NORTHERN TERRITORY GOVERNMENT

DEPARTMENT OF PRIMARY INDUSTRY AND FISHERIES

PRIMARY INDUSTRIES

ANNUAL RESEARCH ACHIEVEMENTS REPORT 2011-12

December 2012

Bibliography:

Northern Territory Government (2012). Primary Industries Annual Research Achievements Report 2011-12. Department of Primary Industry and Fisheries. Technical Bulletin No. 347.

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Contents

About this report

This Annual Research Achievements Report (2011-12) provides a summary of research and development effort in primary industries by science officers during the past financial year. The report covers current and recently completed research in pastoral, plant and biosecurity sectors of primary industries in the Northern Territory (NT). It is intended as a platform to recognise and reward excellence in research, other scientific activity and publication.

The Department of Primary Industry and Fisheries (DPIF) carries out research to:

- *Facilitate sustainable resource management for economic development.*
- *Be innovative and non-repetitive with a focus on industry priorities.*
- *Direct effort on areas of capability and capacity within DPIF.*
- *Help build and develop emerging NT industries.*

Primary industries in the NT are mainly focused around livestock and crop production. Livestock production includes beef cattle, buffalo, crocodiles and horses. Crop production includes horticulture and mixed farming. Horticultural crops include fruit, such as mangoes and melons, vegetables, nursery and cut-flowers. Mixed farming includes field crops, pasture, hay and seeds, and forestry.

Our primary industries have significant links with, and contribute to, other sectors of the NT's economy, such as manufacturing, transport and storage, retail and employment. They also account for a significant proportion of the NT's non-mineral export revenue.

Comments and suggestions for improvements of future editions of this report, including content, layout and structure, are most welcome. Please send your comments and suggestions to technical.publications@nt.gov.au.

Cover Images	
Main:	Road trains at Alexandria (Dionne Walsh).
Bottom from left to right:	Cows from selected Brahman herd at VRRS (Renee Rippon); Rice trial at Tortilla Flats (Rowena Eastick); Red-banded mango caterpillar (Brian Thistleton).
Report compilation:	Hassan Bajhau, Jason De Araujo, Cameron McConchie, Tim Schatz, Richard Weir and Christine Long.

1 Biosecurity and Product Integrity

1.1 Crocodile Skin Project

Contact: Cathy Shilton –Veterinary Pathologist

Project Status: Completed.

The research involved an examination of crocodile skins at the three main stages of processing: “raw” salted skins, when skins are graded at the farm, “crust” skins, which is the intermediate, colourless unfinished leather stage of the tanning process and “dyed” skins, which is the final, finished stage. Lesions were categorised and digital images were taken of about 40 lesions on the belly skin at each processing stage for each of 31 skins from three crocodile farms. A standardised set of grid images were taken of each skin at each stage so that lesions noted at a later stage of processing could be retrospectively compared with the same lesion location in the skin at the earlier stage.

Below left: Researcher examining in crust stage of skin for defects

***Below right*:** Raw salted crocodile skin on a light table with grid for identifying photo locations

Research Outputs

Project results were presented to crocodile industry leaders at a meeting in June 2012. A copy of the results was provided to each attendee in an electronic web-page style format on a compact disc.

Conclusions

Most lesions in the raw skin show up in the finished product.

Lesions with keratin or contour alterations in the raw skin are more likely to show up in the finished product.

Recommendations

An externally funded project should be developed to determine the factors that determine why lesions are expressed.

An externally funded project should be developed to investigate the way in which lucent lesions are differentiated.

1.2 Viral and Endogenous Retroviral Detection and Characterisation in Farmed Crocodiles

Contact: Lorna Melville – OIC Berrimah Veterinary Laboratories

Project Status: Completed.

Past projects funded by the Rural Industries Research and Development Corporation investigated runtism and Chlamydial infections in crocodiles. This research found evidence that viral infections could be contributing to these conditions. However, this could not be confirmed due to the absence of a suitable system for isolating viruses from crocodiles. This project describes the development of primary cell lines from crocodiles and their use to isolate viruses from diseased crocodiles. The isolated viruses were then used to develop serological tests for epidemiological studies.

Below left: Herpesvirus skin lesions

***Below right*:** Crocodile hatchling for cell line development

Research Outputs

Forty primary cell lines were developed from *Crocodylus porosus* and 20 of them have been maintained and used for virus isolation from diseased crocodiles. By December 2011,133 different viruses were isolated. Electron microscope (EM) and polymerase chain reaction (PCR) tests have shown herpesviruses that were isolated from three different diseases syndromes and adenoviruses from a fourth syndrome. Different patterns of virus isolation and serology suggest that at least two different herpesviruses are involved. Definitive experimental work to confirm the role of these viruses in the disease syndromes has not been attempted. However, experience from other species suggests that they do pose a risk to farmed crocodiles. Serology has demonstrated that at least one of the herpesviruses is present in wild populations of crocodiles and that exposure on farms is common.

Conclusions

The development of crocodile cell lines has enabled the first major investigation of viral diseases in crocodiles in Australia. The cell lines have proven to be a valuable addition to diagnosis and research in crocodile diseases and have been provided to other research and diagnostic institutes.

Recommendations

More research should be conducted to determine the significance of these viruses in farmed crocodiles in order to develop specific control measures. In the absence of such information, good farm management is essential for disease prevention and control. Young crocodiles should be isolated from older crocodiles and farm biosecurity plans should be enforced. The introduction of wild caught crocodiles to farms poses a significant risk of introducing new disease agents. Such animals should be subjected to ongoing quarantine and stringent biosecurity.

2 Pastoral Production

2.1 Developing Improved On-ground Practices and Industry Strategies for Beef Production Enterprises across Northern Australia to Adapt to Climate Change (Northern Grazing Systems Project Phases 1 and 2)

Contact: Dionne Walsh – Rangeland Program Coordinator

Project Status: Completed.

Phase 1 of the Northern Grazing Systems (NGS) project identified the four biggest grazing land management issues impacting on the profitability, sustainability and resilience of the northern pastoral industry. Phase 2 of the NGS project evaluated and promoted promising management solutions using bio-economic modelling and on-ground demonstration sites in the Victoria River District and Alice Springs region. Phase 2 also used bio-economic modelling to explore how current recommended management practices would perform under a range of future predicted climate scenarios. This project, which was conducted between 2009 and 2012, was a sister project to the “Climate Clever Beef” project.

Below left: Field camp at Delamere Station

Below right**:** Testing the data loggers on a chilly morning at Delamere Station

Research Outputs

The project identified the most promising management options through (1) a review of all northern Australian grazing land management literature, (2) scenario testing using bio-economic models and (3) practical input from local pastoralists in each region.

The four biggest grazing land management issues impacting on the northern beef industry are (1) The challenge of matching pasture supply to animal demand, (2) Managing pastures in a poor land condition, (3) Thickening of woody vegetation and (4) Ungrazed pastures distant from water.

The four key management options for improving the profitability, sustainability and resilience of the northern pastoral industry were found to be (1) Stocking rate management, (2) Pasture spelling, (3) Prescribed burning, and (4) Infrastructure development.

Research Outputs (cont.)

A demonstration site to evaluate wet season spelling and prescribed burning commenced on Delamere Station in the VRD in 2010. This demonstration is ongoing subject to funding.

In the Alice Springs region, a range of stocking rate and pasture spelling recommendations are now being tested in a grazing trial at the Old Man Plains Research Station (OMPRS). This work is ongoing.

Preliminary results from the climate change modelling indicate that the current best practice management activities recommended by this project will also be successful under a range of future climate scenarios.

Three technical guides on managing stocking rate, pasture spelling, prescribed burning and infrastructure development have been written for the Alice Springs, Barkly and VRD regions. They will be published as Department of Primary Industry and Fisheries (DPIF) Technical Bulletins.

The measured impact of the project showed that more than 600 industry people in the NT were aware of the messages of the project, 32 producers acquired increased knowledge/skills and five changed their practices. The project achieved this by delivering two workshops, initiating three demonstration sites, presenting results at 12 industry events and producing five publications and several newsletter articles.

Conclusions

The NGS project was the first to collate all known published grazing land management literature from northern Australia. This has provided a sound basis for identifying grazing land management issues and solutions relevant to the northern beef industry.

As a result of this project, DPIF has significantly increased its capability in bio-economic modelling and developed excellent working relationships with agency researchers in Queensland.

The results verified many of DPIF's existing recommendations for stocking rate management, prescribed burning and infrastructure development.

The research discovered new recommendations and approaches to wet season spelling and discovered that these recommendations are different for each region in the NT.

Climate change scenarios for the VRD suggest that livestock carrying capacity will be similar or increase compared with current levels because rainfall is predicted to be similar or to increase.

Climate change scenarios for the Alice Springs region suggest that livestock carrying capacity is likely to decrease because rainfall is predicted to decrease compared with current levels. There is a high degree of uncertainty about how large this decrease may be and the implications for grazing land management are uncertain and require more research.

Recommendations

The demonstration and research trials at Delamere Station and OMPRS should continue for the foreseeable future. These long-term trials will provide evidence for the recommendations from this project and will be a focus for industry extension activities in the future.

DPIF should continue to research and demonstrate the key recommended practices arising from the NGS project to increase adoption by the industry.

2.2 On-farm Demonstration of Adaptation and Mitigation Options for Climate Change Across Northern Australia (Climate Clever Beef)

Contact: Dionne Walsh – Rangeland Program Coordinator

Project Status: Completed.

The aim of this project was to evaluate and promote grazing land management practices and animal productivity improvements that will increase business resilience and reduce greenhouse gas emissions intensity in the VRD, Douglas Daly and Barkly pastoral regions. This was a large-scale cross-jurisdictional project operating across northern Australia. This project was conducted between 2010 and 2012 and was a sister project to the Northern Grazing Systems project.

Below left: Early morning in the VRD

***Below right*:** Road trains at Alexandria Station

Research Outputs

Several existing industry benchmarking and scenario testing tools were used to systematically evaluate the current and future animal productivity, profitability, land condition and greenhouse emissions performance of pastoral businesses across northern Australia. In the NT, a commercial property in the VRD adopted this process with an agricultural adviser as part of the project.

The tools were used to identify strengths and weaknesses of the VRD business and to identify options to improve productivity, profitability, emissions and land management outcomes. The likely longer-term performance of these options was subsequently tested using herd and financial modelling.

Greenhouse gas (GHG) audits and soil carbon sampling have been conducted on three properties in the Douglas Daly region. The GHG audits showed that about 80% of the emissions on these properties could be attributed to cattle, highlighting the opportunity to reduce emissions intensity by improving herd productivity.

Soil sampling in the Douglas Daly indicates that the soils beneath improved pastures that are rotationally grazed have carbon levels approaching those of uncleared native bushland. This work is ongoing.

A climate adaptation demonstration site was conducted at Alexandria Station in the Barkly region in 2010. The site aims to show how wet season spelling and best practice stocking rate management can increase business resilience in a variable climate. A Field Day was held at the site in August 2011.

Research Outputs (cont.)

Conclusions

The project confirmed that a suite of existing industry benchmarking and scenario tools can be systematically used to identify and evaluate management options. This approach has subsequently been recognised by the Australian Government for assessing the business case for carbon farming opportunities in the northern beef industry. DPIF has recently been successful in attracting CFI funding for a three-year project to assess the business case for carbon farming options in the NT pastoral industry.

Most of the GHG emissions on NT pastoral properties come from cattle. Improving breeder herd performance and live-weight gains will provide significant opportunities to reduce the intensity of emissions from the industry.

More research is required to determine the levels of soil carbon present in different land types and under a range of grazing land management practices throughout the NT.

The measured impact of the project showed that more than 140 NT industry people were aware of the messages about the project, 22 demonstrated increased knowledge/skills and 10 adopted a practice change. The project achieved this by delivering three workshops, initiating seven demonstration sites, presenting results at 10 industry events and producing five publications and several newsletter articles.

Recommendations

DPIF should use the data collected in this project to evaluate the emissions performance of two common industry strategies currently being implemented in the northern part of the NT: (1) Breeding and growing out cattle in extensive regions, versus (2) Breeding in the extensive regions and growing out on improved pastures, such as in the Douglas Daly.

The demonstration trial at Alexandria Station should continue for the foreseeable future. This long-term trial will provide evidence for the recommendations from this project and will be a focus for industry extension activities in the future.

2.3 North Australian Beef Fertility Project (CashCow)

Contact: Kieren McCosker - Pastoral Production Officer - Beef Cattle

Project Status: Continuing.

The CashCow project is funded by Meat and Livestock Australia. It began in 2007 and will be completed in 2012. About 70 000 cows from 78 commercial properties are included in the study.

The aim of the project is to determine the most important factors associated with variation in reproductive performance between north Australian beef herds. In addition, based on a broad geographical region and management system, typical and achievable levels of reproductive performance will be defined using a range of commercially meaningful measures.

Below: Recording breeder performance data – Auvergne Station, VRD

Research Outputs

The following factors have been found to have a big impact on the proportion of cows back in calf by four months after calving:

1. The proportion of cows that successfully reared their calves during their last pregnancy.
2. The body condition score of cows at the previous year's pregnancy diagnosis muster.
3. The average faecal phosphorus to metabolisable energy ratio during the wet season.
4. The time during the year of the previous calving.
5. The time of the onset and duration of the wet season.

Some of the factors that significantly affected losses from confirmed pregnancy to weaning were:

1. The proportion of cows that successfully reared their calves during their last pregnancy.
2. Exposure to hot, to very hot, weather conditions during the month of calving.
3. The time during the year when calving occurred.
4. The average crude protein to dry matter digestibility ratio (derived from faecal NIRS) during the last trimester of pregnancy.

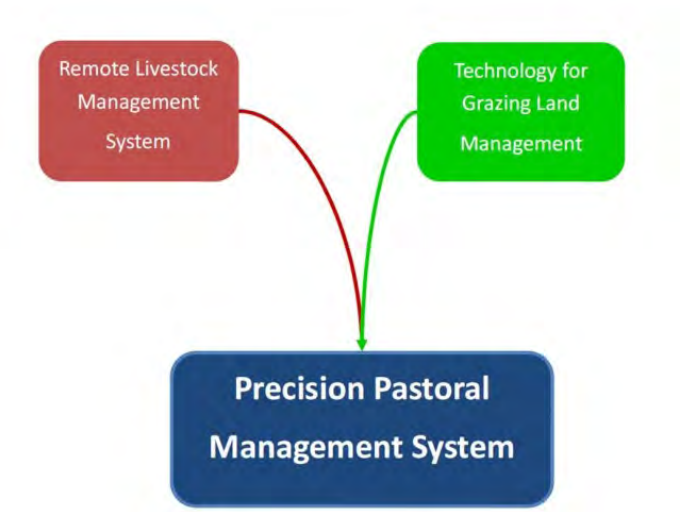
2.4 Precision Pastoral Management Tools (PPMT)

Contact: Sally Leigo – Research Leader

Project Status: Continuing.

This is one of 12 projects being conducted by the CRC for Remote Economic Participation (CRC-REP) in partnership with the NT Department of Primary Industry and Fisheries. It aims to develop a commercial precision pastoral management system (PPMS) based on integrated modules that are compatible with existing software and hardware. PPMS will integrate precision data on cattle and pasture performance, using minimal labour inputs.

***Below*: PPMS diagram showing the data sources for PPMS**



Research Outputs

Consultations were held with 24 beef producers from the NT, Queensland, South Australia and Western Australia and 10 other Australian organisations on the potential research goals for the PPMT project.

A feasibility study was conducted on PPMS by reviewing 62 technology products for use in PPMS. Of those, 32 were short-listed and four will be included.

Nine people from the beef industry were appointed to the PPMT project advisory committee.

A working paper titled “Overview of Technology Products for the Beef Industry in Remote Areas of Australia” was drafted.

2.5 Improving Breeder Herd Efficiency in the Arid Region with Performance Recording and Objective Selection

Contact: Jocelyn Coventry – Pastoral Production Officer

Project Status: Continuing.

This project is using Droughtmaster-infused cattle at Old Man Plains Research Station (OMPRS) to demonstrate benchmarking herd performance, best-practice management, bull breeding soundness evaluation, genetic improvement through objective selection and BREEDPLAN recording in the arid region.

Above right: Alice Springs staff returning Droughtmaster artificial insemination (AI) program cows to the Arid Zone Research Institute (AZRI) for calving in 2012

Right: AZRI staff review cattle data in the yards

Research Outputs

Estimated breeding values (EBVs) have been generated for 89 animals in the Droughtmaster research herd at OMPRS. BREEDPLAN performance recording has commenced with an AI program using bulls with EBVs to promote crosslinking of sires.

All herd bulls used to breed the calves that were branded in 2012 were found to have satisfactory breeding soundness during pre-mating examination. In one group of 81 breeders, ¾ of the calves were sired by two of the four herd bulls.

Calf losses from pregnancy to weaning averaged 11% in 2011-12. Over five years, calf losses have been highest in cows older than 10 years, at 14%.

The benefit of protein supplementation was demonstrated in ‘best-practice’ yard weaning. Weaned heifer calves grew at an average of 0.7 kg/day during the first eight days in the yard.

Three years of favourable feed conditions (2009-10 to 2011-12) followed by culling low fertility (empty) cows in 2011, resulted in the mixed-age breeders in the Droughtmaster herd achieving 95% pregnancy following controlled mating over 88 days in the summer of 2011-12. The most efficient conceptions were recorded in non-lactating cows that had a body condition score of 3 (on a scale of 1 to 5) at the start of mating, and in lactating cows that had a body condition score of 2.5 at the start of mating.

