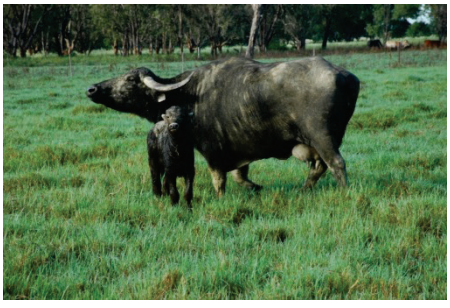
DEPARTMENT OF
PRIMARY INDUSTRY AND RESOURCES

Primary Industries Annual Research Achievements Report 2015-16

Technical Bulletin No: 355
ISSN: 1839-7409



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DEPARTMENT OF PRIMARY INDUSTRY AND RESOURCES

PRIMARY INDUSTRIES

ANNUAL RESEARCH ACHIEVEMENTS REPORT 2015-16

December 2016

Bibliography:

Northern Territory Government (2016). Primary Industries Annual Research Achievements Report 2015-16. Department of Primary Industry and Resources. Technical Bulletin No. 355

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http://www.dpir.nt.gov.au

Technical Bulletin No. 355
ISSN 1839-7409

Contents

About this report

The 2015-16 Annual Research Achievements Report (ARAR) provides a summary of research and development (R&D) activities in primary industries in the Northern Territory (NT) by the Department of Primary Industry and Resources (DPIR), excluding Fisheries, for which there is a separate annual report series now titled The Status of Key Northern Territory Fish Stocks Report, and Mines and Energy. This report covers current and recently completed research in the pastoral and plant industries sectors. It highlights the effort of DPIR's primary industries researchers, through which services are provided to primary producers to improve productivity and profitability.

The Department's Industry Development Plan 2013-17 focuses on profitable and productive primary industries, highlighting the following emerging challenges for R&D among others: provide certainty and security to encourage investment, facilitate continuous improvement in production quantity and quality, expand market options for Territory products, develop and promote a more efficient and environmentally sound production system, promote biosecurity and encourage Indigenous participation. Research project reports in this ARAR address many of these challenges.

The Report contains contributions from Livestock Industries Development, Plant Industries Development and Market Enterprise Development, which are part of the Primary Industry Economic Development Group.

The NT's primary industries sector is involved in pastoral, crop and horticultural production. The main products include beef cattle raised mostly on native pastures, buffalo, crocodiles, field crops, improved pasture, hay, seeds, forestry products, mangoes, melons, vegetables and flowers.

The primary industries sector in the NT has significant links with other sectors of the local economy and contributes to manufacturing, transport, storage and retail, thereby enhancing employment.

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.

Images/photos: Unless otherwise stated, all images and photos are sourced from the lead researcher.

Cover Images	Left: A Composite cow and calf (Source: Barry Lemcke) Centre: Fruit fly (Source: Brian Thistleton) Right: A 20 year old buffalo cow imported from the US in 1996 as a heifer produces her latest calf in 2016 (Source: Barry Lemcke)
Report compilation:	Hassan Bajhau, Jason De Araujo, Tim Schatz, Cameron McConchie and Christine Long

Glossary of abbreviations

ACIAR	Australian Centre for International Agricultural Research
AGBU	Animal Genetics and Breeding Unit
AI	Artificial insemination
a.i.	Active ingredient
ANSTO	Australian Nuclear Science and Technology Organisation
ASPIAC	Alice Springs Pastoral Industry Advisory Committee
AZRI	Arid Zone Research Institute
BF	Berrimah Farm
BHRF	Beatrice Hill Research Farm
BRAC	Barkly Research Advisory Committee
BVL	Berrimah Veterinary Laboratories
CDU	Charles Darwin University
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific Industrial Research Organisation
DDRF	Douglas Daly Research Farm
DPIR	Department of Primary Industry and Resources (NT)
EBVs	Estimated breeding values
F1	First filial generation (the generation of hybrids arising from a first cross (animal genetics))
KPIAC	Katherine Pastoral Industry Advisory Committee
KRS	Katherine Research Station
MLA	Meat and Livestock Australia
MSA	Meat Standards Australia
NABRC	North Australia Beef Research Council
NT	Northern Territory
NTCA	NT Cattlemen's Association
OMPRS	Old Man Plains Research Station
PDS	Producer demonstration site
PD	Pregnancy diagnosis
PPMS	Precision pastoral management system
PPMT	Precision pastoral management tools
QAAFI	Queensland Alliance for Agriculture and Food Innovation
QDAFF	Queensland Department of Agriculture Fisheries and Forestry
QUT	University of Queensland
RCD	Resin canal discolouration
RIRDC	Rural Industries Research and Development Corporation
RLMS	Remote livestock management system
SOC	Soil organic carbon
SRM	Society for Rangeland Management
UNE	University of New England
VRD	Victoria River District
VRRS	Victoria River Research Station

1 Livestock Industries Development

1.1 Does Vaccination Against Clostridial Diseases Reduce Mortality in Calves and Weaners in Northern Beef Herds in the Northern Territory?

Contact: Kieren McCosker – Livestock Industry Development Regional Manager, Katherine
Collaborating staff: Jodie Ward and Jane Douglas.

Reference to DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Commenced.

This study is investigating the economic benefits of a possible reduction in mortality in young cattle following vaccination against clostridial diseases in the Northern Territory. Additionally, data will be collected on mortality rates in recently-weaned cattle managed under commercial conditions. Vaccinations were conducted when 89.3% (range 84.5-96.1%) of study animals were present.

Study animals after mustering

Results

Using a Poisson regression model with adjustment for clustering at the herd level, the main effects castration (yes/no), vaccination (yes/no) and dehorned (poll/dehorned/sinus exposed) were considered in a multivariable model. There was no association between one-shot vaccination of ‘5 in 1’ (p-value 0.83) or dehorning (p-value 0.16) and missing animals. However, preliminary analyses found an association between castration and missing animals ($P < 0.001$).

This study also provided an opportunity to describe the prevalence of dehorning and the prevalence of the frontal caudal sinus being exposed in dehorned animals. After visual appraisal in the branding cradle, 93.4% of study animals were dehorned at the time of branding and ranged between 88.0% and 98.8% in stations.

On average, the sinus was visible on 31.2% of animals after dehorning on four stations where exposed frontal caudal sinuses were recorded.

1.2 'Meating' the Grid with Culled Cows in Northern Australia

Contact: Kieren McCosker – Livestock Industry Development Regional Manager, Katherine
Collaborating staff: Tim Schatz, Grant Hamilton and Bob MacDonald.
External collaborator: Windu Negara*.
* University of Queensland.

Reference to DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Commenced.

The objective of this study is to generate and record biological and economic data to estimate potential economic benefits of feeding different classes of cull cows in feedlots and on floodplains to increase market value based on a grid system to supply a northern abattoir.

Collecting rumen fluid samples (Photo: W. Negara)

Results

A study at Beatrice Hill Research Farm (BHRF) in 2015 to determine the timing of sampling to monitor acute changes in live-weight and differences in rumen microbes following relocation of cattle to floodplains showed that average growth rate in cows grazing floodplain pastures was 0.21 kg/day while that at Victoria River Research Station (VRRS) prior to transport was 0.29 kg/day. This was consistent with current knowledge that cows lose on average 3% (11.8 kg) during transit from VRRS to BHRF. The cows lost a further 1.2 kg (95% CI; -8.7-6.2) between days 0 and 13 and afterwards continually increased in live-weight but average daily gain decreased over time. The highest average daily gain was observed between days 13 and 34 (1.83 kg), which declined to 0.27 kg between days 34 and 61. An average daily gain of 0.04 kg between days 61 and 167 was observed although is likely to be an underestimate due to differences in the fast before weighing.

Changes in live-weight during transition onto floodplains can be attributed to changes in gut content and

potentially have little effect on carcase weight, as cattle previously grazing pastures low in nitrogen can experience decreases in gut content during transition to higher quality pasture (McLean et al. 1983). These findings further highlight the potential misleading nature of using live-weight alone to evaluate cattle performance and the significant confounding effect of gut content. On average, cows gained 48.6 kg over 5.5 months after arriving on the floodplain, which increased their sale value by about $163/cow, due to their heavier weight and an increase in price of $0.25/kg paid by the meat works for heavier cows.

The project has 121 cows grazing on a floodplain at BHRF. Rumen fluid samples have been collected to determine whether rumen microbe populations affect the growth of cows relocated to floodplains.

