resource level, where are the arable soils with irrigation water available?)
2. Is cotton farming economic and how risky is it? (i.e., cost/returns, climatic and market risks).
3. Can production be sustained economically and ecologically? (e.g., will the ORIA experience of 27 years ago be repeated?)
4. What is the environmental impact of cotton farming on-site and off-site?
5. Where the community perceptions of cotton farming are poor can they be improved to the point of acceptance?

Many of the issues relating to the above questions are common to irrigation development irrespective of what crop is grown. Similarly Table II shows that the specific research required to develop a new irrigation area with cotton as a candidate crop is dominated by generic questions. The areas of expertise applicable to the Cotton CRC would only include point 3 and components of points 4, 5 and 6 shown in Table II.

Table II. *The basic research required to evaluate a new irrigation area with cotton as a candidate crop.*

<p>1. Geohydrological surveys/studies These will determine potential salinity problems, water table effects and identify appropriate irrigation and agronomic practices.</p> <p>2. Detailed soils surveys Currently most regions are at a scale not greater than 1:250,000 and irrigation development would require at least 1:100,000 with reference areas at 1:25,000 in locations having potential for irrigated cropping.</p> <p>3. Production system research Integrated crop research is required with the objective of developing a management system that is sustainable economically and has minimal environmental impacts.</p> <p>4. Ecological studies into pest and disease dynamics and effects on flora and fauna.</p> <p>5. Water licensing process and associated studies.</p> <p>6. Infrastructure studies – location of gin, transport links, container needs, etc.</p> <p>7. Whole scheme economic analysis to put in State/national context. This should include an assessment of community value.</p>

v) Recommendations

General

- The Cotton CRC should focus on its strengths, which are skills in sustainable cotton production systems research. **There is simply more to do than can possibly be funded by the Cotton CRC.** The Cotton CRC should facilitate/encourage complementary work by other agencies.
- The Cotton CRC should thoroughly review the likely timetable for land and water surveying and environmental impact assessment for irrigation development before making commitments to production systems R&D.
- A large-scale trial phase is essential and must be included in an R&D plan for any new area. Funding must be available to underwrite infrastructure (e.g., picking, mini gin) and the cost of production at sub-commercial scale.

- There is a lack of cotton research and cotton farming experience. Membership of the Cotton CRC can enable training to occur with partner organisations and others in southern Australia. The basing of experienced production agronomists on-site (as at the ORIA and Richmond) will assist farmer collaborators in gaining experience in growing cotton.
- Many specialised research skills are not available in northern Australia. The Cotton CRC could assist in finding specialised skills for short-term tasks. These researchers may be from the Cotton CRC or other organisations.
- A communication strategy is required and should incorporate interest groups, the general community and the Cotton CRC. The suggestion of sustainability issues symposium(s) with emphasis on community education in the research and development process should be adopted. However an integrated approach to community consultation/awareness is required and should include local tailoring. The Cotton CRC should instigate an evaluation process to provide a mechanism for internal review of communication methods employed and for the development of new methods.

Recommendations specific to regions of current Cotton CRC involvement

Western Australia

- There is a critical short-term need to continue the role of production agronomist, previously supplied by Twynam Cotton, in the large-scale trials at Kununurra. The Cotton CRC should assist in developing a means of funding this position.
- The Cotton CRC should contribute to research into sustainable wet season cover crops and crop rotations at Broome. The collaboration of Cotton CRC members with experience on similar systems in the NT would greatly benefit this work.

Northern Territory

- It is important that the 5-year R&D plan be supported and implemented.
- Studies are required as soon as possible to prioritise potential growing areas prior to involvement of a commercial development partner.
- A commercial partner to replace Twynam Cotton is required in the near future.
- A clear indication of the new NT Government's support for cotton development is required. The Cotton CRC should also seek bipartisan political support.
- Broaden the NT Cotton Working Group to include more irrigation/cotton/land development expertise or create a new group.
- Regular open dialogue with interest groups is essential (eg AFANT, graziers, ECNT).

Queensland

- The risk of salinity developing in the Richmond area needs to be addressed as soon as possible. This is the responsibility of the developer. The Cotton CRC has a role in ensuring the most appropriate methodologies are used. In north Queensland, this type of work is coordinated by the Department of Natural Resources, regional infrastructure development group.
- Cotton CRC involvement in the proposed stakeholders development committee for the Richmond area.
- Stronger links with the DNR regional infrastructure development group should be developed. Cotton CRC membership is also an option for some of this group as there is already a significant in-kind contribution to key research in the soils and geohydrological disciplines.
- The Cotton CRC should facilitate studies into the effect of gin location on possible production scenarios in this region. An analysis of the likely interest in growing cotton in established areas and the factors influencing the decision to grow cotton in addition to ginning infrastructure should also be made. The DPI at Mareeba should be approached to fund and conduct this study.
- As is the case in WA and the NT, there is a need for active Cotton CRC involvement in community consultation and general communication issues.