2.6 Selected Brahmans - Improvement of the Fertility of the Brahman through the Use of BREEDPLAN Estimated Breeding Values (EBVs) and Selection

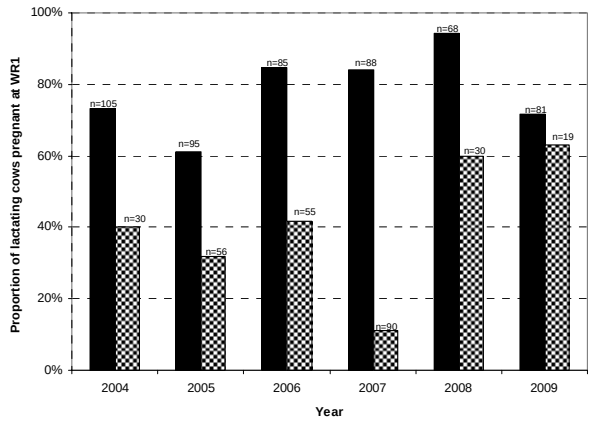
Contact: Renee Rippon – Beef Cattle Research Officer

Project Status: Continuing.

While the introduction of the Brahman breed to northern Australia has resulted in large productivity gains through its adaptation to tropical environments, it is recognised that the breed has a lower fertility compared with *Bos taurus* breeds. This project aims to improve the Brahman's fertility and publicise the techniques that can be used to achieve this. The NT Department of Primary Industry and Fisheries has been selecting for fertility in a Brahman herd since 1994 using objective selection and the genetic evaluation program BREEDPLAN. The project also has an extension component to increase knowledge of objective selection techniques. An additional aim is to make high fertility Brahman genes available to the industry through the sale of selected bulls.

Below left: The proportion of breeders lactating and pregnant at first round weaning muster (May) in the selected Brahman herd (solid black columns) and a commercial herd (chequered columns)

***Below right*:** Cows from the selected Brahman herd at VRRS



Research Outputs

Herd recording for BREEDPLAN continued. Updated 2011 group BREEDPLAN figures showed that the herd continues to be above the national Brahman group average for most EBV traits, specifically fertility.

The extension of this project has continued with magazine articles (MLA Frontier), newspaper articles (Queensland County Life), the Beef CRC newsletter and the Beef Central website.

With increased interest in this project, demand for sires from the herd was very high in 2011. Semen was collected in 2011 and 2012 from the top sire, which is known as DDRF 15431 and was sold to several studs in Queensland and was also used in a Beef CRC project. An embryo transfer program commenced in 2012 to hasten genetic improvement in the herd from elite animals.

The size of the breeder herd is being increased at Victoria River Research Station (VRRS) to enable greater statistical rigour in the future.

Research Outputs (cont.)

The following notable results were observed at Round 1 muster in May 2012:

- 51% of yearling heifers (2011) were detectably pregnant at Douglas Daly Research Farm (DDRF).
- 80% of the 2010 heifers were detectably pregnant at DDRF.
- 87% was the weaning rate in 2009 heifers at DDRF.
- 79% was the wet cow re-conception rate in 2009 heifers at DDRF.
- 82% was the weaning rate for breeders at VRRS.
- 82% was the wet cow re-conception rate at VRRS.

A yearling mating study conducted at DDRF found that over three years, pregnancy rates in heifers from the selected Brahman herd were higher by an average of 35% ($P = 0.009$) than in heifers from commercial Brahman herds.

Re-conception rates in lactating cows at VRRS from 2004 to 2009 were on average 31% higher in cows from the selected Brahman herd than in cows from the commercial herd.

2.7 The Use of Alternative Tropical Breeds Part D: Senepol Crossbreeding Trial

Contact: Tim Schatz – Principal Pastoral Production Research Officer

Project Status: Continuing.

Currently Brahmans have a reputation in Australian domestic markets for having poor meat tenderness. While this has not been a problem in live export markets, high grade Brahman cattle are not as sought after in southern Australian domestic markets. The aim of this project is to investigate whether crossbreeding Senepol bulls with Brahman cows will produce offspring that perform well under NT conditions and have better meat quality than pure Brahmans. If this is the case, then this strategy would increase the marketing options for NT cattle producers with Brahman herds as they could produce cattle that would be suitable for both the live export and Australian domestic markets. The project evaluates a Senepol crossbreeding program in the northern NT and compares the performance of F1 Senepol x Brahman cattle with that of Brahmans.

Right: Senepol calves from Brahman cows and Senepol bulls at VRRS

Next page: Senepol F1 steers aged18 months at DDRF

Research Outputs

The NT Senepol crossbreeding project has been continuing since late 2008 when Senepol bulls were mated to Brahman cows for the first time at Victoria River Research Station (VRRS) and at Manbulloo where the Department of Primary Industry and Fisheries is leasing a paddock. The first year group of calves was weaned in 2010 and the following year's group will be weaned in 2013.

All results are preliminary at this stage as statistical analysis has not been performed. Preliminary results indicate that:

- F1 Senepol cross calves were heavier (by around 20 kg) at weaning than Brahman calves. This is a typical result when crossbreds are compared with a pure breed, due to hybrid vigour.
- F1 Senepol cross heifers appear to grow faster than Brahman heifers following weaning. Combined with their heavier weaning weights, this means that they are heavier at first joining at two years of age by around 30 kg. Pregnancy rates from maiden joining were 10% higher in the F1 Senepol cross heifers in the first year group. However, the number of heifers in that first year group was only 33. Therefore, while the data gives an indication of performance, it should not be relied on to draw solid conclusions.
- The performance of both groups of steers weaned in 2010 and in 2011 on improved pasture at DDRF over the post-weaning year showed that F1 Senepol cross steers gained slightly more weight than Brahmans (+7 kg in 2010 steers and +15 kg in 2011 steers). Combined with their heavier weaning weights, this resulted in F1 Senepol steers being heavier by about 30 kg at the end of the year after weaning.
- Preliminary data shows that around 70% of females and 53% of males are polled and 27% of females and 43% of males are scurred. This means that considerably fewer animals require dehorning at branding.

- These preliminary results indicate that F1 Senepol cross animals are performing better than Brahmans under local conditions. However, the main reason for breeding these crossbred animals is to produce animals that will have better quality meat than pure *Bos indicus* animals so as to improve marketing options for producers. As the crosses are 50% *Bos taurus*, they should grade better in Australian abattoirs and be more marketable in domestic markets. As F1 Senepol crossbred animals appear to perform at least as well as Brahmans in northern environments, it is important for producers to consider crossbreeding Brahman cattle with Senepols.

2.8 Phosphorous Supplementation in Beef Cattle

Contact: Tim Schatz – Principal Pastoral Production Research Officer

Project Status: Continuing.

Despite the potential benefits of wet season phosphorus (P) supplementation, sales of P supplements across northern Australia indicate that this advice has not been widely adopted. Potential reasons for this lack of adoption include difficulties of implementing P supplementation during the west season, a lack of a clear demonstration of the benefits of P supplementation in breeders and a lack of a simple diagnostic test for P deficiency. This project was designed to address these needs in collaboration with the University of Queensland. It aims to determine the response of cows and growing steers to P supplementation at different times of the year (wet season, dry season and all year round) and to propose a diagnostic test for P deficiency.

Since the project is still in its early stages, some results will be reported next year.

Automatic drafters with walk-over-weighing technology are being used to implement the project in the same paddock to minimise potential paddock effects.

Above left: An automatic drafter is used to draft animals into the different supplement treatment enclosures

Above right: Mustering cattle for the P trial

2.9 Cell Grazing of Improved Pastures for Increased Beef Production and Soil Carbon Sequestration

Contact: Tim Schatz – Principal Pastoral Production Research Officer

Project Status: Continuing.

This project is being conducted at the Douglas Daly Research Farm (DDRF) to compare the effects of set-stocking and cell-grazing regimes on animal and pasture production, pasture composition and sequestration of soil organic carbon (SOC).

Comparisons are being made between a) Cell grazing (CELL), b) Set stocking constantly at the long-term safe carrying capacity (SS^C), and c) Set stocking at a variable stocking rate, set to be the same as the effective stocking rate in the cell grazing treatment (SS^V).

Above: The cell grazing group being moved to a new paddock during the dry season at DDRF

Right: (Table) The average growth over the whole post-weaning year in the different groups (note: weights were recorded after a 12-hour fast (no feed or water). SS = Set stocked. Cell = Cell grazing

Year	Treatment	Average growth/animal (kg)	Average growth/ha (kg)
2009-10	SS 1.5 animal/ha	137.3	183.0
	SS 1.33 animal/ha	132.7	199.0
	Cell 1.33 animal/ha	114.6	152.9
2010-11	SS 1.5 animal/ha	174.0	289.9
	SS 1.67 animal/ha	186.0	279.0
	Cell 1.67 animal/ha	161.2	268.6
2011-12	SS 1.5 animal/ha	151.9	278.6
	SS 1.83 animal/ha	167.7	251.6
	Cell 1.83 animal/ha	119.9	219.9

Research Outputs

Young animals are used in the trial shortly after weaning and remain in it for about one year at which time they are replaced by next year's weaners. The large group of animals in the CELL treatment rotate around 26 x 6 ha paddocks, while the set-stocked animals always stay in the same 6 ha paddock. Studies on the effects of different grazing regimes are long-term in nature as it takes time for the effects of the grazing options to become evident in the pasture and soil. This study has been running for three years and is still in its early stages. As such, all the results are preliminary.

Results so far are showing that individual animal performance is highest in the set-stocking group with the lowest stocking rate; production per hectare has been highest in the set-stocking group with the higher stocking rate.

2.10 A Comparison between the Productivity of a Multi-breed Composite and a Brahman Breeder Herd

Contact: Barry Lemcke – Principal Beef/Buffalo Research Officer

Project Status: Continuing.

This project aims to compare the performance of a multi-breed composite with that of the Brahman under Top End conditions to assess its suitability as a possible alternative to the Brahman.

Composite cattle are a stabilised cross of several breeds where the desirable traits from a number of breeds are combined and heterosis (hybrid vigour) is maximised. A multi-breed composite is able to capture a larger amount of the available heterosis than a conventional two- breed cross in future generations. It is expected that this composite will retain 64% of heterosis from the second generation onwards. The mix of breeds in this composite is 56.3% Brahman, 12.5% Africander, 12.5% Tuli, 6.3% Shorthorn, 6.3% Hereford and 6.3% Charolais. This mix is 81% tropically-adapted and 19% unadapted *Bos taurus*. Recently, some other breeds, such as the Senepol, have been introduced through artificial insemination to heifers to test if they can improve the performance of the composite.

Since 2009, the composite breeder herd has been located at Beatrice Hill Farm (BHF) in the Top End's coastal plains. Previously, the herd was located at Victoria River Research Station (VRRS) for six years and prior to that at the Douglas Daly Research Farm (DDRF). The composite herd is compared with a commercial Brahman herd that is managed in the same way. Heifers from both herds are transported to DDRF shortly after weaning where they stay for two matings before re-joining the breeder herds at BHF. The two breeder herds are run together at BHF except during mating between January and March. Their performance is assessed through BREEDPLAN, which is also used to select bull calves for breeding and for annual sale by tender.

Below right: Some of the two-year-old selected composite bulls ready for mating at the start of the 2012 season at DDRF - note the wide phenotypic variation

***Below left*:** Composite heifers at DDRF at the end of the 2012 mating

Next page: (Table) Herd statistics 2011-12

Research Outputs

	Composite breeder herd at BHF	Brahman breeder herd at BHF	Composite 3 year-old heifers at DDRF	Composite 2 year-old heifers at DDRF	Composite yearling Heifers at DDRF	Brahman yearling heifers at BHF
Herd size at start of mating 2012	87	55	65	67	83	21 2009s +14 2010s
Pregnancy rate 2011 mating	105/110= 96% (all non-pregnant were culled)	52/59= 88%	57/65= 88%	46/67= 69%	54/69= 78%	5/21= 24%
No. culled at June 2012 pregnancy test (% of breeders mated)	8/87= 5%	7/55= 12%	7/104 = 7%	0	None culled	None culled
Pregnancy rate, 2012	83/87= 95%	47/55= 86%	57/65= 88%	56/67= 84%	60/83= 72%	2009s: 18/21= 86% 2010s: 1/14= 7%
Calves born 2011-12	84	51	61	49	NA	5
Mean birth weight (kg)	27.2	27.6	24.9	24.1	NA	25.3
Calf mortality	6/83 = 7%	3/51 = 6%	3/61 = 5%	3/49 = 6%	NA	0
Calves weaned	78	48	58	46	NA	5
Weaning rate (%)	90; 39 female, 39 male	87	89	69		24
Mean weaning weight (kg)	215.9 *	217.1 **	199.7	190.9		165.6
Adult mortality	0	0	0	1	0	0

Calf death rates were within reasonable parameters for both stations; dingoes were the main problem. The effect of the reduction in herd numbers at BHF in 2011 was reflected in the better weaning weights of the calves and condition of the cows at weaning.

* 60 kg improvement in mean weaning weight compared to the previous year.

** 86 kg increase compared to the previous year.

2.11 Riverine Buffalo and Crossbreeding

Contact: Barry Lemcke – Principal Beef/Buffalo Research Officer

Project Status: Continuing.

This project aims to build the Australian riverine buffalo population as rapidly as possible by increasing the purebred and backcross lines and making them available to the industry. Imported Italian dairy buffalo semen has allowed the expansion of the herd while avoiding inbreeding problems due to the low starting population base. The target is a 100-animal purebred breeder unit able to turnoff around 40 heifers per year to the industry.

Riverine buffalo were imported from the USA during 1994-97 to serve as the foundation herd. Many buffalo progeny from this herd have now spread through all Australian states. They are the preferred breed for dairying.

Cross breeding with the existing swamp buffalo allowed a more rapid build-up of riverine buffalo numbers. It has allowed dairy farmers to produce milk more rapidly using cheaper first and subsequent crosses while backcrossing to riverine buffalo to increase the riverine content over time.

Crossbreeding also improved growth rates in progeny for meat production by 40% over the swamp breed providing for the production of improved TenderBuff due to earlier age at slaughter, hence improved tenderness.

Above: Young pure-bred riverine bulls at BHF, available as sires for local, interstate or export markets

Below: Crossbred weaners being trained in yards at BHF enabling good handling for the rest of the animals' productive lives

Next page: (Table) Calving results for 2011-12 and pregnancy diagnosis (Aug 2012) for next season's calves

Research Outputs

The pregnancy rates this year were lower than expected. While the wet-cow pregnancy percentage is similar to previous years, there is a larger than expected number of non-pregnant dry cows and a much lower proportion of cows conceiving early in the mating period. This will need to be confirmed at calving next wet season.

Research Outputs (cont.)

A pattern of later conceptions is likely to reduce pregnancy rates in the following year. Early calving improves the chances of more cows getting pregnant before the mating period ends. There are also a number of cows that should have been culled prior to the last mating due to their past performance, but were retained due to a lack of demand for them. General herd productivity may decline due to keeping less fertile animals.

The progress towards the target of a 100-cow herd is progressing well and should be achieved within two years. This will allow higher sales to the dairy industry, which currently has no access to suitable heifers.

Breeder group	**Calving rate 2011-12 (calves born/ cows mated)**	**Pregnancy (cows pregnant Jul 2012/ cows mated Jan 2012)**	**Wet cow preg. rate (preg. and wet cows/total wet cows)**
F1 cows	17 / 22 = 77%	12 / 22 = 55%	8 / 17 = 47%
3/4 cows	22 / 38 = 58%	23 / 36 = 64%	13 / 18 = 72%
7/8 cows	28 / 39 = 72%	24 / 38 = 63%	15 / 24 = 63%
15/16 cows	12 / 16 = 75%	8 / 14 = 57%	8 / 12 = 75%
X-bred heifers	27 / 31 = 87%	24 / 31 = 77%	Calves already weaned
All yearling heifers	na	12/50. Mating is still continuing - only 23 have reached mating weight	na
Riverine cows	15 / 36= 41.7%	Jun 11 4/7 = 57% Jul 11 8/15 = 53% Dec 11 8/20 = 40% Mar 12 6/13 = 46%	2/2 = 100% 8/15 = 53% 4/12 = 33% 1/2 = 50%
Riverine heifers	24 / 29 = 83%		
Total	145 / 182 = 80%	117 / 177 = 66%	59 / 102 = 58%

2.12 Enhancing Productivity Improvements in the Australian Water Buffalo Industry

Contact: Barry Lemcke – Principal Beef/Buffalo Research Officer

Project Status: Continuing.

This project is jointly funded by RIRDC and the Department of Primary Industry and Fisheries and has eight components:

- To continue to develop artificial insemination synchronisation protocols to deliver 50% conception rates from single inseminations.
- To establish benchmark tenderness values for TenderBuff of various age/weight ranges.
- To determine the quality factors in buffalo milk that set it apart from cow's milk in the market.
- To continue to subsidise milk testing at the Millaa Millaa dairy to build up dairy production data in a commercial herd.
- To encourage registration of producer herds throughout Australia.
- To monitor the feedlot performance of crossbred riverine buffalo overseas compared with swamp buffalo.
- To prepare a "Best Practice Manual for Water Buffalo in Australia".

Below: Milking time at the local Beatrice Buffalo Dairy at Lambells Lagoon in the Darwin rural area. Dairy products, including a variety of cheeses such as mozzarella and yoghurt are now available in Darwin.

Research Outputs

Three AI rounds were completed during 2011-12. Two involved the use of sexed semen.