1.3 An Investigation of Finishing and Pre-trucking Strategies to Maximise Meat Standards Australia (MSA) Compliance for Steer Turn-off to Abattoirs

Contact: Jocelyn Coventry - Pastoral Production Officer
Collaborating staff: Chris Materne, Bryan Gill and Sally Sims.
External collaborators: Dr Peter McGilchrist*, Professor David Pethick* and Dr Cameron Jose*.
* Murdoch University.

Reference to DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Continuing.

A pre-trucking study based on anecdotal industry information is conducted using turn-off of steers to abattoirs to improve pre-trucking management and feeding to comply with MSA grading requirements, including levels of muscle glycogen in steer carcasses. 'Walk-over-weighing' data was collected as steers walked through a remote livestock management system (Precision Pastoral Pty Ltd).

Steers were calmer during the follow-up yard observation period

Easy interaction with humans

Results

Social grouping in paddocks remained strong among steers shortly prior to trucking. Familiarisation with the trucking yards appeared to settle the steers. They became calmer, were less vocal, less milling and sat down more often in the yard. It took less time to lead them to the yard and to form a stable group around humans. It was also observed that after a long-distance transport, there was increased bruising ($\chi 2$ test: $P = 0.06$) in steers in the front pens of trucks. Unknown factors also affected compliance with MSA grading of steers off one truck. The use of electrolytes in the water trough prior to trucking increased water consumption, but a white film on top of the water adversely affected some steers.

Post-mortem muscle glycogen was positively correlated with rib fat and pre-trucking growth rate ($P < 0.05$). Post-mortem examination showed muscle glycogen was significantly lower in carcasses with a higher percentage of Brahman genes ($P < 0.05$) and tended to be lower in heavier carcases ($P = 0.051$). It was speculated that confounding effects of a heavier body weight, a larger frame, together with a 50 to 65% Bos indicus infusion in the 25% Droughtmaster steers may have resulted in lower glycogen storage during growth, higher requirements for maintenance or increased use of glycogen stores in transit.

1.4 Five-in-One Vaccination Producer Demonstration Site

Contact: Jodie Ward – Pastoral Production Officer
Collaborating staff: Kieren McCosker, Jane Douglas and Whitney Dollemore.

Reference to DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Continuing.

While the use of the '5 in 1' vaccine to treat clostridial diseases is common practice in intensive livestock industries and in smaller cattle operations, its adoption has been slow in extensive herds in northern Australia. The Northern Territory Pastoral Industry Survey of 2010 found that only 29%, 15% and 56% of properties in the Katherine, Barkly and Top End regions, respectively vaccinated against clostridial diseases. Reasons for its low use include a perceived lack of benefits and difficulties in applying the recommended dosage. In extensive herds, the number of deaths associated with the processing of young stock is hard to determine as is the ability to monitor animals after vaccination since deceased animals are seldom found and those carcasses that are discovered, are very rarely, if ever, diagnosed as death caused by tetanus infection. The aim of this Producer Demonstration Site is to determine the benefit of using the '5 in 1' vaccine to control tetanus, which is known to cause deaths in young stock following processing.

Calves that participated in the '5 in 1' vaccine trial

Data collecting equipment used in the '5 in 1' vaccine trial

Results

Data is being collected on five properties and will continue until June 2017.

1.5 The Use of Alternative Tropical Breeds Part D: Senepol/Brahman Crossbreeding Trial

Contact: Tim Schatz – Principal Pastoral Production Research Officer
Collaborating staff: Kieren McCosker, Whitney Dollemore, Mark Hearnden, Jack Wheeler and staff at KRS, DDRF and VRRS.

Reference to the DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.
1.3 Expand market options for Territory products.

Project Status: Continuing.

Brahman cattle have a reputation of poor meat tenderness in Australian domestic markets. 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 Northern Territory (NT) conditions and have better meat quality than Brahman cattle. If this happens to be the case, then this strategy would increase marketing options for NT Brahman cattle producers as they could then produce cattle suitable for both the live export and Australian domestic markets. The project is evaluating and comparing the performance of Senepol/Brahman crosses with that of pure Brahman cattle in the northern NT.

A first lactation F1 Senepol heifer and calf (3/4 Senepol) at Manbulloo in February 2014 (Photo: W. Dollemore)

F1 Senepol and Brahman females at the weaning muster at Manbulloo in April 2016

Results

Results of a comparison between the performance of Brahman and F1 Senepol/Brahman steers on pasture in the NT and in feedlots in Queensland and Indonesia have been described in earlier reports. That phase of the project has concluded. In 2015-16, 40 ¼ Senepol steers (bred by crossing F1 Senepol heifers with Brahman bulls) and 138 Brahman steers grazed together at Douglas Daly Research Farm during the post-weaning year. Senepol crosses gained 12.7 kg more than Brahman steers (137.9 vs 125.2 kg).

The performance of F1 Senepol and Brahman heifers is being compared on native pasture in the Katherine area. Pregnancy rates have been 18% higher in F1 Senepol heifers (see details in last year's report).

The performance of first-lactation heifers and older females is being compared on native pasture in the Katherine area. Out of the four year groups of heifers, the last year group weaned their first calves in 2016. Calf mortality (from pregnancy diagnosis to weaning) is shown in Table 1. Pregnancy rates in first-lactation heifers are shown in Table 2.

Table 1. Foetal and calf losses in four year groups of Brahman and F1 Senepol first-calf heifers

Group	#10 (%)	#11 (%)	#12 (%)	#13 (%)
Brahman	17.1	14.9	12.0	11.7
F1 Senepol	3.3	15.0	5.1	7.5
Diff.: F1 Senepol – Brahman	-13.8	0.10	-6.9	-4.2

Table 2. Pregnancy rates in four year groups of Brahman and F1 Senepol first-lactation heifers

Group	#10 (%)	#11 (%)	#12 (%)	#13 (%)
Brahman	26.7	7.0	4.5	15.1
F1 Senepol	46.4	6.0	5.6	6.8
Diff.: F1 Senepol – Brahman	19.7	-1.0	1.1	-8.3

Conditions at Manbulloo and Kumbidgee were quite harsh due to low pasture quality and pregnancy rates were lower in the three year group (#12) that grazed there while calving for the first time compared with the first year group (#10) which grazed at Victoria River Research Station. Although these results have not been statistically analysed, they appear to show that the F1 Senepol females performed at least as well as Brahman heifers in this environment. The longer-term performance will be recorded.

The results indicate that crossbreeding with a tropically-adapted Bos taurus breed, such as the Senepol, may be a profitable way to produce more tender beef and increase marketing options locally and overseas for the northern Australian cattle industry.

1.6 Cell Grazing of Improved Pastures for Increased Beef Production

Contact: Tim Schatz – Principal Pastoral Production Research Officer
Collaborating staff: Peter Shotton, David Ffoulkes, Spud Thomas, Cameron Heeb, Chris Hazel, Rachel Hennessy and other DDRF staff.

Reference to the DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.
1.3 Expand market options for Territory products.
2.1 Develop and promote more efficient and environmentally sound p roduction systems.

Project Status: Continuing.

This project is comparing the effects of set-stocking at the long-term carrying capacity (SSc), set-stocking at a variable stocking rate similar to the effective stocking rate in the cell group (SSv) and cell grazing (CELL) on animal and pasture production and pasture composition at the Douglas Daly Research Farm.

Young weaners join 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 number of animals in the CELL group rotates around 26 6-hectare (ha) paddocks; the set stocked groups stay in the same 6-ha paddock.

Cattle in the Cell Grazing trial at Douglas Daly Research Farm during the wet season

Cattle in the Cell Grazing trial at Douglas Daly Research Farm during the dry season

Results

Individual animal performance has been highest in the set-stocking group with the lowest stocking rate; production per hectare has been highest in the set-stocking group with the highest stocking rate. The same general trend has been seen in the six year groups of animals studied.

The results so far were reviewed in 2015. The cell grazing expert Terry McCosker commented that the weight gain in the CELL group was lower than in the SS groups probably because there were not enough paddocks in the rotation and that paddocks were not getting enough rest between grazes. To overcome this problem, from the middle of 2015, when the change-over of cattle occurred, the three SSc paddocks were included in the CELL group, thereby increasing the number of paddocks in the rotation to 29 and adding three extra days of rest between grazes in the wet season and nine extra days of rest in the dry season.

Despite the extra rest period in the CELL group after the changes, growth rate was still higher in the set-stocked animals. Additional changes are planned for next year to increase the rest period between grazes in the CELL group.

Table 1. Average growth rate in the groups during the post-weaning year

Year	Treatment	Avg growth / head (kg)	Avg growth / ha (kg)
2009-10	SSc 1.5 head/ha	132.7	199.0
	SSv 1.33 head/ha	137.3	183.0
	Cell 1.33 head/ha	114.6	152.9
2010-11	**SSc 1.5 head/ha**	**186.0**	**279.0**
	SSv 1.67 head/ha	**174.0**	**289.9**
	Cell 1.67 head/ha	**161.2**	**268.6**
2011-12	SSc 1.5 head/ha	167.7	251.6
	SSv 1.83 head/ha	151.9	278.5
	Cell 1.83 head/ha	119.9	219.9
2012-13	**SSc 1.5 head/ha**	**135.6***	**203.4***
	SSv 1.83 head/ha	**138.0**	**253.0**
	Cell 1.83 head/ha	**122.1**	**223.8**
2013-14	SSc 1.5 head/ha	141.2	211.8
	SSv 1.5 head/ha	139.4**	209.0**
	Cell 1.5 head/ha	127.3	191.0
2014-15	**SSc 1.5 head/ha**	**148.8**	**223.2**
	SSv 1.33 head/ha	**150.6**	**200.7**
	Cell 1.33 head/ha	**134.6**	**179.4**
2015-16	SSv 1.33 head/ha	157.7	209.7
	Cell 1.33 head/ha	125.2	166.6

Note: Weights were recorded after a 12-hour fast without feed or water. SSc = Set stocked at a constant rate (1.5 animals/ha), SSv = Set stocked at a variable rate (equivalent to the stocking rate in the cells) and Cell = Cell grazing.
*Average growth was reduced probably due to wallaby competition for pasture.
**Data from one paddock was excluded due to buffel grass die back, which resulted in its destocking for three months.

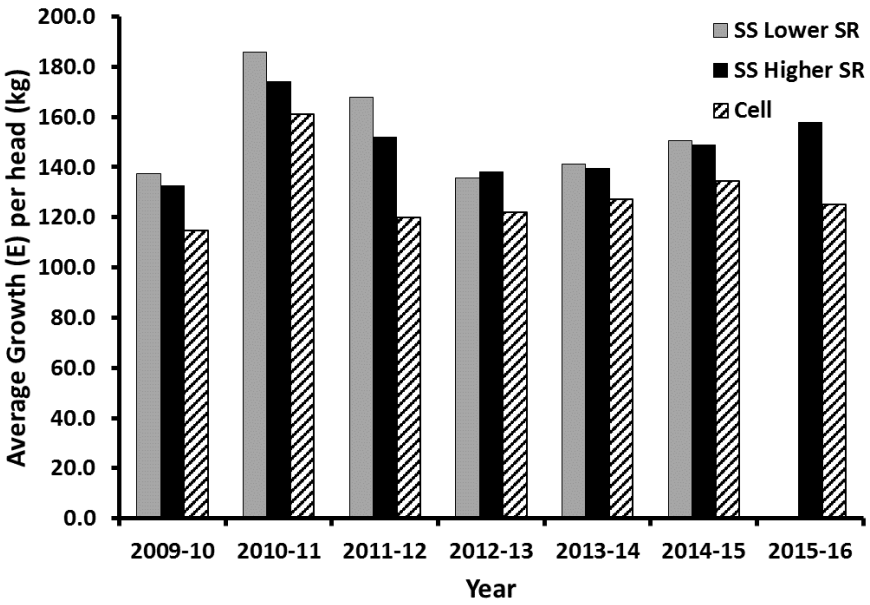


Figure 1. Annual growth per head in the different groups in the Douglas Daly Research Farm Cell Grazing trial

1.7 The Effect of Phosphorus Supplementation on Cow Growth and Fertility

Contact: Tim Schatz – Principal Pastoral Production Research Officer
Collaborating staff: Kieren McCosker, Whitney Dollemore, Joni Hall, Spud Thomas, Bekky Klinkenberg and other VRRS staff. The Ridley Corporation provided the P supplement.

Reference to the DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Continuing.

Despite a common belief among scientists that phosphorus (P) supplementation in P-deficient country is beneficial to cows, its benefits for reproduction remain largely unproven by scientific studies in northern Australia. Sales figures show that P supplementation is lower than expected. It is hypothesised that P supplementation may increase if studies clearly showed improvement in reproductive performance.

This project is studying the effects of P supplementation on the growth and reproductive performance in female cattle grazing native pasture on P-deficient soils at Victoria River Research Station. The +P group receives a P supplement throughout life while the – P group does not. Both groups graze in adjacent paddocks that soil testing has shown to be P-deficient. The groups alternate paddocks each year.

Heifers in the phosphorus supplementation trial at Victoria River Research Station

Heifers during mating at Victoria River Research Station in early 2016

Results

During the 2014 and 2015 dry seasons, growth was similar in the two groups but increased in the +P group during the 2014-15 wet season resulting in heavier pre-mating weights (+32 kg, $P < 0.001$) on 29/10/2015 (+P = 270 kg, -P = 238 kg).

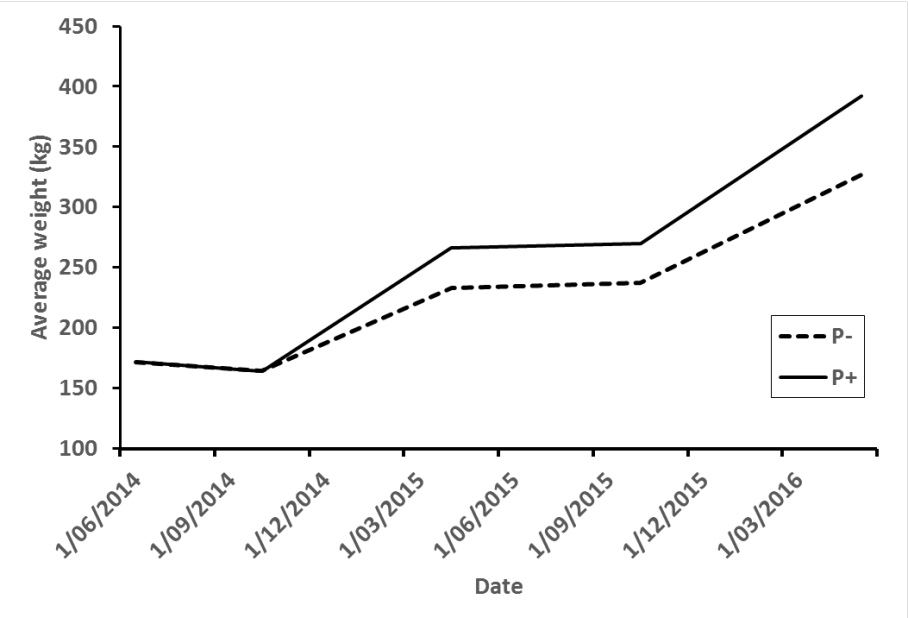


Figure 1. Average weights of the two groups

The +P group continued to grow faster (+ 33 kg, P < 0.001) over the 2015-16 wet season so that after mating (24/5/2016) animals were 66 kg heavier (P < 0.001), 3.3 mm fatter at the P8 site (P < 0.001) and had greater skeletal growth (4 cm hip height; P < 0.001).

The pregnancy rate after a three-month maiden joining period was 10% higher in +P (70% vs 60%) NS (P = 0.18). However, this difference was less than expected from the difference in pre-mating weights between the groups. The pregnancy rate was lower in +P group than in the –P group in the heavier weight ranges (Figure 2). Non- pregnant heifers were ultrasound scanned on 21/6/2016 and showed that a higher proportion of +P heifers were cycling (had a corpus luteum present), especially in the heavier weight ranges. If all cycling heifers in both groups had become pregnant, the pregnancy rate would have been 23% higher in the +P group (87% vs 64%; P < 0.001).