TenderBuff tests for tenderness showed no differences in quality due to the 12-month age difference between the two groups. However, animal numbers were not high enough to give a conclusive result. This work will need to be resumed once a suitable slaughter facility is available.

Milk testing was completed and data will be recorded on the BREEDPLAN database.

Milk quality information was passed on to the University of Melbourne for more in-depth analysis.

The Australian Buffalo Manual will be ready for publication by December 2012.

The final report for the project has been submitted and is available on the RIRDC website.

2.13 TenderBuff Development and Supply

Contact: Barry Lemcke – Principal Beef/Buffalo Research Officer

Project Status: Continuing.

This project aims to develop Tenderbuff and increase its production.

Below left: TenderBuff rib-eye muscle at quartering site where the eye muscle area is measured

Below right: The NTBIC stall at the Royal Darwin Show attracts many customers

Research Outputs

TenderBuff is a registered trade name held by the NT Buffalo Industry Council (NTBIC) for a quality-assured product that resulted from a need to supply a high value product with a small supply base, post the national brucellosis and tuberculosis eradication campaign. To be branded with the TenderBuff brand, meat must be from an animal that complies with five specifications: 150-300 kg hot standard carcase weight, 3-12 mm of P8 fat, no permanent incisor teeth, carcase must be electrically stimulated (or tender-stretched) and be below pH 5.8 after hanging overnight in the chiller.

To produce TenderBuff in the Top End, it is necessary to raise buffalo on improved pastures to achieve the growth rates required or to feedlot wild-caught animals for at least two months to bring them up to a suitable standard. In the dry season, access to floodplain pasture or to irrigated pasture or fodder is an advantage.

Currently, the only meatworks available in the Top End for slaughtering buffalo is at Oenpelli (Gunbalanya Meats) in Arnhem Land, 300 km from Darwin. The facility was extensively upgraded in 2010 and has been operating since then, but is seasonally restricted due to a lack of wet season access. It mainly supplies local communities and some Darwin and interstate markets with both buffalo and beef. Only 94 animals were processed at Oenpelli meatworks during 2011. None were for TenderBuff due to the lack of an electrical stimulator.

The Batchelor abattoir was expected to re-open in late 2011 but this did not happen. Currently, there is no service kill available to local producers to enable them to provide TenderBuff for the local market.

The local supply of TenderBuff was restricted after 2007 due to the lack of a suitable local abattoir. The Department of Primary Industry and Fisheries provided a quality assurance service for TenderBuff until 2007.

2.14 Pasture Sustainability Kidman Springs

Contact: Dionne Walsh – Rangeland Program Coordinator

Project Status: Continuing.

The aims of this long-term research project are to:

- Monitor the pastures and land condition at Victoria River Research Station (VRRS).
- Verify whether the recommended stocking rates derived by Cowley and Bryce (2003) are sustainable.
- Determine the differences between paddocks regarding pasture quality and land condition, and monitor seasonal changes.

Below left: Collecting data at Kidman Springs

***Below right*:** A quad bike set up for pasture sampling

Research Outputs

Five observers completed the annual pasture monitoring in 14 paddocks between 28 May and 2 June.

All the data from 2003 to 2012 has been compiled and quality checked. The database now contains more than 1.5 million records.

The Kidman Springs cattle records database is being compiled and quality checked.

2.15 Shruburn (VRRS long term fire trial)

Contact: Robyn Cowley – Senior Rangeland Scientist

Project Status: Continuing.

The long term Kidman Springs fire trial, which was established in 1993, assessed the impact of fire management on woody cover and pasture condition. The trial is replicated on red and black soil sites, with grazed experimental plots burnt early or later in the dry season, every two, four and six years, as well as unburnt control plots. Bio-economic modelling of the fire trial results were applied to a VRD representative property to assess production and economic implications of fire management. In addition to the Department of Primary Industry and Fisheries work at the site, external research agencies (CSIRO and Qld DERM) with expertise in soil carbon, soil respiration, and above ground carbon storage have recently collected data at the site to enhance the understanding of carbon implications of fire management in a grazed savannah.

Below left: Lighting a fire on the four-yearly late dry season treatment on the cracking clay (black soil) site at VRRS, June 2011

***Below right*:** Aerial view of VRRS fire trial treatments on the clay site, June 2011. The more densely-treed top left and top right are unburned controls.

Research Outputs

Four-yearly late season fires were required on the red earth soil to manage woody cover, whereas on cracking clay (black soil), four-yearly early burns were enough.

Two-yearly or early dry season fires increased annual grass yield, but decreased total yield on the cracking clay; and on the red earths suppressed the increase of *Heteropogon contortus* yield through time and increased the proportion of dicots. *Aristida latifolia* yield was lowest on two and four-yearly burnt cracking clay sites.

Bio-economic modelling of a commercial cattle station found that implementing four-yearly fire improved animal production and enterprise profits, with late season fire providing the greatest benefits. There was an opportunity cost of implementing early season fire (as recommended for carbon and biodiversity outcomes) of $85/km^2 compared to burning later in the year.

2.16 Optimum Levels of Pasture Utilisation at Mt Sanford and Pigeon Hole Stations

Contact: Robyn Cowley – Senior Rangeland Scientist

Project Status: Continuing.

This project investigated the potential for pastoral intensification in the Victoria River District (VRD) of the NT to increase the profitability of the northern beef industry in the face of rising costs.

Below left: Cattle in the Pigeon Hole utilisation trial

Below right: Monitoring utilisation impacts on plant diversity at the Mt Sanford utilisation trial

Research Outputs

The results suggested that intensification can increase a property's profitability without adverse effects on land condition or biodiversity in the short term.

The key is sustainable pasture utilisation rates (20% for productive cracking clays) and appropriate development of paddocks and water points.

Grazing management based on set pasture utilisation appeared to be the most profitable grazing system.

The use of advanced technologies, such as telemetry to manage water points can offer improvements in efficiency and cost savings.

About half the properties in the VRD have the potential for intensification because they currently operate with pasture utilisation rates below the recommended 20%.

An intensification on these properties could see an increase in cattle numbers in the VRD by about 154 000 animal equivalents, generating an additional annual gross margin of about $17m.

The project identified a series of guidelines for the sustainable development of properties and also a number of recommendations for the protection of biodiversity under pastoral intensification.

2.17 Improving the Reproductive Performance of Cows and the Performance of Fattening Cattle in Low Input Systems of Indonesia and Northern Australia (StrawCow), (Project LPS/2008/038)

Contact: Kieren McCosker - Pastoral Production Officer - Beef Cattle

Project Status: Commenced.

The StrawCow project is being conducted in Indonesia and Australia. It is funded by the Australian Centre for International Agricultural Research. The Northern Territory (NT) Department of Primary Industry and Fisheries (DPIF) is managing the Australian component of this project and is also participating in the work being conducted in Indonesia.

Domestic beef consumption in Indonesia is increasing at 4% annually while the national herd is only increasing at 1.1%. To meet future beef demand in Indonesia, local smallholder enterprises need to both increase the number of breeding cows and improve the reproductive performance of breeding stock. The factors that limit the productivity of smallholder enterprises in Indonesia are similar to those in the NT, such as time of weaning and the management of bulls and cows under low protein feeding systems.

To improve the nutritional management of cattle all year round, the project will investigate the effect of a change in diet on body condition and other important traits.

Above left: A cow with an unweaned calf – Katherine Research Station

Above right: A Brahman calf in the Indonesian trial

2.18 Making Production and Conservation Gains through Adaptive Grazing: Beetaloo Pilot

Contact: Dionne Walsh – Rangeland Program Coordinator

Project Status: Commenced.

This project aims to evaluate and promote grazing land management practices, infrastructure development and animal productivity improvements that will increase business resilience in the Barkly pastoral region. The project is funded by Caring for Our Country until June 2013. It is a collaborative effort between the Department of Primary Industry and Fisheries, the Barkly Land Care and Conservation Association, the Department of Land Resource Management and Beetaloo Station.

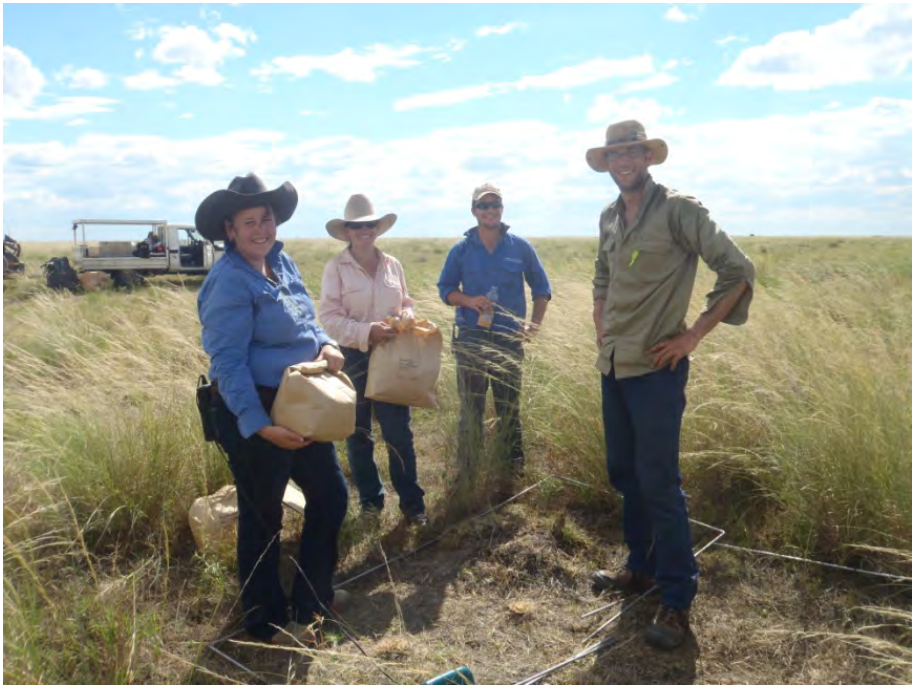
Right: Tank on Mungabroom Station

Below: Pasture sampling at the Beetaloo-Mungabroom trial site

Research Outputs

Five observers completed the inaugural pasture monitoring from 18 to 22 April in the trial paddocks on the Mungabroom lease.

Pasture, cattle and management data is being compiled and checked.



2.19 Arid Zone Grazing Strategies

Contact: Chris Materne – Pastoral Production Officer

Project Status: Commenced.

This is a long-term grazing trial on the Old Man Plains Research Station (OMPRS) that aims to improve land management guidelines for optimising sustainable production in a remote region with a variable and unpredictable climate. It will develop, practically demonstrate and objectively test how stocking rate management and spelling influence consistent quality beef production in Central Australia. It will also identify grazing strategy options to optimise production and improve land condition.

Above: Presenting the trial concept to the Alice Springs Pastoral Industry Advisory Committee at OMPRS in May 2012

Research Outputs

The trial plan was presented to the Alice Springs Pastoral Industry Advisory Committee in May 2012 and their support was obtained.

Five of the six planned strategies have been put in place. The sixth is subject to infrastructure development.

Pre-trial pasture assessments were completed in 2011. The 2012 pasture assessments were conducted in April.

Cattle performance data was collected in September 2011, December 2011, March 2012 and May 2012. Pre-trial data on all indicator steers in the trial was collected in July 2011.

3 Plant Industries

3.1 Addressing Product Quality and Safety with LOTE (Language Other Than English) Growers of Vegetables

Contact: Stuart Smith – Senior Research Officer, Sustainable Production

Project Status: Completed.

This project addresses three high priority information needs of vegetable growers in the Darwin region whose first language is not English. They are:

- Post-harvest management and the supply chain.
- Product quality and safety.
- Environmental stewardship.

The activities of this part of the project were mainly toward extension in the extension-research spectrum, with on-farm workshops, market tours, Freshcare audits and water-smart audits taking up most of the time and effort. Moreover, temperatures of vegetable consignments were also recorded during the season.

Below left: Presenting results of temperature monitoring of vegetable loads – Grower shed – Humpty Doo

***Below right*:** Inspecting product quality with growers at Sydney markets

Research Outputs

A report has been prepared titled ‘Poor post-harvest temperature lowers vegetable quality in transit from Darwin to Sydney’.

Conclusions

It was discovered that current cool chain practices were inadequate for Darwin vegetables between harvest and loading on prime movers to southern markets. In some situations, loading at super-optimal temperatures led to respiration heat ruining consignments of snake beans. Further extension work is needed to increase the adoption of forced-air cooling on-farm and refrigerated transport between farms and businesses that consolidate loads for transport to southern states.

Recommendations

Use forced-air cooling of vegetables at vegetable farms.

Use refrigerated transport of vegetables between farms and transport consolidators.

3.2 The Determination of an Optimum Irrigation Strategy for Tropical Passionfruit

Contact: Stuart Smith – Senior Research Officer, Sustainable Production

Project Status: Completed.

This project investigated the root structure and water use of Panama red passionfruit grown on a Brazilian rootstock.

Research Outputs

The root depth of passionfruit grown at Berrimah Farm was quite shallow (0-30 cm) and plants lacked a distinct taproot. Tensiometer readings, timing of wetting, front detector movement through the soil and sprinkler output were used to estimate crop factors. Crop factors (K_c) were estimated for both young and mature passionfruit plants. Young plants had a crop factor of 0.5 and established fruiting plants had a crop factor of 0.9. A report has been prepared.

Above right: Rooting pattern for passionfruit growing in tropical conditions at Berrimah Farm

Right: Young pre-fruiting vines at Berrimah Farm

Conclusions

Tensiometers and wetting front detectors are effective tools for scheduling irrigation.

Young passionfruit plants only need 0.5 x reference crop evapotranspiration up to fruiting.

Established and fruiting passionfruit plants need 0.9 x reference crop evapotranspiration.

Recommendations

Passionfruit growers in the Northern Territory should irrigate their crops daily. The amount of irrigation water they apply should be calculated from reference crop evapotranspiration (www.bom.gov.au/eto) from a nearby weather station along with a crop factor of 0.5 for crops up until fruiting, then 0.9 after that.

3.3 Integrated Tropical Passionfruit Production Systems in South Sulawesi

Contact: Mark Hoult – Senior Horticulturalist

Project Status: Completed.

This ACIAR-funded project addresses common issues that influence passionfruit production in both South Sulawesi (SS) and north-west Australia (NWA), where only destination markets and product end use are different. For SS, the primary market driver is a consistent monthly supply for processing fruit; for NWA, it is a high-priced market niche for fresh fruit. Pathologically, in NWA, a short vine life issue is a prominent concern; in SS, root pathogens affect vine longevity. The project aims to resolve these issues through three key objectives, namely to improve passionfruit vine longevity through appropriate disease management in highland production areas of SS and NWA, to improve continuity of quality pulp supply through the introduction of new germplasm in both lowlands and highlands of SS and re-invigorate NWA “fresh” fruit production, and finally to develop supply chain models to meet long-term market demand.

***Below left*:** Sulawesi ACIAR passionfruit project partners and commercial passionfruit vineyard, Darwin River

Below right: Good flowering “Pan 2” Panama Red passionfruit clone

Research Outputs

Comprehensive disease surveys have been completed in SS and NWA. In SS, the project team has identified the economic disease Fusarium wilt - *Fusarium oxysporum* var. *passiflora* and confirmed this pathogen as a key cause of disease impacting on production there. Several other pathogens and nematodes have been identified; suspected viruses have also been collected. This work provides the basis for a management strategy of economic pathogens in both regions. Key survey findings were presented at the APPS conference in 2011.

In NWA, young vines were surveyed and a number of pathogens were identified, notably base rot (*Fusarium solani*). To date, Fusarium wilt and Woodiness virus have not been isolated. In the Ord Valley of WA, *Pythium* and *Rhizoctonia* have been isolated from wilting vines. As in the Darwin region, no Fusarium or Woodiness viruses have been detected up to now.

Following the quantification of economic pathogens, disease management strategies for passionfruit rely on the use of *Passiflora edulis* form *flavicarpa* "Bogor Gold" seedlings as tolerant rootstocks in combination with selected scion wood from proven local lines of "edulis" types. In SS, initial workshops on the use of disease-tolerant rootstocks and grafting techniques were complemented with follow up events in Malino, Bonto Bonto and Malakaji. "Flavicarpa" seed lines with *Fusarium* tolerance and a “Panama red” seed line, all sourced from Sumatra, have been distributed to farmers in Kanreapia and Tombolo Pao sub district.

Research Outputs (cont.)

All plantings in NWA established on “DPI flavicarpa” seed line (Australian industry standard stock) have succumbed to "short vine life" syndrome. The current suggested "flavicarpa" rootstock seed line is "Birdwood Brazilian". A number of seed lots of this accession have been distributed in the NT and in the Ord Valley, WA. This accession, as a rootstock for Panama red scions, is exhibiting good longevity and all vines grafted to this stock are growing well in the NT.

Early evaluation of new germplasm near Makassar indicates that some will flower and set fruit in the hot lowlands. These have been principally "Flavicarpa" and “Panama red” seed lines. Key phenology events are strongly linked with the monsoonal season and harvest periods appear to mirror upland "edulis" periods. Without additional irrigation into the dry season, alternative supply periods maybe difficult to achieve.

Project partners with the Queensland Department of Agriculture, Fisheries and Forestry have developed a method for micro-grafting of passionfruit once vine tips have received heat therapy for freedom from viruses. Cuttings of several key commercial Australian varieties were established in growth cabinets and were subjected to high day-time temperatures (36-38 °C). Tips of heat-treated plants were micro-grafted to virus free “DPI flavicarpa” rootstocks. Confirmation of virus freedom was achieved through polymerase chain reaction testing and standard inoculation methods. To date two lines maintain virus freedom in an insect-proof screen house.