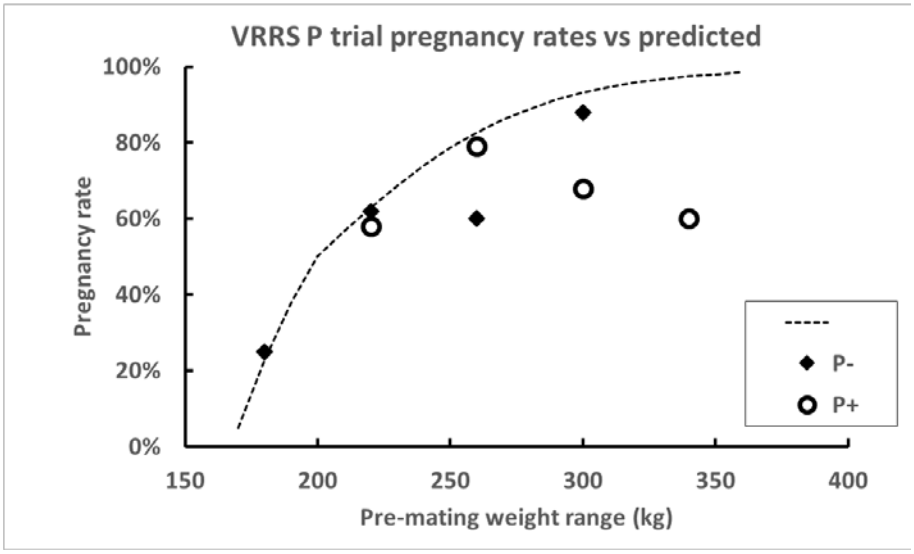


Figure 2. Actual pregnancy rates

1.8 The Repronomics Project – the Animal Genetics and Breeding Unit (AGBU) Collaborative Genetics Project

Contact: Tim Schatz – Principal Pastoral Production Research Officer
Collaborating staff: Whitney Dollemore, Cameron Heeb, Spud Thomas, Chris Hazel, Rachel Hennessy and other DDRF staff.

Reference to the DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Continuing.

In collaboration with AGBU and QDAFF/QAFFI, this project uses heifers from the Department of Primary Industry and Resources selected Brahman herd to study genetic effects on age at puberty (determined by ovary scanning) and postpartum anoestrus interval after first calving. It is expected that the project will increase the accuracy of fertility estimated breeding values (EBVs), which will improve the rate of progress through selection. It may also develop new fertility EBVs and find genomic markers for the traits.

Ovaries of three-year groups of heifers were scanned at regular intervals to determine age at puberty. Three-year first-lactation heifers were tested for pregnancy and their ovaries were scanned to determine the time taken to resume cycling after calving for the first time. As pasture conditions and nutrition at Douglas Daly Research Farm (DDRF) are good, most heifers (>70%) reconceive before their calves are weaned. Those that fail to reconceive have their ovaries scanned at regular intervals until they resume cycling. Genotypes of heifers and ovary scanning results are used to identify gene markers for high fertility and improve EBVs.

Collecting ovary scanning data at Douglas Daly Research Farm

Ovary scanning

Results

DNA sampling and genotype study results together with ovary scanning details are being processed and collated.

1.9 Selected Brahmans - Improvement in the Fertility of the Brahman Breed through the Use of BREEDPLAN EBVs and Selection

Contact: Whitney Dollemore – Pastoral Research Officer
Collaborating staff: DDRF, KRS and VRRS staff, especially Christine Hazel, Joni Hall, Barry Lemcke and Tim Schatz.

Reference to the DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Continuing.

Research to improve fertility in a Brahman herd started in 1986 using local cows and bulls. A high selection pressure involved the use of yearling heifer mating and culling of females over two years, selecting bulls at 12 and 18 months on testicular size, growth and dam performance. Artificial insemination (AI) was also used to introduce outside genes. AI sire selection was based on a selection index that places high importance on low days to calving and high scrotal circumference estimated breeding values (EBVs). The herd joined the Australian Brahman Breeders' Association and became a member of BREEDPLAN in 1994. In 2015-16, pressure on dam selection was increased. Breeders born prior to 2012 that missed a successful mating at yearling were removed from the herd to reduce the stocking rate. The herd now has 165 females at Victoria River Research Station (VRRS) and 208 first and second calf heifers, 159 bulls (of which, 81 are for mating at VRRS and Katherine Research Station, and 78 for sale) and 298 weaners at Douglas Daly Research Farm (DDRF).

Top priced bull in June 2016

Calves at Douglas Daly Research Farm

Results

The success of this project is shown by the improvement in reproductive EBV traits, such as the average days to calving and scrotal circumference, which are well above the breed average for the Brahman Group BREEDPLAN, the Jap Ox Index and the Northern Live Export Index.

Emphasis will be on gaining linked sires with the Beef CRC herd for the collaborative project with AGBU: Intensive genotyping and phenotyping for accelerated genetic improvement of reproduction in northern Australia.

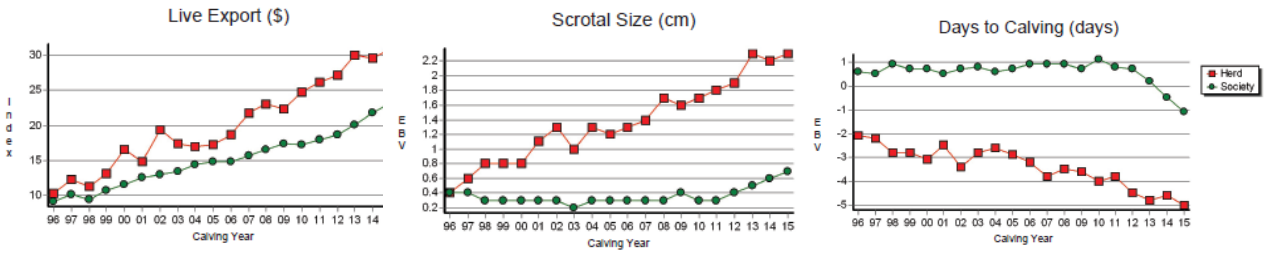


Figure 1. Important reproductive traits

The following notable results were observed at Round 1 muster in May 2016:

- 58% of yearling heifers (2015) were detectably pregnant at DDRF.
- 82% (36/44) 2014 lactating first calf heifers re-conceived at DDRF.
- 88% (76/86) wet cows (2013 heifers) re-conceived at DDRF.
- 83% (86/104) weaning rate in 2013 heifers at DDRF.
- 78% (132/170) wet cows re-conceived at VRRS.
- 7% (13/183) calf loss at VRRS.

The breeder herd pregnancy rate at VRRS was below the 10-year average. The pregnancy rate in yearling mated heifers at DDRF was considerably higher than in previous years due to an increase in the average joining weight. Calf losses were just below normal at 8%.

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

Contact: Jocelyn Coventry – Pastoral Production Officer
Collaborating staff: Bryan Gill, Sally Sims and Coral Allan.

Reference to the DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Continuing.

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

Neo-natal calf mortality was the main cause of reproductive losses

Movement of cattle in a paddock rotation was associated with neo-natal calf mortality in late-calving cows

Results

Preparations were made to register 158 calves branded in 2015 and 181 calves branded in 2016 on the Droughtmaster Breed Society's database following careful selection.

Over three years, the combined foetal and calf mortality reached 14.3%. Over that period, post-natal calf mortality was 4.9%, which exceeded a benchmark of 1% recommended for northern Australia. Peri-natal calf mortality was the main cause of reproductive losses at 7.3%.

A poster about modified management to reduce calf losses at muster was prepared for the North Australia Beef Research Update Conference in Rockhampton in August, 2016.

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

Contact: Barry Lemcke – Principal Livestock Management Officer
Collaborating staff: Tim Schatz, Whitney Dollemore, Grant Hamilton, R. Mc Donald, D. Dickerson, J. Palmer, Cameron Heeb, C. Hazel and R. Hennessey.

Reference to the DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Continuing.

The production limitations of the Brahman breed in the Top End are well known. Finding a better breed that will also be suitable for southern markets is important, particularly if and/or when South-East Asian markets fail, as happened in 2011. Under Top End conditions, this project compares the performance of a multi-breed composite developed by the Department of Primary Industry and Resources with that of the Brahman breed to assess its suitability as a possible alternative to the Brahman breed. A multi-breed Composite can combine the attributes of a number of breeds and can retain a larger amount of heterosis than conventional two-breed crosses in future generations. The Composite consists of 56.3% Brahman, 12.5% Africander, and 12.5% Tuli, plus 6.3% each of Shorthorn, Hereford and Charolais. This mix contains 81% tropically-adapted and 19% unadapted Bos taurus. Some other breeds have been introduced through artificial insemination, such as Belmont Red and Senepol, to see whether they can contribute to overall productivity. It is expected that the Composite will retain 64% of heterosis in the second generation onwards. The two breeds are run together except during mating between January and March. Their performance is assessed using performance records, a selection index and BREEDPLAN data. Females are culled if they fail to get pregnant before they are three years old or if they fail to be pregnant as mature cows over four years old. Yearling heifers that calve at two years of age are allowed one missed pregnancy after the first calf, but thereafter there are no exceptions. Cows are culled if they do not raise a calf to weaning, unless it is due to a known accidental cause. There is emphasis now on selection for polledness to expedite the infusion of the polled gene into the herd.

A Composite cow and calf

Semen assessment for use in selected Brahman and Composite herds

Results

Table 1 summarises the 2015-16 results.

Table 1. Herd records for 2015-16

Cattle groupings	Composite breeder herd at *BHRF	Brahman Breeder herd at BHRF	Composite 3 and 4 year-old heifers at mating at *DDRF	Composite 2 year-old heifers at mating at BHRF	Brahman 2 year-old heifers at mating at BHRF	Composite yearling heifers at mating at DDRF	Composite yearling heifers at mating at BHRF	Brahman yearling heifers at mating at BHRF
Number at start of mating 2016 (head)	126	70	10 (4 year-old) 39 (3 year-old)	64	28	38	48	22
2015 pregnancy rate	93.1% (n=102) All non-pregnant culled	92.6% (n=54) All non-pregnant culled	79.3% (n=87) All non-pregnant culled	67.6% (n=34)	100% (n=28)	78.3% (n=46)	67.7% NA	3.3% NA
2016 pregnancy rate	95.1% (n=122) All non-pregnant and dry cows culled	81.4% (n=70) All non-pregnant and dry cows culled	4 year-old 80.0% (n=10) 3 year-old 94.9% (n=39)	Dry 9/11 (82%) Wet 7/53 (13%) All 16/64 (25%)	Dry 26/27 (96%) Wet 0/1 (0%) All 26/28 (92.9%)	39.5% (n=38)	68.8% (n=48)	9.1% (n=22)
Number culled at pregnancy test Jun-16 (% of breeders mated)	15 (11.9%) 6 not pregnant 9 dry	15 (21.7%) 13 not pregnant 2 dry	2 (20%) of 4 year-old 2 (5.1%) of 3 year-old	1 (2.9%) Not culled as 2 year-old unless not preg-nant + dry	0	0	0	0
Mean live-weight at pregnancy diagnosis Jun-16	368 kg	383 kg	453 kg, 4 year-old 391 kg, 3 year-old	296 kg	371 kg	277 kg	298 kg	271 kg
Mean birth weight for calves born in 2015-16	30.0 kg (n=118)	31.3 kg (n=69)	26.8 kg	24.3 kg (n=54)	28.5 kg (n=1)	NA	NA	NA
Calf mortality to weaning / Number of calves born	6/118 (5.1%)	0/69 (0%)	3/32 (9.4%)	0/54 (0%)	0/1 (0%)	NA	NA	NA
Mean weaning weight of calves (kg)	180.3	185.6	177.7	148.4	100	NA	NA	NA
Adult breeder mortality	0	1	1	0	0	1 (Urea)	0	0

*BHRF = Beatrice Hill Research Farm. * DDRF = Douglas Daly Research Farm.

The Composites had higher pregnancy rates than Brahmans in all age groups except in two-year-old heifers when the pregnancy rate in Brahmans was higher because a much higher percentage of two-year-old Composite heifers were lactating and only one two-year-old Brahman heifer became pregnant as a yearling. Poor seasonal conditions reduced the pregnancy rate in two-year-old composite heifers. The high pregnancy rate in mature Brahmans in 2015 was not repeated this year. Their pregnancy rate was 14% lower than in the Composites.

Composite mated yearling heifers had conception rates seven times higher than the Brahmans at BHRF.

But the weaning weight in Composite calves was 5 kg lower than in Brahmans, probably due to stocking rates.

1.12 Riverine Buffalo and Crossbreeding Project

Contact: Barry Lemcke – Principal Livestock Management Officer
Collaborating staff: Tim Schatz, Grant Hamilton, R. Mc Donald, J. Palmer, D. Dickerson and D. Rout.

Reference to the DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Continuing.

Imported riverine buffalo served as the foundation herd for their spread throughout Australia. This helped establish the buffalo dairy industry. An increase in riverine buffalo numbers was helped by crossbreeding with the local swamp buffalo. Crossbreeding with the swamp buffalo also improved growth rates by 40%, increasing meat production. This also helped in the production of quality meat termed TenderBuff from young animals, which is more tender. It has also helped dairy farmers to produce milk more rapidly, using first and subsequent crosses, whilst backcrossing to the riverine breed. Imported Italian dairy buffalo semen has helped in the expansion of the herd and prevented inbreeding. The target of the project was 100 purebred breeders able to turn-off around 40 purebred heifers per year to the dairy industry.

Results

Table 1. Calving in 2015-16 and pregnancy diagnosis results (Aug 2016) for next season's calving

Breeder group	2015-16 calving rate i.e. calves born / cows mated 2015	2016 pregnancy rate i.e. cows pregnant Aug 2016 / cows mated January 2016	2016 pregnancy rate in wet cows i.e. preg wet cows / total wet cows
7/8 cows	64.3% (n=42)	82.5% (n=40)	80.8% (n=21)
15/16 cows	84.5% (n=58)	43.8% (n=48)	37.1% (n=35)
2 year-old X-bred heifers (continuous mating)	67% (n=9)	67% (n=3)	NA
X-bred yearling heifers (Continuous mating)	NA	46.7% (n=30)	NA
2 year-old purebred heifers (continuous mating)	72.4% (n=29) (excludes sales of 21 pregnant heifers)	76.9% (n=26)	NA
Purebred yearling heifers (continuous mating)	NA	46.4% (n=56)	NA
Riverine cows by AI	37.4% (n=171) Note – pregnancy rate was 42% but there was 9.9% (7/71) foetal loss from early pregnancy test to birth	11/12/15 11 / 19 = 58% 04/02/16 19 / 40 = 48% 11/03/16 7 / 14 = 50% 24/06/16 22 / 31 = 71% total 59/104 = 57%	11/12/15 No wet cows 04/02/16 1/4 = 25% 11/03/16 0/2 = 0% 24/06/16 18/24 = 75% total 19/30 = 63%
Geriatric pure breeder group			
Old cows	57.1% (n=21)	33.3% (n=12)	0%
Younger AI (3 x fails)	58.8% (n=17)	50.0% (n=14)	All dry
Total	54.5% (n=347)	55.9% (n=333) including AI groups	57.0% (n=86)

The mean weaning weights in calves born in the 2015-16 calving season were:

- 15/16th calves from 7/8th cows = 227.5 kg (n = 25)
- Purebred calves from 15/16th cows = 242.1 kg (n = 35)
- Purebred calves 272.3 kg (n = 78).

Pregnancy rates were again variable this year with the 7/8 group attaining satisfactory performance. The 15/16 breeder group's pregnancy rate dropped to 44%, almost half that of the previous year. Also, calving was late in 2016 in both groups. The likely reason for this would be related to poor bull performance. Some early postpartum calf mortality in the 15/16 group was probably due to bacterial infection in the navel area from wallowing. Joint swelling was the main visual symptom. A 15-kg difference in the mean weaning weight between the 15/16 and the 7/8 group calves may have been due to a larger supply of milk to the former group.

This year the mean pregnancy rate was 57% compared with 42% the previous year, probably due to improved inseminator skills.

Four purebred bulls were sent to artificial insemination centres in Java to assist in increasing meat production.

Thirty two in–calf heifers were sold to South Australia.

A 20 year old buffalo cow imported from the US in 1996 as a heifer produces her latest calf in 2016

Four buffalo bulls from the Northern Territory arrive at the Lembang Quarantine Yard, 150 km from Jakarta

1.13 Alexandria Spelling and Stocking Rate Trial

Contact: Casey-Anne Collier – Pastoral Production Officer
Collaborating staff: Jane Douglas and Mark Hearnden.

Reference to the DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Continuing.

The project is investigating if sustainable stocking rates and wet season spelling can improve land condition at old bores and maintain land condition at new bores.

Results

Overall yield has declined and is the lowest at all three bores since the trial started. Perennial yield of *Astrebla* spp. has declined at all three bores.

Cattle grazing close to the bore in the East Ranken paddock in July 2016

***Astrebla* spp. at Bore 153 at a distance of 4000 m from water, July 2016**

1.14 Pasture Sustainability - Kidman Springs

Contact: Jodie Ward – Pastoral Production Officer
Collaborating staff: Robyn Cowley, Caroline Pettit and Dionne Walsh.