Conclusions

Commercial production of Panama red passionfruit is feasible in the Top End of the NT. A number of commercial vineyards have been established and are producing fruit as a consequence of this project. To date Purple edulis germplasm, the traditional purple or black passionfruit, has not performed well in the hot monsoonal environment of the Top End. The key pathogens of passionfruit interstate (Fusarium wilt and Woodiness virus) have not been detected here. Selected “flavicarpa” seed line rootstocks are available to ensure good vine longevity. Pest pressures have been minimal and easily managed apart from winged vertebrates, cockatoos and magpie geese. Vineyards may need bird netting to ensure profitability.

Recommendations

The movement of vegetative plant material from interstate should be prohibited to minimise the introduction of Fusarium wilt and Woodiness virus, both of which are potentially very limiting pathogens for any new production region. Currently, seed introduction and selection are the only secure means of introducing healthy germplasm. As a consequence of this project, virus-free clonal material via heat therapy may be a future option.

To ensure a sustainable production of a quality product, scion and stock selection are critical. Current recommendations are to use “Pan 1” and “Pan 2” Panama red clonally-grafted to Birdwood Brazil flavicarpa rootstock seedlings. The “Pandora” seed line of Panama red warrants further clonal selection and development.

Industry development strategies now need to be developed to ensure the continued growth of this emerging crop. These should embrace extension and knowledge requirements and facilitate local grower integration into a peak national industry body, such as ‘Passionfruit Australia Incorporated’.

3.4 An Evaluation of Candidate Table Grape Varieties for Central Australia

Contact: Vivek Bhat – Research Horticulturist

Project Status: Completed.

Twelve CSIRO table grape selections were trialled at Ti Tree Research Farm as a part of a National Varietal Evaluation program since 2007 to evaluate their performance in the tropical arid zone. Four different rootstocks were used to make 24 different stionic combinations, which were planted in two rows of 36 vines. The vines were maintained with minimum inputs in order to assess their performance. Interestingly, all of them except three vines were disease and insect pest-free, thereby needing only one round of chemical use against powdery mildew infection in the entire season. Delayed pruning in late July was evident in the early shoot and cane growth in the season before maturing bunches in a normal harvesting time for the region. Dormex spray did not seem to have any influence on enhancing bud burst as the untreated vines, including Menindee Seedless, also had bud burst in the same first week of September as the treated plants. There was an indicative influence of the rootstock Paulsen in producing a vigorous canopy with a compensatory loss of fruiting compared with the other rootstocks Ramsey and Freedom. However, this observation was anecdotal as the trial lacked an appropriate design for statistical analysis. The top late-maturing selection in temperate climates had an early season harvest in Central Australia. Similarly a favoured red-berried fruit gave an unreliable colour development at Ti Tree. A sensory analysis of some of the better yielding selections revealed a heavy yielding vine with a strongly muscat-flavoured fruit.

Below left: Sensory analysis being conducted at AZRI

Below right: Unique shaped berries within the diversity table grapes evaluated at Ti Tree Research Farm

Research Outputs

An extensive catalogue of performance data was released of the cultivars' performance in a tropical arid zone climate.

The project released two new commercial cultivars.

Conclusions

The two new released cultivars will generate royalty payments for the NT Government and for the NT Table Grape Growers Association.

Recommendations

Future work on table grapes cultivar evaluation should be conducted at the Arid Zone Research Institute (AZRI) to reduce travel cost and facilitate more intensive evaluation.

The NT Government should continue its involvement in the evaluation of CSIRO cultivars since the next batch to be evaluated is likely to have a greater proportion of seedless berries.

3.5 Delimiting Survey for Cocoa Pod Borer (*Conopomorpha cramerella*, Lepidoptera: Gracillaridae) in the Solomon Islands (with Brian Thistleton)

Contact: Lucy Tran-Nguyen – Molecular Scientist

Project Status: Completed.

The cocoa pod borer (CPB), *Conopomorpha cramerella*, is a major pest of cocoa in South-East Asia. Rambutan, pulasan and nam-nam are considered to be the original hosts, since they are native to South-East Asia. CPB was first detected in the Papua New Guinea provinces of East New Britain (2006), West Sepik (2006), Madang (2008) and Bougainville (2009). An eradication program was implemented in 2006-07. However, CPB re-emerged and spread rapidly and is currently causing significant economic losses in the Solomon Islands. A delimiting survey for CPB in the west of Solomon Islands was undertaken in February 2012 by OCPPO's International Plant Health Program, the NT Department of Primary Industry and Fisheries and the Solomon Islands Agricultural Quarantine Service. Specimens collected from pheromone traps were sorted into different morphotypes based on their wing patterns. A subset of these specimens was then subjected to molecular characterisation using DNA barcoding targeting the *cytochrome oxidase* I gene.

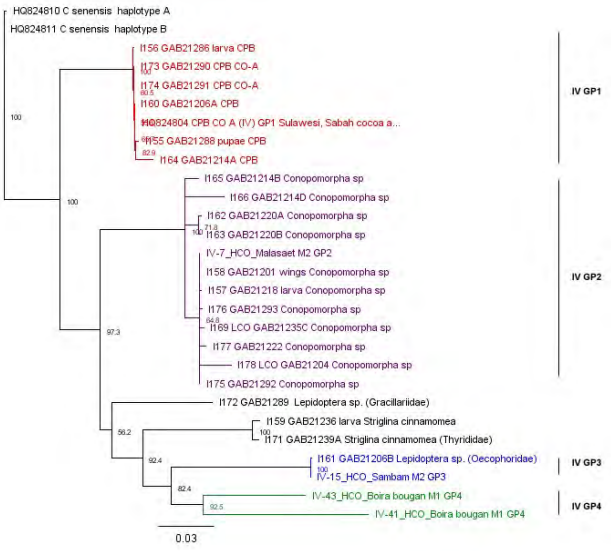
In Australia, the pest was previously considered to be exotic; however, it was first detected in Queensland near Cairns in 2011. A national eradication program is being conducted in Queensland. Overseas, CPB is known to be difficult to control. If it becomes established in Australia, it could become a major production-limiting factor.

Below left: Typical cocoa pod borer damage (Photo courtesy of Smilja Lambert)

***Below right*:** Neighbour joining phylogenetic tree inferred from the cytochrome oxidase gene sequence data. Bootstrap values are indicative of 1000 replicated trees. *Conopomorpha senesis* was used as the out-group for the analysis.

Research Outputs

Twenty-four specimens were examined for molecular characterisation. Genetic information provided by Dr Isabel Valenzuela of the University of Melbourne and the Barcode of Life Database (http://v3.boldsystems.org/) were used for identification. Adults (morphotypes 1, 2 and 3), larvae and pupae were identified as CPB from lineage COI_A. A large proportion of specimens of morphotypes 1 and 2 were identified as *Conopomorpha* sp. (from *Pometia pinnata*). Several non-described species could not be identified using DNA barcoding based on a single gene. Genetic diversity within the Solomon Islands' specimens indicated high levels of diversity (14-18%). The results indicated a large suite of genetic diversity within the Solomon Islands but also a large number of non-described species.



Research Outputs (cont.)

Conclusions

Conopomorpha cramerella was identified from adults, pupae and larvae specimens. In addition, a large number of specimens were identified as *Conopomorpha* sp. (from *Pometia pinnata*). DNA barcoding based on one gene was unable to differentiate between the aggressive and non-aggressive *Conopomorpha cramerella* species.

Recommendations

Further molecular work is needed to differentiate between the aggressive and non-aggressive *Conopomorpha cramerella* species, characterise the *Conopomorpha* sp. (from *Pometia pinnata*) and the non-described Lepidoptera species found in the Solomon Islands.

3.6 Quality Management to Enhance Effective Supply Chains for Mangoes and Rambutans in Nusa Tenggara Barat (NTB), Indonesia and Australia (ACIAR funded project)

Contact: Brian Thistleton – Principal Entomologist

Project Status: Completed.

The project aimed to develop effective and competitive supply chains that can deliver high quality mangoes and rambutans to profitable higher-value markets in NTB and Australia by improving fruit quality pre-harvest, maintaining fruit quality through the supply chain and developing suitable supply chain models to maintain fruit quality until the fruit reached higher value markets. The research involved defect analysis in mangoes and rambutans, control methods for pests and pathogens, and other factors, such as the supply chain, that affect fruit quality. Trial fruit shipments have been made from Indonesia to Singapore, Hong Kong and Malaysia.

Below left: Mango fruit (Calypso) in the NT

Below right: Rambutan fruit in laboratory ready for quality assessment

Research Outputs

In Australia the project identified the key factors that reduce mango quality from class 1 to class 2, leading to more focus on key constraints, such as lenticel marks.

A key issue was to develop a robust disease control system using pre and post-harvest strategies. The system had to be robust even in unfavourable conditions i.e. rain at harvest, and achieve a low incidence of disease after 21 days storage in the commercial supply chain. The project tested a successful strategy based on timely strobilurin pre-harvest sprays and post-harvest fludinoxinol treatment appropriate for existing farming systems.

Leafhoppers and plant hoppers are sucking pests of mangoes which are becoming increasingly important. The project demonstrated that the use of the systemic insecticide thiomethoxam (Actara) as a soil drench or as an application to the trunk gave good control of these pests. Residue analysis indicated that the current withholding period of 120 days could be substantially decreased. The mango fruit borer, *Citripestis eutraphera*, is a new pest in the Northern Territory. There was little known about this insect at the start of the project and studies in the field and in the laboratory in Australia and in Indonesia increased current knowledge of its life cycle and biology. Work on pheromones of this species and the red-banded mango caterpillar is continuing. For market access, it was established that fenthion post-harvest at current rates killed all eggs and young larvae, but when fruit was dipped in dimethoate, some eggs developed to adults.

The application of potassium nitrate in Australia brought harvesting time ahead.

Research Outputs (cont.)

Key outcomes of this project in Indonesia included higher priced and more profitable mangoes because domestic markets were using early production technology based on paclobutrazol, and export markets were using better pre and post-harvest technology for better quality. The project focused on lifting the farm gate mango price above 4000 rupiah/kg from the current 1000 rupiah/kg by developing earlier fruiting technologies and developing export opportunities. Benchmark studies of farmers and a value chain analysis showed many farmers were currently below the poverty line. Increasing the price to 4000 rupiah/kg was the best strategy to lift farm income.

The project researched and demonstrated a consistently earliness response to paclobutrazol in two Indonesian mango varieties (Arumanis and Gedong gincu), over three years, including one year of very poor seasonal conditions and on a number of farm sites. The system extended the mango season consistently from the current the 2.5 months (mid Oct to late December) to at least five months (August to late December). The system is easy to use, low cost and is widely accepted. It has immediate application to 150 000 mango farmers across Indonesia. It allows farmers to increase price in the existing, large, domestic market with no additional input (other than 10 000 rupiah/tree application cost). The response to paclobutrazol in Indonesia is much stronger and consistent than in other mango producing regions around the world. Farm prices for early production in the large domestic market are well over the benchmark of 4000 rupiah/kg.

The project identified mango quality defects in Indonesia, pre and post-harvest and developed management strategies to deal with these constraints. Pre-harvest factors in mango quality were related to the source of the fruit (from dry areas with less rain at harvest), reduced insect damage (by using fruit bagging and or trunk banded insecticides) and varietal factors, which are critical in a low input system. Latex marks from sap contact at harvest were a major quality defect, which was resolved through the use of a modified picking pole and locally available soaps.

Post-harvest quality defects in mangoes were caused by fruit flies and a number of diseases in the two main varieties - Arumanis and Gedong gincu. The project demonstrated the use of fludinoxinol post-harvest dips for 2 minutes at ambient temperature to effectively control diseases both in laboratory trials and during commercial testing of the technology. This was superior to using azoxystrobillurin and hot water. This technology was tested in a large, commercial sea-freight trial, with virtually no disease up to 21 days after harvest.

For rambutan in Australia and Indonesia, the project identified key quality constraints pre and post-harvest. Strategies to move rambutan harvest time by using paclobutrazol and potassium nitrate failed. Cincturing showed some prospects for earlier rambutan flowering. The project successfully tested post-harvest strategies in Indonesia to extend shelf life. Rambutan export was limited by the high cost of air-freight.

Conclusions

The project achieved most of its objectives to improve and maintain mango fruit quality from pre-harvest to the market shelf.

Recommendations

It is recommended that the results of this study be widely promoted for the benefit of mango producers and sellers in Australia and Indonesia.

3.7 Molecular Characterisation of *Colletotrichum* Species Causing Mango Anthracnose in the Northern Territory and Indonesia (part of the ACIAR project "Quality Management to Enhance Effective Supply Chains for Mangoes and Rambutans in Nusa Tenggara Barat (NTB), Indonesia and Australia") (with Andrew Daly)

Contact: Lucy Tran-Nguyen – Molecular Scientist

Project Status: Completed.

Mango post-harvest diseases include mango anthracnose and stem end rot (SER). Mango anthracnose is caused by various species of the fungus *Colletotrichum*. *C. gloeosporioides* was believed to be the common pathogen causing anthracnose in Australia and Indonesia but recent literature indicated that this species was not a common tropical fruit pathogen. SER is predominantly caused by *Lasiodiplodia theobromae* and *Neofusicoccum parvum*. In Australia and Indonesia, the causal agent of SER has only been morphologically identified. The molecular aspects embedded into the larger Australia/Indonesia project were to identify the species which causes anthracnose and SER in the two countries.

Next page left: Bootstrapped phylogenetic tree inferred from the partial ß tubulin 1 gene, bootstrap values are indicative of 1000 replicated trees. *Colletotrichum graminicola* was chosen as the out-group to root the tree.

Next page right: Bootstrapped phylogenetic tree inferred from the glyceraldehyde-3-phosphate dehydrogenase gene. Bootstrap values are indicative of 1000 replicated trees. *Colletotrichum falcatum* was chosen as the out-group to root the tree.

Research Outputs

Ten Australian and four Indonesian isolates were characterised. Isolates originated from anthracnose symptoms clustered into different lineages from both known and undescribed *Colletotrichum* taxa. At present, there are two *Colletotrichum* species complexes – *C. gloeosporioides* and *C. acutatum*. None of the isolates investigated in this study was C. gloeosporioides and none clustered within the *C. acutatum* species complex. However, they all clustered within the *C. gloeosporioides* species complex. In particular, two Australian and two Indonesian isolates were characterised as *C. asianum*. The remaining Australian isolates were identified as *Colletotrichum* species and clustered with those identified from tropical fruits. The phylogenetic trees based upon the partial beta tubulin (BT1), BT2 and glyceraldehyde-3-phosphate dehydrogenase (GDPH) genes to characterise the *Colletotrichum* species did not have strong branch support or high bootstrap values. Further work to include more isolates or analyses to include the whole genes may help in resolving these species with higher levels of confidence.

Three Australian isolates originating from SER-like symptoms were identified as *Pestalotiopsis* sp. and one isolate was identified as *Phomopsis* sp. *Lasiodiplodia theobromae* and *Bortyosphaeria diothidea* were identified from two Indonesian mangoes with SER symptoms. Further work to include more SER isolates from Indonesia and Australia is intended for future.

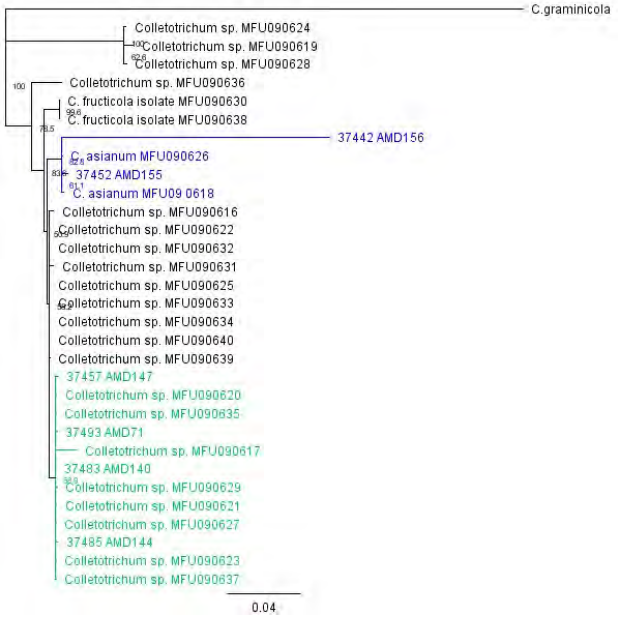
Research Outputs (cont.)

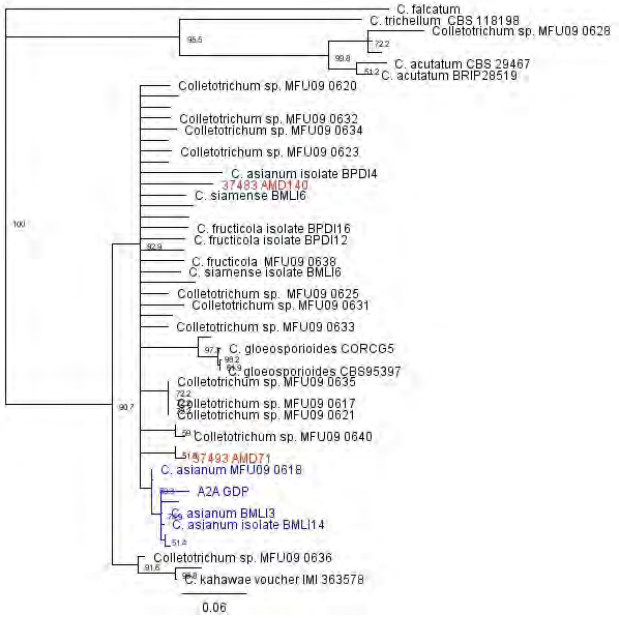
Conclusions

Australian and Indonesian isolates originating from mango anthracnose symptoms belong to the *C. gloeosporioides* species complex. In addition, *C. asianum* was also identified.