Reference to the DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Continuing.

There are 16 different land units at Kidman Springs, ranging from alluvial grey cracking clays, calcareous red earths, to spinifex hills. They vary significantly in pasture production and carrying capacity. Pasture growth models from Cobiac (2002) and Carter (2002) were used to estimate median (50 percentile) annual pasture growth for the land units at Victoria River Research Station (VRRS). Estimated levels of safe utilisation and animal equivalent annual consumption rates were then used to calculate safe carrying capacities for each paddock. These recommendations are monitored annually to ensure that VRRS plots are not being overgrazed and that recommendations to pastoralists about carrying capacity of different land systems are accurate.

Results

There are no results yet as data is being collected and analysed to prepare recommendations.

***Themeda triandra,* a favoured native pasture species by pastoralists, growing prolifically at Victoria River Research Station in 2016**

1.15 Shruburn (Victoria River Research Station Long-term Fire Experiment)

Contact: Robyn Cowley – Senior Rangeland Scientist
Collaborating staff: Caroline Pettit, Jodie Ward, Dionne Walsh, Dale Jenner, Cameron Heeb and Joni Hall.
External collaborators: Gabrielle Lebbink (University of Queensland student) and Estelle Taylor (SC Station Services).

Reference to the DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Continuing.

The long-term Kidman Springs fire experiment (established in 1993) assesses the impact of fire management on woody vegetation cover and pasture condition. The experiment 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, and compared with unburnt control plots.

Assessing plant species diversity on the Kidman fire experiment red soil plots in April 2016

Lighting fire on black soil plots in October 2015

Results

Early dry season fire was not effective as a management tool for woody cover control and led to poorer pasture composition. Late dry season fires were the most effective in managing woody cover. If using early fire, post-fire spelling is recommended until after the following wet season to protect pastures.

1.16 Central Australian Quality Graze Trial and Producer Steer Challenge

Contact: Chris Materne – Pastoral Production Officer
Collaborating staff: Coral Allan, Jocelyn Coventry, Bryan Gill, Sally Sims, Deb Roberts, Darren White, Simon Carr, Greg Crawford, Dale Jenner, Jane Tincknell and Pieter Conradie.

Reference to the DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Continuing.

The project aims to demonstrate and test the impact of various grazing strategies on land condition and on consistent production of quality beef in Central Australia.

All pasture data collected between 2011 and 2015 has been collated and is being analysed.

Data on cattle performance was recorded in August 2015, December 2015 and February/March 2016. In May 2016, new 2016-branded steers from Old Man Plains Research Station were added to the trial group as well as 32 locally-purchased steers.

Steers branded in 2014 ready for the abattoir

Steers from the Central Australian Quality Graze trial that were branded in 2014 ready for trucking

Results

By March, 2016, most of the 2014-branded steers had reached the target daily growth rate of 0.5 kg (79%), p8 fat depth of >5 mm (89%), ossification score of <175 (86%), fat colour of <4 (97%), meat pH of <5.71 (97%), meat colour of <4 (95%) and thus 84% achieved the Meat Standards Australia grade.

Project results were presented at the Alice Springs Pastoral Industry Advisory Committee meeting and to the public at the 2015 Alice Springs Show. The results were also presented at the 32nd Northern Territory Cattlemen's Association Annual Conference in Alice Springs in April, 2016.

A poster was presented on the performance of 2014-branded steers to participants at the Quality Graze Producer Steer Challenge PDS in March 2015.

1.17 Improved Performance in Young Cattle Supplemented with Molafos® during the Dry Season in the Katherine District

Contact: Kieren McCosker – Livestock Industry Development Regional Manager, Katherine

Reference to DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Completed.

Feeding cattle for production is often too expensive in remote areas of the Northern Territory due to transportation costs. However, due to an increase in market value of export cattle, there is increasing interest in better feeding of growing stock to reduce age at turn-off and improve weight at sale. This study investigated the potential of a commercially available molasses-based liquid supplement (Molafos®) for this purpose. One group of about 112 mixed-sex Brahman cross cattle of about 18 to 21 months of age were fed a dry season (June-December) supplement of Molafos® at a rate of about 0.985 kg/head/day. The control group was provided with a typical commercial dry season mineral loose lick containing ~20% urea. The animals were kept at equivalent stocking rates in similar paddocks predominantly with black spear grass (*Heteropogon contortus*). During the following wet season, all animals grazed in a single paddock with access to a high phosphorus loose lick supplement.

Results

Using a sale weight of 280 kg, 2.6% more molasses-fed animals reached sale weight by April 2016. However, this was not statistically significant ($P = 0.33$). The molasses group had a significantly higher (+14.6 kg) dry season growth (12.6-16.7 kg; $P < 0.01$). However, the molasses supplement did not have a significant effect on growth during the wet season ($P = 0.18$).

The average total growth of all study animals was 101.4 kg (95% CI 99.6-103.3 kg). The molasses supplement had a statistically significant ($P < 0.001$) effect on total growth with 10.7 kg (95% CI 7.0-14.3) higher growth in the supplemented group compared with the control.

Supplementation did not significantly improve the pregnancy rate as it was only 1.6% higher (57.0% vs. 55.4%; $P = 0.84$).

Dry season growth and pre-wet season weight caused the greatest amount of variation in wet-season growth (both $P < 0.001$). Generally, animals with a heavier pre-wet season weight had greater wet-season growth than lighter animals. In addition, animals that had lower growth during the dry season grew more over the wet season, which may be due to compensatory growth. Growth over the dry season was also influenced by initial weight with lighter animals having higher growth than heavier animals ($P < 0.001$).

Conclusions

Despite the 10.7 kg improvement in total growth, the associated cost of the molasses supplement may outweigh the gains. Therefore, an individual whole of business assessment is recommended before adopting this production strategy.

Recommendations

A careful economic study should be conducted before embarking on a molasses supplementation program.

1.18 Case Study: Body Weight Loss in Young Cattle during Transport

Contact: Kieren McCosker – Livestock Industry Development Regional Manager, Katherine
Collaborating staff: Spud Thomas, Cameron Heeb and staff at VRRS and DDRF.

Reference to DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Completed.

This project studied the effect on young cattle of commercial transport between Victoria River Research Station and Douglas Daly Research Farm, particularly on weight loss and the impact of trailer position. Body weight was recorded individually for 270 male and female weaners about 12 hours prior to transport without fasting (as they had access to hay and water) and compared with weights taken as soon as possible after a trip that took 17.5 hours, which included 8 hours of standing while the trucks were not moving during loading, unloading and driver rest periods.

Results

Overall, body weight loss was 8.7% (95% CI 8.5-9.1%). The main effects of trailer number, deck position and their interaction on body weight loss were not significantly related ($P = 0.45$, $P = 0.85$ and $P = 0.82$, respectively) using a multivariable linear regression model. A general trend was observed that a higher body weight loss occurred in animals that were heavier prior to transport. But it was not significant ($P = 0.10$).

Conclusions

The position of cattle during transport (trailer and deck) did not affect body weight loss. On average, animals lost 8.7% of initial body weight during transport, which was 0.5% of body weight per hour, assuming a linear association between transport time and body weight loss.

1.19 The Interaction between Weaning Weight and Post-weaning Nutrition on Live-weight Gain and Body Size in Cattle

Contact: Kieren McCosker – Livestock Industry Development Regional Manager, Katherine
Collaborating staff: Jack Wheeler, Tim Schatz and staff at KRS; Spud Thomas, Joni Hall and staff at VRRS.
External collaborators: Tiago Silva, Simon Quigley and Dennis Poppi (University of Queensland, Gatton Campus).

Reference to the DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Completed.

The project examined the effect of plane of nutrition and weaning weight in the first dry season on performance of replacement heifers. Two groups of Brahman-cross female calves were weaned at either a 'heavy' weaning weight (average 181.7 kg; n = 75) or at a 'light' weaning weight (average 118.5 kg; n = 60). Both groups were provided with one of five supplement levels (0, 1.0, 2.5, 5 and 10 g/kg live-weight/day). The supplement consisted of equal amounts of copra meal and cracked corn. The animals grazed sabi grass and had access to Rumevite® 30% and phosphorus (P) blocks *ad libtum* from weaning until the end of the first dry season. The supplement was provided from 18/06/2014 to 02/12/2014. After that all heifers grazed together at Victoria River Research Station and received a wet season supplement (mineral loose lick 73 g P/kg dry matter (DM)) and a dry season supplement in the second dry season (mineral loose lick 21 g P/kg and 700 g crude protein/kg DM) and the same wet season supplement in the second wet season.

Live-weight was recorded to detect changes between weaning and pregnancy testing after first mating. Pregnancy was determined by rectal palpation.

Trial heifers during the pen feeding phase

Trial heifers in January 2016

Results

There were no significant differences in growth rates due to supplementation (Figure 1). However, the effect of weaning weight on total growth over the two-year period approached significance when light weaners (196.2, 95% CI 189.6-202.9 kg) gained 7.9 kg more than heavier weaners (204.1, 95% CI 196.6-211.7 kg; P = 0.06).

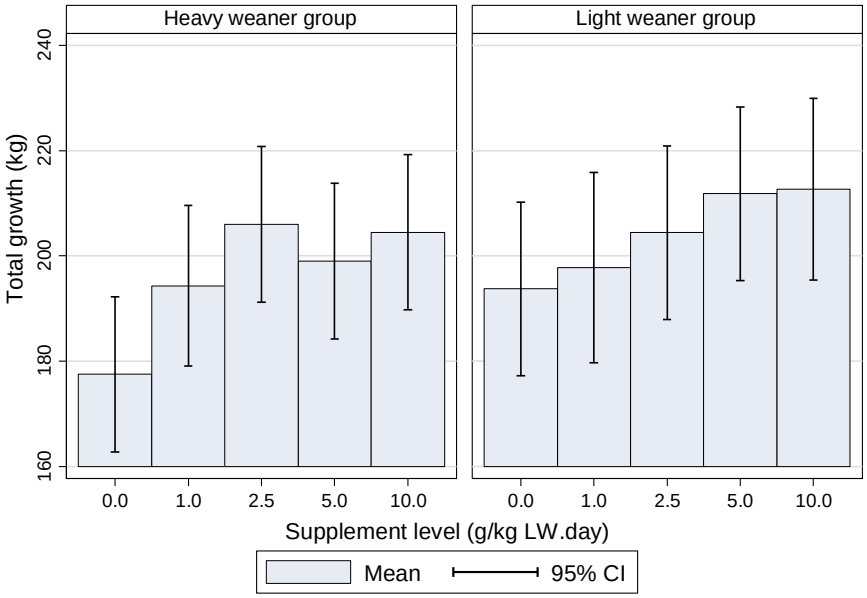


Figure 1. Total growth in the two groups of heifers at different supplement levels

Despite the increased total weight in light-weaned heifers, the actual final live-weight in heavy-weaned heifers was greater (378 vs 323 kg) and was similar to the difference at weaning.

Due to insufficient numbers, it was not possible to determine whether differences in pregnancy rates within groups were significant. However, pregnancy in the heavy weaner group was 40.4% higher (69.0% vs. 28.7%) than in the lighter group. Within groups, pregnancy rates were not affected by the level of supplementation (Figure 2).

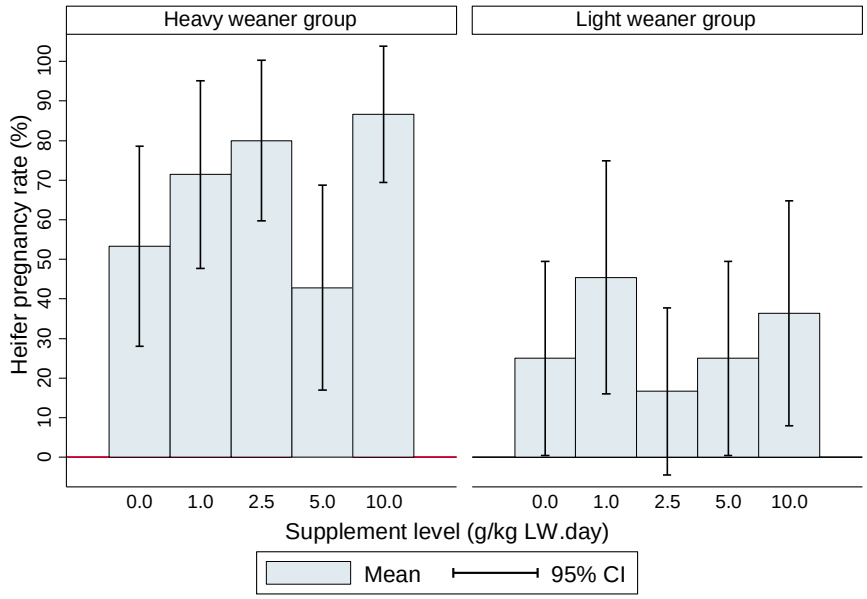


Figure 2. Pregnancy rates in heifers at different supplement levels in the two groups

Heifers that received the lowest levels of supplementation during the first dry season demonstrated compensatory live-weight gain over the following wet season. Approximately 40% of the weight difference

gained over the first dry between un-supplemented and the highest supplemented group disappeared during the subsequent season.

The performance of light-weaned heifers was higher during the second dry season but not significantly so.

Conclusions

Different levels of high-quality supplement during the first dry season did not greatly influence overall heifer performance to the end of their first mating. Supplementation during the post-weaning dry season increased weight but could not be sustained after supplementation stopped.

Over the post-weaning dry season, light-weaned heifers grew more than heavy-weaned heifers.

Recommendations

Mineral block licks with urea are a lower cost alternative in northern Australia for weaners in the 130 to 180 kg range with no adverse effects on long-term weight gain in heifers. Higher cost supplements during the post-weaning dry season are unlikely to be cost-effective.

1.20 Production Responses to Injectable Trace Minerals in Young Cattle on Pasture in the Northern Territory

Contact: Kieren McCosker – Livestock Industry Development Regional Manager, Katherine
Collaborating staff: Trisha Cowley and Barry Lemcke.

Reference to the DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Completed.

Existing live-weight gain datasets were analysed in which cohorts of animals had been allocated according to whether they had received injectable trace minerals or not. Two datasets represented heifers and steers that grazed either native tropical tall grass or on floodplains typical of the Top End major river systems. A third dataset consisted of two-year-old heifers that had been relocated from the Sturt Plateau region to the Adelaide River district for backgrounding.

Results

There was no production response to injectable trace minerals in any dataset. Animals in each dataset were fed above maintenance requirements, which supported growth. There were no significant differences between individual groups and the control group (Table 1). Therefore, there was no production advantage from the use of trace mineral injections.

Table 1. A summary of average live-weight gain in injected and control groups

Animal class and pasture conditions	No.	Average live-weight gain (g/d; 95% CI)			P-value
		Injected	Control	Difference	
Tropical tall grass wet season; pasture (Site A)					
-2013 year drop	124	313 *(298, 329)*	311 *(296, 326)*	1.9 *(-19.7, 23.5)*	0.86
-2012 year drop	136	735 *(712, 758)*	757 *(735, 780)*	-22.6 *(-54.7, 9.4)*	0.17
Yearling heifers and entire males; Floodplain (Site B)	131	203 *(186, 221)*	197 *(180, 213)*	6.7 *(-17.3, 30.7)*	0.71
Two-year-old heifers; tropical tall grass late-wet season pasture (Site C)	183	861 *(786, 937)*	870 *(790, 950)*	-9.0 *(-119.0, 101.0)*	0.87

These results are not definitive as marginal deficiencies vary between years and locations. However, even in a study where tissue analyses indicated a low to marginal copper deficiency, a production response to supplemental copper was not detected (Westley-Smith and Schlink, 1990).

Conclusions

These results agree with existing knowledge that unless known consistent trace mineral deficiencies exist, a production response to trace mineral injections is unlikely.

Recommendations

Nutritional management should primarily emphasise meeting the major known nutritional requirements of energy (through the appropriate management of pasture resources) and provide strategic supplementation of nitrogen in the dry season and phosphorus in the wet season.

1.21 Making Production and Conservation Gains through Adaptive Grazing: Beetaloo Pilot Project

Contact: Natalie Jane Douglas – Pastoral Production Officer
Collaborating staff: Dionne Walsh, Robyn Cowley, Caroline Pettit, Jodie Ward, Dale Jenner, Mark Hearnden and Helen McMillan.

Reference to the DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Completed.

The project aimed to evaluate and promote grazing land management practices, infrastructure development and improve animal productivity to increase business resilience in the Barkly pastoral region by comparing the effect of rotational and continuous grazing on animal and pasture productivity. It was funded by Caring for our Country in collaboration with the Department of Primary Industry and Resources, the Barkly Landcare and Conservation Association and the Barkly Pastoral Company.