Recommendations

Further molecular characterisation of isolates and full-length gene analyses are required to determine with a high confidence the *Colletotrichum* species identified in this project to enable publication. In addition, more SER isolates from both Australia and Indonesia are needed for further characterisation studies.





3.8 Darwin Mango Post-harvest Disease Control Trial (part of the ACIAR project "Quality Management to enhance Effective Supply Chains for Mangoes and Rambutans in Nusa Tenggara Barat (NTB), Indonesia and Australia")

Contact: Andrew Daly

Project Status: Completed.

Wherever mangoes are grown, their shelf-life is limited primarily by post-harvest rots. In humid environments, such as the mango-producing areas of northern Australia and Indonesia, the most significant of these rots is anthracnose, caused by various species of the fungus *Colletotrichum*. Stem-end rot, another significant disease worldwide, is caused by a number of (mostly) related fungi, including *Lasiodiplodia theobromae* and *Neofusicoccum parvum*. In growing areas with inclement weather, such as Darwin, the use of fungicides in the field and post-harvest is essential. There are, however, few options for fungicide use on mangoes post-harvest. For many years, prochloraz and carbendazim were the only two registered for use in Australia. Moreover, carbendazim was reviewed by the Australian Pesticides and Veterinary Medicines Authority because of health and safety concerns and approvals for its use were suspended. A post-harvest trial was undertaken to evaluate new chemical and non-chemical options, such as fruit brushing (Table 1). Assessments during the trial also provided information on the occurrence and importance of the wider range of post-harvest diseases.

Below: (Table) Treatments used in the post-harvest spray trial on Kensington Pride mangoes in 2011

Bottom: (Table) Effect of post-harvest treatments in 2011 on the mean (%) incidence of post-harvest diseases in 'Kensington Pride' mango fruits following storage at 20 °C.

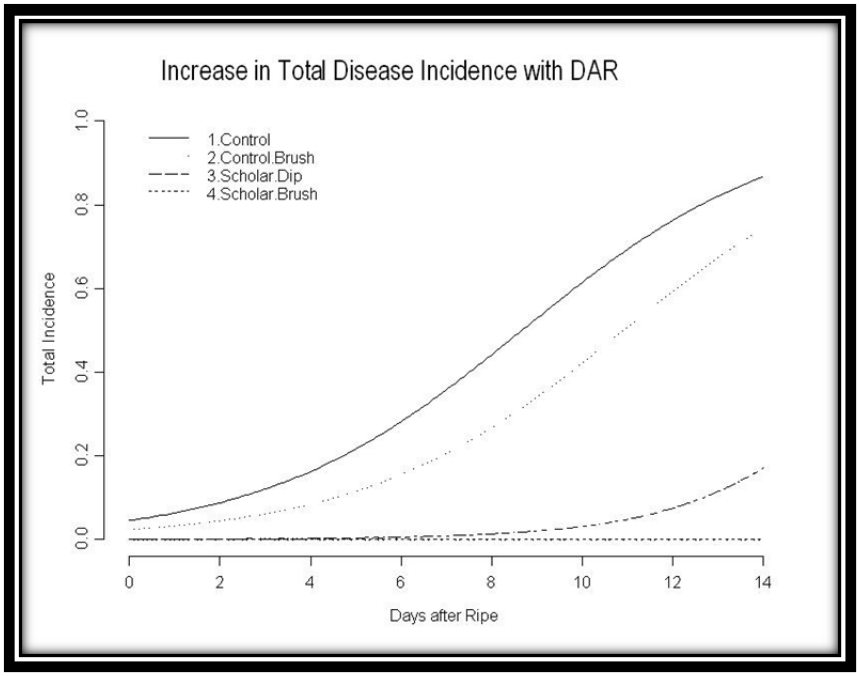
Treatment	Product	Active ingredient (ai)	Treatment method	Dose ai (ppm)	Treatment time (min)
1	water	n/a	dip	0	1
2			brush		
3	Scholar®	fludioxonil	dip	598	1
4			brush		

Research Outputs

The effect of treatments on disease incidence in the 2011 post-harvest trial is presented in Table 2. At ripe, disease was already beginning to appear in fruit not treated with fungicides (treatments 1 and 2). At seven days after ripe (DAR) all treatments were providing control of disease, with the incidence of total anthracnose only 1% in treatment 3 and no disease in treatment 4, compared with 43% in the control (treatment 1). At 14 DAR there was still relatively little disease in either of the fungicide treatments, with a total disease incidence of 16% in treatment 3 and 0% in treatment 4. The rate of increase in total disease incidence (%) for each treatment with DAR is presented in the figure on the next page.

Treatment	Anthracnose (total)			Anthracnose body rots	Stem-end anthracnose	Lasiodiplodia body rots	Stem-end rot
	DAR						
	0	7	14	14	14	14	14
1	2.0	43.0	80.0	52.0	68.0	32.0	1.0
2	1.0 ns	26.0 *	63.0 *	28.0 **	55.0 ns	13.0 **	3.0 ns
3	0.0 ns	1.0 ***	16.0 ***	6.0 ***	11.0 ***	1.0 ***	0.0 ns
4	0.0 ns	0.0 ***	0.0 ***	0.0 ***	0.0 ***	0.0 ***	0.0 ns

*** = highly significant (p<0.001); ** = very significant (p = 0.001 to 0.01); * = significant (p = 0.01 to 0.05); ns = not significant (p>0.05)



Left: The effect of post-harvest treatments on the rate of increase in total disease incidence (%) in Kensington Pride mangoes, DAR

Below: (Table) The effect of post-harvest treatments in 2011 on the severity of post-harvest diseases in Kensington Pride mangoes following storage at 20 °C

Research Outputs (cont.)

Fruit brushing without fungicides did not reduce the incidence of anthracnose at the stem-end of the fruit or total disease incidence in comparison with the control. It did, however, significantly reduce body (side) rots of anthracnose and those caused by *Lasiodiplodia theobromae*. Anthracnose body rot was reduced to 28% compared with 52% in the control. *Lasiodiplodia* body rot was reduced to less than half that of the control. The severity of both total anthracnose and *Lasiodiplodia* body rot was also significantly reduced in all treatments compared with the control at all stages of the assessment (Table 3). Stem-end rot in the trial fruits was insignificant at 14 DAR. Whilst the majority of disease in the trial was anthracnose, the incidence of *Lasiodiplodia* body rot was significant as a disease in its own right. Its incidence was 32% in the control at 14 DAR compared with 52% for anthracnose body rot. However, anthracnose body rot and *Lasiodiplodia* body rot were well controlled (treatments 3 and 4).

Treatment	Anthracnose (total)		Lasiodiplodia body rot
	DAR		
	7	14	14
1	0.64 a	2.02 a	0.92 a
2	0.33 b	1.36 b	0.28 b
3	0.10 c	0.18 c	0.01 b
4	0.00 c	0.00 c	0.00 b

Means followed by the same letter in the columns are not significantly different (Tukey's HSD test, P < 0.05)

The majority of anthracnose lesions occurred at the stem-end as opposed to the side of the fruit. At 14 DAR, brushing alone was effective at reducing both anthracnose and *Lasiodiplodia* body rots, but not stem-end anthracnose. By comparison, the use of fungicides led to a relatively equal control of the two forms of anthracnose. It appears that treatment of fruit by brushing is more effective for controlling rots occurring on the sides of the fruit than on the shoulders and/or directly adjacent to the fruit stalk, probably due to the contact of the brushes with the fruit being predominantly on the sides. All types of rots were successfully controlled with the use of fludioxonil, either as a dip or a brush, with brushing seemingly providing a superior control at 14 DAR.

Research Output (cont.)

In a separate and non-replicated experiment, Kensington Pride mangoes were used in the following treatments: 1) control, 2) spore droplet, 3) spore droplet + 30-second brushing and 4) spore droplet + 5-minute brushing. Each of the fruits was inoculated at three locations on one side with a droplet of either water only (treatment 1) or water containing spores of *Colletotrichum* sp. (treatments 2, 3 and 4) and incubated at 100% humidity for 48 hours. Mangoes in treatments 3 and 4 were then brushed under a spray of water for 30 seconds and 5 minutes, respectively. Six days after inoculation, some skin discolouration was occurring at the inoculated sites in all treatments except the control. These symptoms continued to progress rapidly into large areas of decay in treatment 2 (not brushed), but most symptoms in treatments 3 and 4 (brushed) remained restricted and did not show decay. Lesion expansion was least apparent in treatment 4 (5 minute brushing) 18 days after harvest, even though the skin of the fruits was becoming shrivelled due to dehydration.

Whilst the results of this trial are not scientifically significant, they demonstrate more clearly what has been observed in post-harvest trials previously in 2010 and 2011. However, the nature of the brushing effect is not known. Whilst the effect is undoubtedly due to the physical action, it is not clear whether the removal of the fungal inoculum or stimulation of a biochemical change in the peel of the fruit, thereby enhancing natural resistance, is the reason behind the effect. In preliminary results, Kobiler et al. (1998) found that a delay in decay development due to anthracnose in mango fruits dipped in 55 °C water for 5 minutes was related to an increase in an anti-fungal compound in the peel.

Conclusions

Post-harvest sprays of fludioxonil provide an excellent control of anthracnose and *Lasiodiplodia* body rot, especially in combination with brushing.

Fruit brushing in the absence of chemicals provides disease control.

Recommendations

Fludioxonil should be used as an ambient, low volume, non-recirculating spray at the rates of 130 mL or 260 mL/100 L in combination with fruit brushing.

Further studies should be conducted to understand the nature of the brushing effect and to further develop the treatment as a component of post-harvest disease control practices.

Above top: Kensington Pride mangoes ripening at 20 °C for disease assessment after post-harvest treatment

Above bottom: Kensington Pride mangoes inoculated with droplets containing spores of *Colletotrichum* sp. then either not brushed (left) or brushed with a water spray for 5 minutes (right)

3.9 Defects Analysis on Mangoes in Darwin, Katherine and Kununurra (part of the ACIAR project "Quality management to enhance effective supply chains for mangoes and rambutans in Nusa Tenggara Barat (NTB), Indonesia and Australia")

Contact: Sohail Qureshi – Quality Management Specialist

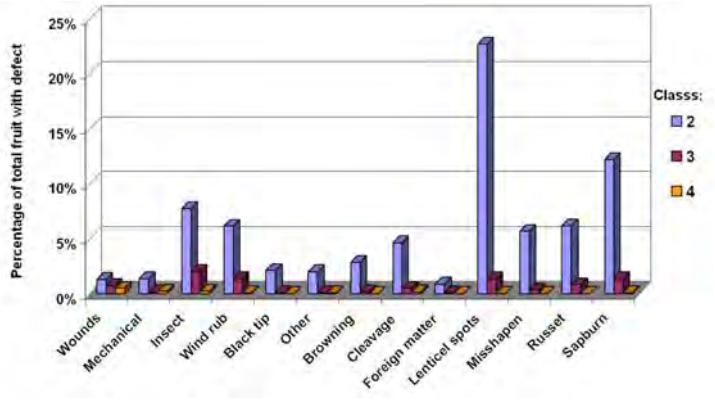
Project Status: Completed.

A mango defect analysis study was conducted on 15 mango samples from Darwin, 16 samples from Katherine and four samples from Kununurra during the 2011 mango season. The purpose was to determine the major defects associated with mangoes produced in northern Australia and check if such defects were consistent across these three regions. It was a continuation of similar studies carried out in the previous two years. Kensington Pride, Calypso, Honey Gold, R2E2 and three new varieties (1243, 1201 and 4069) were sampled. Randomly, 110 mangoes were washed and treated with fungicide before grading. They were then held at between 21 and 23 °C before each was assessed individually for each type of defect.

Below left: Lenticel spots

Below right: Percentage of defects

***Bottom right*:** Sap-burn



Research Outputs

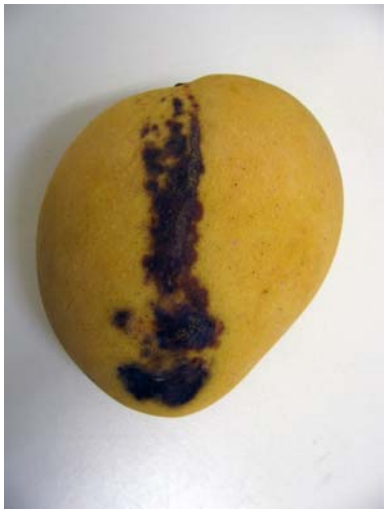
There was a relatively large variation in defects. The most prominent defects were lenticel spotting, sap-burn, mechanical and insect damage, especially by caterpillars, leafhoppers, plant hoppers, and thrips.

Conclusions

Lenticel spots and sap-burn are major causes of defects in mangoes in northern Australia.

Recommendations

More research is needed to further assess the factors that cause common and consistent defects in mangoes in northern Australia and ways to control them.



3.10 Systemic Insecticides for Managing Sap-sucking Insect Pests in Mangoes (part of the ACIAR project "Quality management to enhance effective supply chains for mangoes and rambutans in Nusa Tenggara Barat (NTB), Indonesia and Australia")

Contact: Sohail Qureshi – Quality Management Specialist

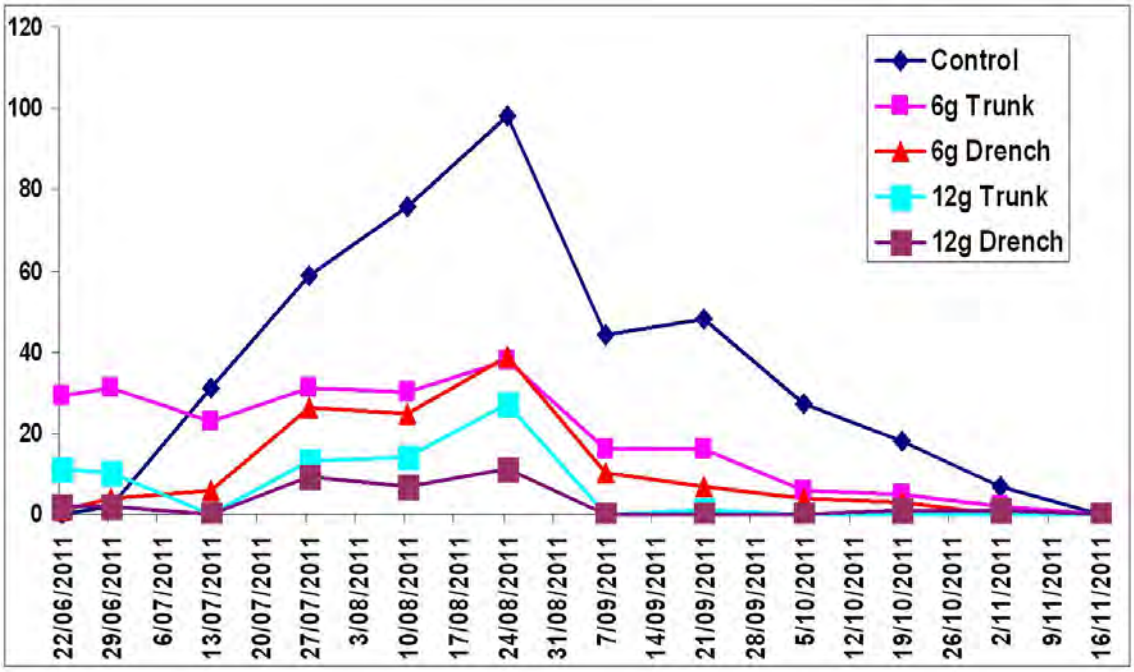
Project Status: Completed.

Mango leafhoppers, (*Idioscopus nitidulus*), have been present in the Darwin area for some time. They were first discovered here in 1997. While they can be controlled with insecticide sprays, there is a risk that they will develop resistance to these sprays as they have done overseas. It is therefore beneficial to extend the range of chemical groups that can be used. The aim of this trial was to test the effect of the systemic insecticides thiamethoxam (Actara) and imidacloprid (Confidor®) to control mango leafhoppers, mango plant hoppers and other sap-sucking insects. The final two trials were conducted in 2011-12.

Below: Populations of mango leafhopper nymphs

Next page left: Heavy infestation of mango leafhopper nymphs on mango flowers

***Next page right*:** Damage to mango flowers by mango leafhopper



Research Outputs

The study confirmed that Actara applied at 12 g/tree (3 g ai thiomethoxam) as either a soil drench or applied to the tree trunk provided a significantly better control of mango leaf hoppers compared with untreated trees.

The application of Actara at 12 g/trees (3 g ai thiomethoxam) as a soil drench at 120, 90, 60 and 30 days pre-harvest indicated that it should be possible to reduce the current withholding period from 120 days to 30 days. Even at 30 days, the residue levels in the fruit were very low and well within the maximum residue limit for mangoes.

Trials to control mango leafhoppers with thiomethoxam were not very successful in Indonesia since no irrigation was applied to carry the chemical into the soil from where it can be taken up by the roots.

Research Outputs (cont.)

Conclusions

Thiamethoxam at 12 g/tree of Actara (equivalent to 3 g ai/tree) by soil drench, in a litre of water gives good control of mango leafhoppers and other sucking pests of mangoes.

Residue data indicates that the current withholding period of 120 days (APVMA permit PER12637 for mango seed weevil and 6 g/tree of Actara) could be reduced to 30 days and the rate increased to 12 g/tree of Actara.

Recommendations

It is recommended that the Australian Mango Industry Association use these results to justify an extension of the Minor Use permit for seed weevils to also include mango leaf hoppers and other sucking insects. The rate can be increased from 6 g/tree of Actara to 12 g/tree and the withholding period can be reduced from 120 days to 30 days.

3.11 Smart Forests Alliance Queensland

Contact: Don Reilly – Forestry Research Officer

Project Status: Completed.

The Smart Forests Alliance Project has used world-leading biotechnology to accelerate production of fast growing trees for the forest plantation industry in marginal tropical and sub-tropical environments.

The project has discovered gene markers that can predict growth and wood quality at an early age in existing tropical and subtropical trees to enable the identification of high quality hardwood timber trees.

Discussions have focused on the two new techniques developed for large-scale *in vitro* (laboratory based) propagation of Corymbia hybrids and African mahogany.

The technology allows the production of tens of millions of Corymbia plantlets from a single seed in less than a year; similarly, it allows the production of tens of thousands of African mahogany plantlets from a single seed in the same time frame.

The floral biology of African mahogany has been investigated to gain an understanding of male/female ratios in flower panicles, pollen production and viability, and in initiating controlled pollination techniques.

The collaborative project also involves the assessment of environmental benefits, such as carbon sequestration and the identification of plantations with low risk of genetic pollution into native forests.

Research Outputs

A number of papers published in collaboration with the industry and the progress made by the Queensland/Northern Territory governments' breeding program have led to a better understanding of African mahogany's genetic material, which is being deployed to generate new plantings.

A better understanding has been gained of the floral biology of African mahogany through the collection and application of pollen from one tree to another (controlled pollination).

A methodology has been developed to mass-produce African mahogany plantlets in vitro from a single embryo.

'Markers' have been identified for DNA sequencing of various African mahogany provenances.

Conclusions

New technologies are now available for the industry and tree breeders to improve plantation-grown African mahogany,

Wood property determinations of younger age African mahogany are now available to help predict veneer and solid wood properties of mature age trees.

Recommendations

The industry can utilise the findings and the new technologies for collaborative genetic improvement.

3.12 Strategies for Using Floriculture to improve Livelihoods in Indigenous Australian and Pacific Island Communities

Contact: Doris Marcsik – Research Horticulturist

Project Status: Continuing.

The aim of this project is to develop and evaluate strategies for improving Indigenous livelihoods through the development of floricultural activities and enterprises. To achieve the project's aim, there are three project objectives: (1)To characterise under-realised and novel floriculture business potential by analysing enterprise and associated value chain arrangements and opportunities for improving livelihoods, (2)To provide new and improved product and practices to nascent floriculture enterprises, fostering their evaluation and adoption and (3)To strengthen floriculture enterprises by building horticulture and business skills, and foster a positive environment for their development. These objectives will be addressed through and across a series of five 'case studies' with different partners in different locations, different value chain relationships and levels of floriculture technology, each with its own case study-level objectives. The Department of Primary Industry and Fisheries (DPIF) will work on specific case studies under objective 2 for the commercial development of the unique Northern Territory endemic flora and further advancement of the existing cut-flower industry based on heliconias and gingers. This is an ACIAR-funded project led by the University of Queensland.

Below left: Plant Industries and Aboriginal Bush Traders staff conducting post-harvest studies on cycad fronds

Below right: Flower market in Honiara, Solomon Islands

Research Outputs

Post-harvest studies have commenced on bush-harvested *Cycas armstrongii* fronds to determine baseline post-harvest conditions for exporting fronds interstate. Preliminary findings indicate that fronds stored for three days at 4 °C and covered with plastic sleeves still had an acceptable vase-life of up to 10 days from harvest.

Research work on ornamental ginger nutrition and native plant propagation techniques was commenced in June 2012.

3.13 Development of a National Diagnostic Protocol for Mango Malformation Disease (MMD) (with Lucy Tran-Nguyen)

Contact: Andrew Daly – Plant Pathologist

Project Status: Continuing.

This project aims to extend our knowledge of MMD, including the potential for different Fusarium species associated with mango buds to be genuine causal agents of MMD. This includes learning efficient techniques for successful pathogenicity testing to demonstrate that *Fusarium* sp. nov., which has been detected in the Northern Territory (NT), is a causal agent, learn efficient detection and isolation methods and ascertain molecular techniques currently used at the University of Florida, observe the symptom expression (range) and impact of the disease according to agro ecological conditions, better understand the disease epidemiology and resultant effective field control techniques that are being employed in Florida and establish linkages with American researchers for future collaborative projects.

Below left: Malformation of Tommy Atkins inflorescence caused by *Fusarium mangiferae*

Below right: Malformation of a Tommy Atkins vegetative shoot caused by glyphosate

Research Outputs

Training was completed at the University of Florida's Tropical Research and Education Centre (TREC), Homestead, Florida with Dr Randy Ploetz. *Fusarium mangiferae* is the only known causal agent of MMD in South Florida. Similar to the NT, the disease is present in Florida, but at a low impact level and does not seem to be a serious production issue. A number of malformation symptoms were observed in the field (Figures 1 and 2) where the disease incidence had increased ten-fold since the previous season. This may have been caused by commercial mechanical hedging, which will be important in the NT, since contract hedging with this type of machinery, is widespread in the industry and may have implications for disease management. In addition, MMD symptoms can be described as typical and atypical, where atypical symptomatology can be associated with management practices (such as the use of paclobutrazol and herbicide) and nutritional deficiencies. Molecular techniques were exchanged between NT researchers and TREC staff to improve the detection of the pathogen from direct tissue material.

3.14 Linking Rambutan Phenology and Key Economic Germplasm for Improved Production

Contact: Mark Hoult – Senior Horticulturist

Project Status: Continuing.

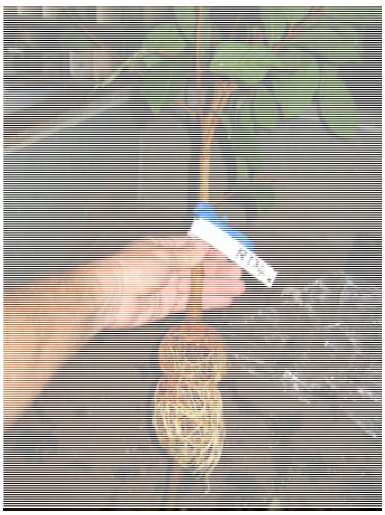
Two core elements are central to this project namely, the *Nephelium* germplasm and propagation. The *Nephelium* genus is the most extensive of the economic fruit genera within the Sapindaceae family and represents a valuable resource for further development of rambutan. A review of the genera complements the consolidation of known germplasm currently within Australia and targeted sourcing and introduction of other species from overseas collections. This will allow for a subsequent evaluation of this resource as potential propagules in the development of unique scion and stock combinations and provide secure germplasm for future breeding and gene marker work. Concurrent with this will be a propagation evaluation in which germination, vegetative (i.e. clonal cuttings) and graft compatibility studies will be undertaken. This will form the basis for field plantings of unique stock/scion combinations aimed at developing novel, high- density orchard systems with resilience to potential climate change events, such as heightened storm and cyclone activity in north Australia.

Below: Marcott at 11 weeks from preparation

***Next page*:** Cuttings of" Binjai" cultivar

Research Outputs

Germplasm and taxonomic linkages to *Nephelium*



Researchers of the Sapindaceae family have only recently found some consensus about its structure and systematics after several studies, including pollen morphology, phyto-chemistry and molecular sequence data. The Nephelieae tribe within the Sapindaceae family includes the key focal genus for this project, *Nephelium* (rambutan, pulasan etc.), along with other important horticultural genera, such as *Dimocarpus* (longan), *Litchi* (lychee) and *Pometia* (Tuan, Fiji longan). Some studies have also aligned the *Blighia* genus (Akee) in to Nephelieae; however, this is still a rather contentious association. The botanical linkage within the family is of importance for future propagation studies and allows the project to refine the selection of other genera warranting a graft compatibility study. The most promising closely associated genus to *Nephelium* is the genus *Pommetia* and there is some justification in its inclusion for graft compatibility studies with Nephelium, given their close botanical association.

The comprehensive study on wood anatomy of the Sapindaceae family by Klaassen (1999) may prove a valuable resource in early identification of graft compatibilities and/or incompatibilities for inter- and intra-generic grafts. Similarity in wood anatomy components, such as paratracheal parenchyma and inter vessel pitting, may indicate better graft wound bridging, hence compatibility, between species and/or genera. The review of the *Nephelium* genus by Leenhouts (1986) and subsequent work on the Borneo species by Adema, Leenhouts and van Welzen (1996) represent the most valuable treatments of the genus. There are 22 species in total, with 15 found in Borneo, of which, Leenhouts identified six new unnamed species and subdivided *Nephelium cuspidatum*, giant rambutan, into six varieties and four sub-varieties and *Nephelium lappaceum*, the rambutan, into three botanical varieties.

Research Outputs (cont.)

AQIS records up to 1995 show 131 clonal introductions into Australia of *Nephelium lappaceum* “Rambutan”, all of which were released from post-entry quarantine. This comprised 48 named cultivars. There were also eight introductions of *Nephelium ramboutan-ake* “Pulasan” comprising six named cultivars. Records of introductions post-1995 are currently not available. Important collections are maintained in Indonesia (Bogor Botanic Gardens) and in Hawaii (USDA Hilo Station).

Propagation studies

Preliminary investigations of cutting production (standard semi-hardened terminal shoots at Berrimah Research Farm (BRF)) have yielded disappointing results with less than 5% root initiation. Physiologically, cutting material has responded to varying auxin treatments with more than 90% of material developing rapid callus; however, root initiation has been very poor. Marcottage has been far more successful with up to 100% recovery of field placed marcotts. More advanced methods are being implemented, such as blanching and etiolation in combination with basal heating of cutting media and various auxin forms and rates.

Germination and seedling studies have confirmed that rambutan is a classic recalcitrant seed and a “seed held in whole fruit by time” study revealed that the seed maintains viability for no more than two weeks and supports anecdotal industry observations. Seed weight and seedling growth data have highlighted variability within open-pollinated seedling populations derived from a) mixed pollen sources - cultivar collection block with multiple pollen sources compared with b)seed derived from a single out-of-season flowering maternal cultivar, that is, potentially self-pollinated seed source and c)seed from a commercial block of a single cultivar. Overseas researchers have suggested that rambutan may have the capacity for apomictic seed development. Pollen source by seed development may warrant further investigation.

3.15 Studies on Pheromones of Mango Fruit Borers and Red-banded Mango Caterpillars

Contact: Brian Thistleton – Principal Entomologist

Project Status: Continuing.

Below left: Mango fruit borer larva Darwin

Below right: Red-banded mango caterpillar Indonesia

The mango fruit borer is the caterpillar of a small moth, *Citripestis eutraphera* (Lepidoptera: Pyralidae), which bores into mango fruit. The insect was originally described from Indonesia and was first discovered in the Northern Territory in 2008. Surveys in 2009 showed that the pest is widespread but at low frequency in the Darwin and Katherine regions. The red-banded mango caterpillar (RBMC) causes a similar damage and is also found in Indonesia and in Cape York where it is under quarantine control. Both moths are candidates for monitoring and control with synthetic sex pheromones. A sex pheromone has already been developed for RBMC in Queensland and has been tested by the Department of Agriculture and Food, Western Australia (DAFWA) and the Department of Primary Industry and Fisheries (DPIF) in Java and Lombok, respectively. DPIF is collaborating with the New Zealand Institute for Plant and Food Research Limited to develop a pheromone for mango fruit borer.

Research Outputs

The initial pheromone blends used in Lombok to catch moths of the mango fruit borer were not successful. Further refinement is required. The New Zealand Institute for Plant and Food Research Limited has identified another component from the pheromone extract, which will be included in a new trial.

The use of the RBMC pheromone in Java and Lombok has also been unsuccessful. The pheromones from DAFWA have been sent to Queensland for testing on the RBMC populations there to determine if the Queensland and Indonesian populations of the moth are reacting to the pheromone differently.

3.16 Reducing Greenhouse Gas Emissions through Improved Nitrogen Management on Northern Territory Farms

Contact: Stuart Smith – Senior Research Officer, Sustainable Production

Project Status: Commenced.

The project aims to trial and demonstrate on-farm practices/technologies to reduce agricultural greenhouse gas emission by reducing nitrous oxide emissions through better understanding and management of inorganic nitrogen (N) in the vegetable, melon and hay industries in the wet/dry tropics. In addition, it addresses the priority of increasing carbon stored in the soil with the use of green manure/cover and legume crops.

For vegetable and melon crops, the project will do this by improving the understanding of N movement during rotations of these crops: in the soil, in soil and water, in emissions to the atmosphere and in conversion to organic forms. Cover crop trials will investigate the best way to trap N to minimise nitrous oxide emissions throughout the wet season. Legume cover crops will be included in this trial to determine whether N fixed from the atmosphere over the wet season is a sufficient substitute for applied N fertilisers in subsequent melon or vegetable crops. The impact of non-leguminous cover crop species on converting non-utilised N fertiliser from the previous season's melon or vegetable crop into organic forms will also be measured. Regular soil and plant sap testing for N will also be demonstrated as a management tool to maximise N use efficiency in vegetables and melons. Plant growth promoting rhizobacteria, which contain free living N fixers, will also be trialled as a way to reduce reliance on artificial N sources. All these practices have the potential to lower nitrous oxide emissions, which will be directly tested as part of the project. In addition, cover and green manure crops are a proven method for increasing soil carbon.

In hay crops, new enhanced efficiency fertilisers will be demonstrated and tested, and nitrous oxide emissions will be recorded. The role of legumes in the rotation will also be assessed.

Hay growers will be intimately associated with these demonstration trials to improve their understanding and uptake of this new technology to lower nitrous oxide emissions.

3.17 Rice Production Systems for the Northern Territory (NT)

Contact: Rowena Eastick – Research Scientist

Project Status: Commenced.

Renewed interest in rice production in the NT commenced in 2009. A collaborative project with SunRice was initiated as a component of the ACIAR Project CSE/2009/005. The overall aim of the project is to develop rice production in the NT through enhanced germplasm selection and commercially viable agronomic practices for sustainable farming systems.

Field experiments were conducted at the Katherine Research Station (KRS) and the Coastal Plains Research Station (CPRS) over the 2011 dry season and the 2011-12 wet season, respectively to evaluate cultivars under upland conditions. Field experiments were conducted at Tortilla Flats over the 2011 and 2012 dry seasons to evaluate lowland-adapted cultivars. A pot trial was also conducted in the shade house during the 2011 dry season at KRS to increase the amount of seed for selected lines.

Below left: Lowland variety assessment at Tortilla Flats in the 2011 dry season demonstrating different times to harvest maturity

***Bottom right*:** Harvesting the 2012 wet season upland rice varieties at Coastal Plains Research Station

Next page: (Table) Grain yield, stover yield and harvest maturity indicated by days after sowing (DAS) for rice cultivars assessed at Tortilla Flats and KRS over the 2011 dry season (DS).

Research Outputs

Data is presented for the Tortilla Flats and KRS 2011 dry season field experiments (see Table).

Data for the CPRS 2011-12 wet season experiment is currently being analysed.

The field experiment crop at Tortilla Flats for the 2012 dry season is currently approaching maturity and will be harvested in October-November.

Research Outputs (cont.)

Tortilla DS Sown 31 May 2011 Harvested 10-31 October 2011				Katherine DS Sown 18 May 2011 Harvested 25 Oct – 28 Nov 2011			
Cultivar	**Grain yield (kg/ha)**	**Stover yield (kg/ha)**	**DAS**	**Cultivar**	**Grain yield (kg/ha)**	**Stover yield (kg/ha)**	**DAS**
Langi	6667	4792	141	Vandana	1735	2497	160
IR64	***6889***	***5917***	***146***	**NTR426**	**2880**	**2259**	**194**
Doongara	7167	5889	133	Azucena	3095	4080	175
PW7[#]	7167	8139	142	***IR64***	***3168***	***2580***	***176***
Lemont	7611	5500	138	Lemont	3194	2049	182
Fin	7778	6389	147	PSBRC9	3228	2312	181
NTR426	**8000**	**8667**	**147**	Takanari	3298	1903	175
Viet1	8278	8639	150	Tachiminori	3465	3288	168
NTR587	8417	6375	153	Yunlu29	3892	3872	162
Viet5	8833	7500	148	B6144FMR6	3961	2578	179
IR72	8889	7056	149				
Kyeema	8917	6792	140				
Quest	9611	5806	133				
Illabong	9722	6361	140				
Viet4	11167	6167	143				
LSD (5%)	4443	3413	3		1389	1142	2.59

3.18 Evaluating New Mango Scions and Stocks

Contact: Mark Hoult – Senior Horticulturist

Project Status: Commenced.

Mangoes are a significant horticultural commodity in the Northern Territory (NT) with a gross value of production of $46 million in 2009. The industry and the NT Government contribute substantial resources towards research activities in mango production. The activities are guided, in part, by the Australian Mango Industry Strategic Plan 2010-15, the Department of Primary Industry and Fisheries' Agribusiness Strategy 2011-15 and regionally through the NT Mango Industry Association, which has identified mango stock and scion development as a key initiative. Trial 1 of this new program was established at the Katherine Research Station in July 2012 as an RCB design with three new scions from the National Mango Breeding Project and two industry standard scions in combination with five advanced rootstocks and one industry standard stock. There are six single datum tree replications of 30 (five scions by six stocks) stock scion treatments.

Below left: Screen house with 3000 advanced seedlings of less than 70 stock accessions

Below right: New mango germplasm initiative-Trial 1 KRS, July 2012

3.19 Optimisation of Date Pollination

Contact: Contact: Vivek Bhat – Research Horticulturist

Project Status: Commenced.

The aims of the project are to work with existing date palm growers in Central Australia to optimise pollen collection and storage to facilitate artificial pollination. Pollen will then be used to identify optimal timing of pollination and pollen parents for major commercial date cultivars. Different pollen parents are expected to affect fruit size, flesh and seed development, and time to fruit maturation. Techniques for manual pollination and pollen dilution will be described. These results will assist the productivity of existing date farms while enabling optimal use of the extensive germplasm collections that have been assembled with the support of RIRDC. These collections are now at a suitable age to refine these management techniques. These investigations will assist existing growers to improve production techniques while ensuring that future growers will have useful information for selecting appropriate polleniser cultivars.

Research Outputs

The evaluation of pollen collection and polleniser cultivars suitable for major commercial cultivars has commenced.

The evaluation of different methods for manual pollination of date palms, including pollen-filled balloons has commenced.

Experiments have been established to describe the duration of stigma receptivity, pollen dilution and pollen storage.

Below left: Emerging male date flowers

Below right: Manual pollination of dates (Spike gets up close to bag another female spathe)

3.20 Wet Season Nitrogen Management Trial – Maneroo Station, Douglas Daly

Contact: Malcolm Bennett - Agronomist

Project Status: Commenced.

Jarra Finger grass (*Digitaria milanjiana*) and Cavalcade (*Centrosema pascuorum*) are the two most common crops grown for hay production in the Northern Territory. At a hay industry meeting in July 2011, one of the priorities identified was to develop a 'ready reckoner' for nitrogen (N) application in grass hay crops to assess the cost/benefit (both yield and quality) of fertiliser application. A paddock at Maneroo Station was selected to investigate grass-legume rotations and N fertiliser requirements for Jarra Finger grass during the 2011-12 wet season. The experiment measured the contribution of N by the legume (Cavalcade) after a one-year and a two-year period following the Cavalcade. Overlaying a N application rate trial across this area allowed for further assessment of Jarra grass' N requirements and the cost/benefit of N application.

Right: Second year Jarra (photo taken on 22 February 2012)

Research Outputs

A field day was held in April at Maneroo Station in conjunction with the NT Agricultural Association's Caring for Country Project to discuss observations to date.

3.21 An Investigation of Growth Regulators for the Control of Termites

Contact: Brian Thistleton – Principal Entomologist

Project Status: Commenced.

A major chemical company has contracted DPIF to conduct trials of three termite bait and active ingredient candidates against *Coptotermes acinaciformis* and *Mastotermes darwiniensis*. The products are based on insect growth regulators and are potential candidates for the control of these termites in horticultural crops. The research will also provide an increase in knowledge of the biology of these species, which will assist in the development of other control measures.

Research Outputs

The effects of the three termite bait and active ingredients were compared with those of an industry standard growth regulator against *Coptotermes acinaciformis*. Initial results have helped in the development of new techniques to conduct further trials on *Coptotermes acinaciformis* and *Mastotermes darwiniensis* in 2013.

Below left: Opening *Coptotermes* mound to assess effect of termiticide

Below right: *Coptotermes* workers inside mound

3.22 Fusarium wilt of Watermelon

Contact: Lucy Tran-Nguyen – Molecular Scientist

Project Status: Commenced.

Fusarium wilt is one of the most severe diseases in watermelons and is caused by a fungus called *Fusarium oxysporum* f. sp. *niveum* (*Fon*). This strain is only pathogenic on watermelons and can be divided into four races (0, 1, 2 and 3). The disease is one of the major yield- limiting factors in production, worldwide. *Fon* was first detected in the Northern Territory (NT) in May 2011. The disease affected three different varieties of watermelon seedlings and plants from six different locations. Symptoms included leaf necrosis and death of seedlings in seedling trays, wilting and vine collapse in the field (Figures 1 and 2). To date, two of the races have been detected in Australia. However, there is limited published information about the Australian *Fon* races. It is unclear what race the NT *Fon* strain is, whether it is a new race and its level of aggressiveness.

Below left: Watermelon field sample displaying vascular colouring (cross section)

***Below right*:** Watermelon seedling which has been inoculated with *Fusarium oxysporum* f.sp. *niveum*

Research Outputs

Fusarium oxysporum f. sp. *niveum* was identified to be the causal agent of the watermelon Fusarium wilt in the NT. The finding was confirmed by pathogenicity trials and molecular testing. As a consequence of the initial detection, a Horticulture Australia Limited proposal was submitted in early 2012 for a three year project entitled “Characterisation and management of Fusarium wilt of watermelon”.

3.23 Investigate Closed Production Systems for Ornamental Ginger Production

Contact: Doris Marcsik – Research Horticulturist

Project Status: Commenced.

The major focus of this project is to investigate and develop baseline production protocols for growing new varieties of ornamental ginger flowers in a closed system. A collection of new Curcuma accessions and inter-specific Zingiber hybrids developed by DPIF have been identified as ideal candidates to trial in this closed production system. Pilot trials will be conducted in pots and in the ground to investigate and develop systems for rhizome storage and production, and optimum environmental conditions to control growth and flowering of these gingers. In addition, optimum nutritional requirements will also be determined to produce uniform, high-quality ginger flowers. The results from these pilot trials will then be transferred to on-farm trials to test these closed production techniques in a commercial setting. This work will provide north Australian growers with increased knowledge and capacity on production techniques and protocols for growing Curcumas and Zingibers in a closed system for cut-flowers or potted colour. It will increase product availability and production efficiency by controlling growth and flowering. It will also provide growers with new Curcuma flowering products. This project is funded by RIRDC.

Above left: Flowering hybrid ornamental Zingiber

Above right: Flowering hybrid Curcuma

3.24 Systems Approach to Eliminate Post-harvest Disinfestation of Katherine Mangoes against Fruit Flies

Contact: Austin McLennan – Senior Entomologist

Project Status: Commenced.

The study aims to test assumptions that untreated mangoes harvested at the hard green mature stage have a very low to no risk of containing live fruit fly larvae. If this risk could be shown to be virtually absent, it would be possible to eliminate the need for post-harvest disinfestation of mangoes destined to international and domestic markets. To obtain a measure of the potential for mangoes to be infested, populations of two tropical pest fruit flies (*Bactrocera tryoni* and *B. jarvisi*) were monitored around orchards in the study area using traps baited with male lures. To determine background levels of fruit fly infestation under the current production system, large numbers of commercially harvested and untreated mangoes were collected and assessed for the presence of fruit fly larvae.

Below: Cutting and inspecting mangoes for the presence of fruit fly larvae

Below right: Collecting commercially-harvested B74 mangoes for fruit fly assessment

Research Outputs

Trapping studies showed that none of the four production zones studied in the Katherine/Mataranka region currently qualify for area of low pest prevalence status, especially due to the large peaks of *B. jarvisi* flies caught at certain times of the year.

Out of 28 073 mangoes assessed across four varieties (Kensington Pride, B74, Honeygold and R2E2), only nine were found to be infested with fruit fly larvae. Of these, eight were determined to be reject class fruit based on either maturity (i.e. they had commenced ripening) or the presence of defects involving broken skin.

The results so far suggest that commercially harvested mangoes at the hard green mature stage of development are extremely unlikely to be infested with fruit fly larvae of either *B. tryoni* or *B. jarvisi*.

External Recognition

The following is a summary of the 2011-12 internal and external awards and invitations to significant meetings and conferences.

Robyn Cowley	Nominated for a DPIF Star Award for the NT Carrying Capacity project. Invited to contribute to the Shruburn datasets by the Australian Centre for Ecological Analysis and Synthesis, Carbon and Nitrogen Dynamics Working Group (one of four agro-ecological trials selected from across Australia). Invited by MLA (travel fund) to attend the PIARN Climate Change Adaptation Masterclass Program in South Australia, the ACT and northern Queensland. Proposed and assisted in the development of a session on fire at the Australian Rangeland Society conference in September 2012. The session reviews Shruburn and other fire trials to synthesise northern Australian fire research to determine best practice fire management in a carbon economy and future research requirements.
Andrew Daly	Participated in a planning workshop for a future ACIAR-funded mango project, Jakarta, September 2011. Participated in a banana plant protection workshop, South Johnstone Research Station, June 2012. Commenced a scoping study of the Cambodian mango industry, Cambodia, June 2012.
Austin McLennan	Invited by the Australian Mango Industry Association to present results of fruit fly infestation study (Ayr and Mareeba, Queensland). Invited to present NT fruit fly research to the ACIAR Policy Advisory Council. Invited to present research results to the National Horticultural Network on NT fruit fly research.
Doris Marcsik	Presented a session on evaluating and selecting new cut-flower cultivars at a Crawford-funded ‘Training-the-Trainer’ workshop in participatory trialling techniques, a part of the ACIAR project ‘Strategies for Using Floriculture to improve Livelihoods in Indigenous Australian and Pacific Island Communities’, Brisbane.
Chris Materne	Member of the Swiftsynd Project team, with Robyn Cowley, Caroline Pettit and Coral Allan, which was nominated for the DPIF 2011 Star Award.
Don Reilly	Invited with D. Nikles to present a paper at the AFG conference in Gympie in October, 2012.

External Recognition

Tim Schatz	Master's degree by research, Charles Darwin University.
	Presented one of the main session papers at the Northern Beef Research Update Conference, Darwin in August 2011.
	Spoke at a senior staff meeting for S. Kidman and Co. Pty Ltd. on NT heifer research in February 2012.
	Spoke at the head stockmen's conference for CPC (Terra Firma) Pastoral Company in April 2012.
Cathy Shilton	Nominated by the crocodile industry for a DPIF Star Award.
Peter Shotton	Made a presentation at Beef 2012, Rockhampton on Leucaena in the NT.
Stuart Smith	Presented a paper on the identification of soil and water resources: "Food for the Territory" at the Australian Soil Symposium in Sydney in April 2012.
	Invited to speak at a carbon farming forum by CSIRO, Darwin, April, 2012.
Lucy Tran-Nguyen	Received the Primary Industries Science Excellence Award for 2010-11.
	Invited to participate in the bacteriology training and annual diagnosticians' workshops.
	Made a presentation at the Fourth International Barcode of Life Conference titled "Using DNA barcoding to identify invertebrates exotic to the Northern Territory, Australia".
	Made a presentation at the Horticultural Australia Limited National Research Network Showcase titled "Checkout barcode – item and price, DNA barcode – species and economic threat".
	Made a presentation at the Banana Plant Protection Workshop titled "Fusarium wilt in the NT".

Staff and Students

Science Staff	Graduate Students
Biosecurity and Product Integrity	
Lorna Melville (OIC, Berrimah Veterinary Laboratories)	
Cathy Shilton (Senior Veterinary Pathologist)	
Plant Industries	
Vivek Bhat (Research Horticulturist)	
Malcolm Bennett (Agronomist)	
Andrew Daly (Pant Pathologist)	Rachel Meldrum – PhD – University of Queensland
Rowena Eastick (Research Scientist)	
Austin McLennan (Senior Entomologist)	
Doris Marcsik (Research Horticulturist)	
Sohail Qureshi (Quality Management Specialist)	
Don Reilly (Forestry Research Officer	
Stuart Smith (Senior Research Officer)	
Brian Thistleton (Principal Entomologist)	
Lucy Tran-Nguyen (Molecular Scientist)	Rachel Meldrum – PhD – University of Queensland
Pastoral Production	
Casey Collier (Pastoral Technical Officer)	
Jocelyn Coventry (Pastoral Production Officer)	
Robyn Cowley (Senior Rangeland Scientist)	
Chris Materne (Pastoral Production Officer)	
Kieren McCosker (Pastoral Production Officer – Beef Cattle)	Whitney Dollemore – Master's in Phosphorus nutrition in beef cattle – University of Queensland
Sally Leigo (Research Leader)	
Barry Lemcke (Principal Beef/Buffalo Research Officer)	
Renee Rippon (Beef Cattle Research Officer)	
Tim Schatz (Principal Pastoral Production Research Officer)	
Peter Shotton (Systems Research Officer/Acting Farm Manager DDRF)	
Dionne Walsh (Rangeland Program Coordinator)	

Research Visitors

Visitor	Affiliation	DPIF Contact
ACIAR Advisory Committee Contingent 23 September 2011.	NT visit.	Rowena Eastick
Dr Robert Barigye	Berrimah Veterinary Laboratories for bovine ephemeral fever research.	Jocelyn Coventry
Chinese Government representatives	Visited a forestry site.	Don Reilly
Peter Clifton	NT Cattlemen's Association, NT Regional Landcare Facilitator	Peter Shotton
Geoff Dickinson	Queensland Department of Agriculture Fisheries and Forestry visited to finalise results and writing up of the reproductive biology and pollination work on African mahogany for the SFAQ project, November 2011.	Doris Marcsik
Tim Driver	Precision Pastoral Pty Ltd for developing a remote livestock management system.	Jocelyn Coventry
Associate Professor Theodore Evans PhD	Department of Biological Sciences, National University of Singapore, July and October 2011, regarding termites	Brian Thistleton
Patrick Gleeson	CSIRO, Canberra, July and October 2011, regarding termites.	Brian Thistleton
Dr Tamara Hartke	ARC Centre of Excellence, Plant Energy Biology, The University of Western Australia, October 2011, regarding termites.	Brian Thistleton
Professor Philip Hugenholtz	Australian Centre for Ecogenomics, August 2011, regarding termites.	Brian Thistleton
International Delegations	Delegations from China, Indonesia and Vietnam were received this year to view buffalo and cattle research.	Barry Lemcke
Dr Lisa Kidd	University of Queensland	Tim Schatz
Scott Kleinsmidt	BASF Australia, August 2011, regarding termites.	Brian Thistleton

Research Visitors

Visitor	Affiliation	DPIF Contact
Alex Lindsay	Queensland Department of Agriculture Fisheries and Forestry, visited to conduct controlled pollination trials on African mahogany as part of the Smart Forest Alliance Queensland (SFAQ) project, August 2011.	Doris Marcsik
Professor Michael McGowan	Senior Lecturer in Livestock Medicine, School of Veterinary Science, University of Queensland.	Kieren McCosker
Dr Lisa Margonelli	Director, Energy Initiative, New America Foundation, CA, USA, August 2011, regarding termites.	Brian Thistleton
Dr Roberto Marques	Queensland's DAFF	Stuart Smith
Professor John Milne	Rangelands Journal editor, who spent half a day touring Old Man Plains Research Station and discussing the PPMT project and other projects in the CRC-REP.	Sally Leigo
Fergal O'Gara	NT Agricultural Association, Principal Project Officer	Peter Shotton
Professor Dennis Poppi	Professor of Animal Nutrition, School of Agriculture and Food Sciences, University of Queensland.	Kieren McCosker
Dr Simon Quigley	Senior Animal Research Officer at Animal Studies, University of Queensland.	Kieren McCosker/Tim Schatz
SunRice/Rice Research Australia Pty Ltd	NT visit.	Rowena Eastick
Professor Sherrie Wei	Chienkuo University, Taiwan and Prof Daryl Joyce, University of Queensland, visited to conduct a value-chain analysis on bush-harvested *Cycas armstrongii* fronds as cut foliage and using other native plants for floriculture. In addition, meetings were held with Professor Daryl Joyce to discuss the progress of the project on germplasm and native plant work, February 2012.	Doris Marcsik

Research Visitors

Visitor	Affiliation	DPIF Contact
Western Australia Department of Agriculture, Fisheries and Food	NT visit.	Rowena Eastick

Research Service

The following is a summary of science staff participation on significant scientific, industry or policy development committees and editorial boards.

Robyn Cowley	Reviewed two scientific papers for *Rangeland Ecology and Management* and *The International Journal of Animal Biosciences*.
Andrew Daly	Member on the Elsinoe (citrus scab) Scientific Advisory Panel. Member on the HLB – ACP (citrus greening) Taskforce. Member on the Mango Malformation Disease Working Group.
Rowena Eastick	Plant Industry representative on the Weeds Risk Advisory Panel.
Austin McLennan	President of Australasia-Pacific Extension Network
Tim Schatz	Represent the Department of Primary Industry and Fisheries at the North Australia Beef Research Council. A member of the organising committee for the Northern Beef Research Update Conference, Darwin, 2-5 August, 2011. The acting NT representative on the Red Meat Co-investment Committee. Participated in the Cash Cow project's annual meeting In Rockhampton.
Stuart Smith	On the panel that advises the NT Controller of water resources.
Brian Thistleton	The NT representative on the national subcommittee on Plant Health Diagnostic Standards which reports to the Plant Health Committee. Member of the NT Mango Advisory Panel. Served on the national scientific advisory panels for emergency plant pests. Served on the national panels to categorise emergency plant pests for the Emergency Plant Pest Response Deed.
Lucy Tran-Nguyen	A Senior Editor for the *Australasian Plant Disease Notes Journal*. A reviewer for the following scientific journals: *Australasian Plant Pathology, Federation of European Microbiological Societies, Plant Pathology, Plasmid, Journal of Phytopathology, Annals of Applied Biology, Australasian Plant Disease Notes* and *Public Library of Sciences*. A member of the Scientific Advisory Panel for the Department of Agriculture, Fisheries and Forestry. A member of the Mango Malformation Disease Working Group. A member of the National Citrus Pathology Working Group. A member of the National Banana Plant Protection Working Group. The NT's Regional Councillor for the Australasian Plant Pathology Society. Member of the National Citrus Pathology Working Group.

External Linkages

Industry Collaboration – details of specific collaborative industry-focused projects.
Research Collaboration - details of specific collaborative research projects or consortia.

Name	(I) Industry Collaboration / (R) Research Collaboration
Malcolm Bennett	(R) This project was jointly funded by the Department of Primary Industry and Fisheries and the NT Agricultural Association, through their Caring for Country Project, and would not be possible without the generous contribution of the Howie family.
Vivek Bhat	(R) David and Anita Reilly, Gurra Downs, Date Palm Nursery, PO Box 1029, Loxton - South Australia 5333. http://www.gurradowns.com.au/Aboutus.php
Casey Collier	(I) The Barkly Research Advisory Committee secretary. (R) The University of Queensland – Phosphorus trial.
Jocelyn Coventry	(I) The AI program-cooperated by using Droughtmaster stud breeders with the Queensland Department of Agriculture, Fisheries and Forestry. (I) Cooperated with the Alice Springs Pastoral Industry Advisory Committee to promote Meat Standards Australia grading for cattle from the district. (I) Cooperated with the Blatherskite Park Show Committee to display and present Alice Springs cattle for competition. (R) Collaborated with the Droughtmaster Stud Breeders Society, the Sydney University's Veterinary School and the Elizabeth MacArthur Agriculture Institute on cattle genetics. (R) Collaborated with Precision Pastoral Pty Ltd. to develop a remote livestock management system.
Robyn Cowley	(I) Through the Pigeon Hole utilisation trial, collaborated with CSIRO, Heytesbury Beef, DNRETA and the University of Queensland. (R) Contributed Shruburn data to the Australian Centre for Ecological Analysis and Synthesis, Carbon and Nitrogen Dynamics Working Group. (R) Through the Northern Beef Scoping Project, collaborated with CSIRO and the Qld Department of Agriculture, Fisheries and Forestry (DAFF). (R) Through on-farm demonstration of adaptation and mitigation options for climate change across northern Australia, collaborated with CSIRO and the Queensland DAFF. (R) Through developing improved on-ground practices and industry strategies for beef production enterprises across northern Australia to adapt to climate change, collaborated with CSIRO and the Queensland DAFF. (R) Through improved empirical models of cattle growth, reproduction and mortality from native pastures in northern Australia, collaborated with Greg McKeon (Qld Centre for Climate Change Excellence, DERM) and David Mayer (Qld DAFF).

External Linkages

Industry Collaboration – details of specific collaborative industry-focused projects.
Research Collaboration - details of specific collaborative research projects or consortia.

Name	(I) Industry Collaboration / (R) Research Collaboration
Andrew Daly	(I) Collaborating in the ACIAR project on mango quality management to enhance effective supply chains for mangoes and rambutans in Nusa Tenggara Barat (NTB), Indonesia and Australia. (I) Collaborating in the Banana - Plant Protection Program by HAL. (R) Collaborating in the CRC for National Plant Biosecurity.
Whitney Dollemore	(I) Kidman Springs Field Day 2012. (R) University of Queensland/ACIAR – Strawcow. (R) University of Queensland/MLA – Cashcow.
Rowena Eastick	(R) ACIAR / SunRice collaborative rice project.
Sally Leigo	(I) The PPMT project has four contracted industry partners: the North Australia Pastoral Company, the NT Cattlemen's Association, Observant P/L and Precision Pastoral P/L. (I) The project has established an advisory committee made up of nine members from predominantly pastoral properties in the NT, Queensland, South Australia and Western Australia. (I) During the financial year 2011-12 the project engaged with over 20 pastoral properties from the NT, Queensland, South Australia and Western Australia about the proposed research in the project. (I) Presentations were made to the Alice Springs Pastoral Industry Advisory Committee and the Western Queensland Beef Research Committee about the PPMT project. (R) The PPMT project has five contracted research partners: the NT Department of Primary Industry and Fisheries, the Queensland Department of Agriculture, Fisheries and Forestry, the WA Department of Agriculture and Food, the SA Department of Environment, Water and Natural Resources, and The University of New England. (R) In addition, relationships have been established with the Queensland Department of Environment and Resource Management, the University of Adelaide, CSIRO, Meat and Livestock Australia and the University of South Australia.
Barry Lemcke	(I) Participated in an MLA funded overseas cattle export in-country assistance program in Vietnam in 2011-12. (I) Honorary member of the Australian Buffalo Industry Council Board. (I) An associate member of NTBIC. (I) A vice-president for Oceania on the International Buffalo Federation. (R) Involved in discussions with Prof. Michael D'Occhio of the University of Queensland on collaboration in buffalo fertility issues.

External Linkages

Industry Collaboration – details of specific collaborative industry-focused projects.
Research Collaboration - details of specific collaborative research projects or consortia.

Name	(I) Industry Collaboration / (R) Research Collaboration
Chris Materne	(I) With the assistance from Dale Jenner, provided carrying capacity estimates for three consultants and the CLC for the preparation of business development plans for five stations in the Alice Springs and Barkly regions. (I) Collated, reviewed and updated previous Department of Primary Industry and Fisheries (DPIF) fire work at Narwietooma Station to capture an evidence-based view of Chris Connellan's use of fire as a pasture management tool. (R) Represented the DPIF for the Alice Springs and Barkly regions on the NT Weed Risk Assessment Committee.
Kieren McCosker	(I) Attended a senior staff meeting of S. Kidman and Co. Pty Ltd. (I) Attended meetings of the Katherine Pastoral Industry Advisory Committee. (R) The manager of the $2.3 million CashCow project, which is funded by MLA. This project is a joint collaboration across northern Australia between DPIF, the University of Queensland, the Queensland DAFF, QAAFI, AusVet Pty Ltd., Outcross Performance Pty Ltd., Chinchilla Veterinary Services, 78 commercial properties, 23 veterinarians and 35 field data collectors. (R) A collaborating scientist in the $1.6 million ACIAR project, StrawCow. It is being conducted in several villages throughout Indonesia and at the Katherine Research Station. Other collaborators in this project are the University of Queensland and QAAFI.
Austin McLennan	(R) Member of GRDC's National Invertebrate Pest Initiative network.
Lorna Melville	(I) The management and staff of Porosus Pty Ltd are thanked for providing the hatchlings for the cell line development, collecting samples from the sentinel crocodiles, submitting diseased crocodiles for necropsy and virology, and collecting blood samples from slaughtered crocodiles. (R) The investigation of endogenous retroviruses was conducted at the Faculty of Veterinary Science, University of Sydney. (R) The Faculty of Veterinary Science, Murdoch University, conducted the herpesvirus and adenovirus PCR and sequencing to confirm a relationship with known herpesviruses. (R) The staff of the Electron Microscopy Unit at the Australian Animal Health Laboratory conducted the EMs to identify the viruses as herpesvirus and adenovirus.

External Linkages

Industry Collaboration – details of specific collaborative industry-focused projects.
Research Collaboration - details of specific collaborative research projects or consortia.

Name	(I) Industry Collaboration / (R) Research Collaboration
Tim Schatz	(I) A presenter in the Katherine breeder fertility course to industry participants in March, 2012. (I) Presented a session on data recording to participants at the CPC (Terra Firma) head stockmen's conference in April, 2012. (I) Presented a talk on fertility research to AA Co. managers at a senior staff conference in May, 2012. (I) The Department of Primary Industry and Fisheries' representative on the North Australia Beef Research Council and participated in regional beef research committees, such as KPIAC, BRAC, and ASPIAC. (I) Collaborated with the manager of Brunchilly Station to implement the Phosphorous trial. (R) Project leader for the collaborative Phosphorus project with the University of Queensland. (R) Participated in an ACIAR-funded scoping study in collaboration with James Cook University to develop a project to reduce calf losses in West Timor.
Peter Shotton	(R) Collaborated in a project with the Queensland Alliance for Agriculture and Food Innovation titled "Diet selected and growth of steers grazing *Leucaena leucocephala* - grass pastures in a seasonally dry tropical environment" to be presented at the International Grasslands Congress in September, 2013.
Stuart Smith	(I) The project "Addressing Product Quality and Safety with LOTE (Language other than English) Growers of Vegetables" was funded through Horticulture Australia Limited and was endorsed by Ausveg. (R) Collaborating with Queensland's Department of Agriculture, Fisheries and Forestry (DAFF) in the Calypso mango project. (R) Collaborating with Charles Darwin University on the project "Reducing Greenhouse Gas Emissions through Improved Nitrogen Management on Northern Territory Farms"

External Linkages

Industry Collaboration – details of specific collaborative industry-focused projects.
Research Collaboration - details of specific collaborative research projects or consortia.

Name	(I) Industry Collaboration / (R) Research Collaboration
Brian Thistleton	(I) Collaborating with BASF on the control of termites with growth regulators. (I) Collaborating with NTMIA on mango research. (R) Collaborating with the Australian Forest Research Company on termite research. (R) Collaborating with Dr Tamara Hartke, ARC Centre of Excellence, Plant Energy Biology, The University of Western Australia on termite research. (R) Collaborating with the WA Department of Agriculture and Food on mango research in Australia and Indonesia. (R) Collaborating with the University of Mataram, Balai Pengkajian Teknologi Pertanian (BPTP) Assessment Institute for Agriculture Technology (AIAT) in Nusa Tenggara Barat (NTB) and Dinas Pertanian Provinsi, Nusa Tenggara Barat (NTB) on mango research (ACIAR project). (R) Collaborating with the New Zealand Institute for Plant and Food Research Limited on pheromone research for several species of moths. (R) Collaborating with NAQS (DAFF) and Solomon Islands Agricultural Quarantine Service on cocoa pod borer research. (R) Collaborating with Michael Braby, Biodiversity Conservation, Department of Land Resource Management on the exotic Tawny Coster butterfly (Acraea terpsicore).
Lucy Tran-Nguyen	(I) Mangoes - Improve identification of *Fusarium* species associated with mango malformation disease and identify mango anthracnose. (I) Melons - Molecular identification of *Fusarium oxysporum* f.sp. *niveum*, which causes Fusarium wilt in seedless watermelon seedlings. (I) Bananas - Expand knowledge of *Fusarium oxysporum* f.sp. *cubense*. (R) CRC for National Plant Biosecurity. (R) Australian Centre for International Agricultural Research.

External Linkages

Industry Collaboration – details of specific collaborative industry-focused projects.
Research Collaboration - details of specific collaborative research projects or consortia.

Name	(I) Industry Collaboration / (R) Research Collaboration
Dionne Walsh	(I) The spelling and stocking rate demonstration trial at Alexandria Station is a collaborative project between the North Australian Pastoral Company, DPIF and the Australian Government.
	(I) The prescribed burning and spelling demonstration trial at Delamere Station is a collaborative project between the Australian Agricultural Company, DPIF, Team Savannah, Greening Australia and the Australian Government.
	(I) The spelling, stocking rate and infrastructure development demonstration trial at Beetaloo-Mungabroom Station is a collaborative project between the Dunnicliff and Armstrong families, DPIF, the Barkly Land Care and Conservation Association, NRETAS and the Australian Government.
	(I) The benchmarking and on-ground option testing demonstration at Limbunya Station is a collaborative project between Limbunya Station, DPIF and the Australian Government.
	(R) The NT project manager for two large, multi-state collaborative projects between Meat and Livestock Australia, DPIF, Queensland DAFF, WA Agriculture and Food, CSIRO and the Australian Government.
	(R) The DPIF representative on the multi-state “Rubber Bush Scientific Advisory Committee” which includes members of the NT & Queensland pastoral industry, Charles Darwin University, Queensland DAFF and NRETAS.

Overseas Travel

Date	Destination(s)	Officer(s)	Outcomes
July 2011	Jakarta, Indonesia	Richard Galton	Live export trade discussions
	Timor Leste	Lorna Melville and Neville Hunt	Met with Ministry of Agriculture and Fisheries (MAF) and Food Agriculture Organisation staff to assess training needs for staff of the MAF Veterinary laboratory.
	Honiara, Solomon Islands	Doris Marscik	Exchange and provide new germplasm and improved cultivars of cut flowers and delivery of two floriculture training workshops within an approved Australian Centre for International Agricultural Research project.
August 2011	Hai Phong, Vietnam	David Ffoulkes	Import facilities were assessed and improvements recommended for the holding ground, feedlot and slaughterhouse. Standard operating procedures were developed with Importer's staff.
	Hong Kong - Hanoi - Ho Chin Min City	Rod Gobbey	Oversee the first shipment of live export of cattle to Vietnam; ensuring animal welfare standards were met.
September 2011	Hai Phong and M'Drak, Vietnam	David Ffoulkes and Barry Lemcke	All cattle were unloaded safely and the feeding operation was improved to a satisfactory level for weight gain at Hai Phong port receival at the holding facility.
	Jakata, Indonesia	Bob Williams, Brian Thistleton and Andrew Daly	New ACIAR project related to the development and implementation of full chain analysis program in Indonesia. Also conducted work for two ACIAR projects on mango and papaya mealy bug.
	South East Asia	Scott Wauchope	Strengthened existing relations between the NT government and industry with the government and industry in countries importing NT live cattle.

Overseas Travel

Date	Destination(s)	Officer(s)	Outcomes
October 2011	Phnom Penh, Cambodia	Bob Williams	Meeting for the new ACIAR mango project. This project will focus on mango production and supply chain and will also complement the proposed mango program being developed in Indonesia.
	Bogor, Indonesia	Brian Thistleton	Papaya Mealy Bug (PMB) training workshop.
November 2011	Nelson New Zealand	Stephen West	Understanding the strategic engagement of the NZ Government and the Kiwi Fruit Industry with their response to a bacterial disease in the Kiwi fruit.
	Jakarta, Indonesia	David Ffoulkes	Beef production using imported Australian cattle in establishing a cattle enterprise in Vietnam
	Hai Phong and Hanoi, Vietnam	Barry Lemcke and David Frost	Resolution of feed trough space issues at feedlot. MLA funded.
	Indonesia	Kieren McCosker	Provide strategic input and technical advice for the management of research sites to improve reproductive performance of cows and performance of fattening cattle in low input systems of Indonesia.
December 2011	Lombok, Indonesia	Sohail Qureshi and Andrew Daly	ACIAR project "Quality Management to Enhance Effective Supply Chains for Mangoes and Rambutan in Nusa Tenggara Barat (NTB), Indonesia and Australia".
February 2012	Hai Phong and Hanoi, Vietnam	David Ffoulkes	Two importers are committed to sourcing NT cattle in appreciation of the technical assistance provided by the NT.

Overseas Travel

Date	Destination(s)	Officer(s)	Outcomes
March 2012	Indonesia	Brian Thistleton and Sohail Qureshi	Final meeting for the ACIAR project Quality Management to Enhance Effective Supply Chains for Mangoes and Rambutan in Nusa Tenggara Barat (NTB), Indonesia and Australia.
April 2012	Miami, USA	Lucy Tran-Nguyen and Andrew Daly	Undertake training as part of the Australian Government Training Scholarship in diagnosing Mango Malformation Disease
	Kupagn, West Timor	Tim Schatz	ACIAR funded scoping study into the issue of high calf loss rates.
May 2012	Brazil and Peru	Cameron McConchie	Study tour organised by the Australian Mango Industry Association to investigate mango flowering manipulation.
	Vietnam	Ben Beumer	Supervise the construction of receival yards at Hai Phong feedlot in Vietnam as part of Technical Services Live Export Program.
	Vietnam	David Ffloulkes	Providing technical services to Vietnamese live cattle importers.
June 2012	Cambodia	Bob Williams, Brian Thistleton, Andrew Daly and Cameron McConchie	Develop a new ACIAR Mango Project in Cambodia.
	China	Bob Williams	Attend the Tropical and Sub-tropical Fruit Conference and Network Assembly.

Seminars and Lectures

Date	Officer	Seminar/Lecture
01 July 2011	Richard Galton	Montara Wellhead Platform incident - What happened and why it occurred
29 July 2011	Tim Schatz	Recent Research to Cost Effectively Improve Heifer Fertility in the NT
26 August 2011	Mark Grubert	Improving Gear Selectivity in Australian Mud Crab Fisheries
30 September 2011	Rachel Meldrum	Banana Fusarium Wilt Tropical Race 4
24 February 2012	David Frost	Will an export abattoir in the Top End affect meat quality and prices in Darwin?
20 April 2012	Brian Thistleton	A Survey of Cocoa Pod Borer in Solomon Islands and Implications for the Northern Territory
29 June 2012	Andrew Tomkins	Developing Interstate Market Access Protocols for Fruit Flies - Starting from the Basics

Publications

Scientific Papers, Peer reviewed and other Publications.

Anderson, S. and Tran-Nguyen, L. (2012). National Diagnostic Protocols for Exotic Moths *Citripestis eutraphera, Chilo auricilius, Chilo infuscatellus, Chilo partellus, Chilo polychrysus, Chilo sacchariphagus, Chilo terrenellus, Deanolis sublimbalis, Scirpophaga excerptalis, Scirpophaga nivella and Orthaga euadrusalis*. http://old.padil.gov.au/pbt/

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