Rotation paddocks at Beetaloo Station

Bulls at Beetaloo Station

Results

There were no significant differences between rotational and continuous grazing on pasture or cattle production. There was evidence of a higher stocking rate that exceeded recommended carrying capacity.

All pasture yields (total standing dry matter in the different functional and species groups) were highly dependent on rainfall across both grazing systems. All yields increased with increasing rainfall and decreased with decreasing rainfall.

Live-weight gain in the rotation group was very poor in 2013-14 because the cattle were on inundated black soils in February and lost weight, which they were not able to recover subsequently. Daily live-weight gain per animal equivalent (AE) was similar in the two groups during the other two years.

Table 1. Live-weight gains per AE and per hectare

	kg/AE/day			kg/ha		
	2013	2014	2015	2013	2014	2015
Rotation	0.42	0.35	0.34	18.6	11.4	11.6
Continuous	0.41	0.53	0.37	22.8	19.9	14.0

The stocking rate exceeded the recommended carrying capacity each year in both groups.

Table 2. Stocking rate and carrying capacity (AE/km^2)

	Rotation	Continuous
Average actual stocking rate (range)	14.5 (12.5 - 16.3)	16.2 (12.4 - 18.7)
Average carrying capacity (range)	9.5 (7.2 - 12.8)	11.2 (9.5 - 12.2)

From an economic standpoint, the continuous grazing group performed better than the rotation group every year in $/AE and also in $/hectare during two out of the three years.

Table 3. Economic comparison ($/AE and $/hectare)

	$ per AE			$ per hectare		
	2013	**2014**	**2015**	**2013**	**2014**	**2015**
Rotation	108.96	-0.79	61.62	15.40	-0.13	6.90
Continuous	117.93	86.22	54.32	20.81	16.10	6.67

Conclusions

Live-weight gain per hectare was superior in the continuously grazed paddock due to the combination of better individual animal performance in some years, as well as higher stocking rates.

Stocking rate is the main driver of animal production rather than the grazing system per se. Regardless of the grazing system employed, it is important to match stocking rates to the long-term carrying capacity of the land type in its current condition to optimise animal and land performance.

The results highlight that the economic performance of a grazing system in any given year is determined by complex interactions between live-weight gain, stocking rates, land type and costs.

The lower or similar production combined with higher operating and capital costs of rotational grazing make it less profitable, at least in the short term.

It can take more than ten years to see long-term changes in pasture or land condition. The short time span of the trial was insufficient to detect any divergence in pasture or land condition between the two grazing systems.

Recommendations

Ensure that the stocking rate does not exceed carrying capacity.

The lower or similar production combined with higher operating and capital costs of rotational grazing make it less profitable, at least in the short term.

There is no compelling evidence to recommend very high intensity rotational grazing over other methods on the Barkly.

2 Plant Industries

2.1 The Impact of Different Pruning Times on Bud and Shoot Development (Maturity) in Mango Cultivars “Honey Gold” and “Calypso” (B74) in the Subtropical Climate of Katherine

Contact: Ali Sarkhosh – Senior Research Horticulturalist
Collaborating staff: Mike Kahl, Teagan Alexander, Sarah Featherstone, Johnny Cooper and Karl Bourne.

Reference to the DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Commenced.

This project is examining the effect of the progressively cooler weather in Katherine from April to July, particularly night temperatures, on developing mango buds. This information will be used to detect periods of growth to plan fruiting times (early or late harvest), better management of fruit harvesting and packing to improve productivity and profitability for mango farmers.

Figure 1. Growth of first flush in cvs. “B74” and “Honey Gold” over 91 days

Results

Climate data showed that cultivar “Honey Gold” experienced 305 hours below 20 ˚C over 13 weeks, while cultivar B74 experienced 209 hours below 20 ˚C during a similar period. Mean flush length was 135 mm in B74 and 112 mm in Honey Gold at the end of seven weeks during first pruning. Flower induction should happen in both cultivars as first flushes have attained sufficient time resting in temperatures below 20 ˚C (see Figure 1).

2.2 Fruit Trees for Central Australia: Dates, Pistachios, Pomegranates and Figs

Contact: Ali Sarkhosh – Senior Research Horticulturalist
Collaborating staff: Mike Kahl, Teagan Alexander, Sarah Featherstone, Johnny Cooper and Karl Bourne.

Reference to the DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Commenced.

Regional testing of different fruit tree varieties would provide information on their comparative performance regarding yield and quality of the fruit. The results of the study should be useful for growers in Central Australia to select suitable varieties to diversify their enterprises.

Results

Current work is focussed on identifying cultivars suitable for flowering and fruiting under local conditions. For example, of all the pistachio cultivars tested, only Sfax flowers and fruits consistently. This project is in its initial stages.

2.3 The Performance of NMBP Hybrids (4069, 1201 and 1243) Grafted onto Kensington Pride Rootstocks in the Katherine Region

Contact: Ali Sarkhosh – Senior Research Horticulturalist
Collaborating staff: Mike Kahl, Teagan Alexander, Sarah Featherstone, Johnny Cooper and Karl Bourne.

Reference to the DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Commenced.

The Katherine region is one of the largest mango producing areas in Australia. Diversification of mango production could improve internal and external markets. Grafting of the three hybrids on to Kensington Pride has started.

NMBP 1201 NMBP 1243 NMBP 4069

NMBP-released cultivars will be evaluated

Results

This project is in initial stages. Results should provide information on the comparative performance in adaptability, yield and fruit quality of NMBP hybrids in the Katherine region.

Physiological traits, such as tree size, tree height, canopy width and trunk diameter were recorded 10 cm above the graft union.

2.4 Improved Management Options for the Cucumber Green Mottle Mosaic Virus (CGMMV)

Contact: Lucy Tran-Nguyen – Principal Molecular Scientist
Collaborating staff: David Lovelock, Nadine Kurz, Sharl Mintoff, Natasha Burrows and Mary Finlay-Doney.

Reference to the DPIF Industry Development Plan 2013-2017:
3.3 Protect the reputation of the Territory as a producer of quality primary produce.

Project Status: Commenced.

This project examines the longevity of CGMMV in a variety of soils in pot trials, in order to determine the time between detection and re-growing of melons and cucurbits. Potential non-host crops will be screened for their susceptibility to the virus, giving affected growers other avenues for income by utilising economically important crops grown in the Northern Territory. The potential spread of CGMMV will also be assessed by examining the ability of the pathogen to spread via contaminated seeds from host weed species and through the transfer of infected pollen to healthy plants by bees. This will provide a better understanding of how the virus can be spread and indicate ways to minimise the threat.

Pot trial experiment to investigate the longevity of CGMMV in different soil types from different trial sites across the Northern Territory

Experimental field site at Berrimah Farm testing the viability of non-host crop plants (sweet corn, capsicum and spring onions) as alternative crops in CGMMV-infested soil

Results

Initial results indicate that CGMMV is viable in infected soils 12 months after host plants have been removed. Tests of bee products have shown that CGMMV can be detected in various bee products (pollen, brood, honey, wax etc.), but the virus' viability remains unclear.

2.5 Quinoa Agronomy Trial

Contact: Callen Thompson – Senior Extension Agronomist
Collaborating staff: Ian Biggs, Teagan Alexander, David Hancock, Karl Bourne and Johnny Cooper.
External collaborator: Richard Snowball (Western Australian Department of Agriculture and Food).

Reference to the DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Commenced.

The trial is part of a broader national project in each state supported by the Rural Industry Research and Development Corporation to promote quinoa production from a niche crop to a widely-adopted product across Australian broad-acre farming areas. The project will attempt to improve knowledge on quinoa's agronomy, production, seed processing and genetics.

Inspecting insect damage

Results

Visually, quinoa is growing well in our irrigated dry season environment. Quinoa has a tendency to lodge but the plots with higher sowing rates are shorter and look less susceptible to lodging. Post-flowering irrigation has not caused sprouting. The first of two sowings have been harvested using a conventional header; windrowing may be a better option to reduced harvest losses.

2.6 Agricultural Viability in the North Australia Water Resource Assessment

Contact: Mila Bristow – Principal Research Scientist
Collaborating staff: Ian Biggs, Alan Niscioli and Arthur Cameron.

Reference to the DPIF Industry Development Plan 2013-2017:
1.1 Provide certainty and security to encourage investment.

Project Status: Commenced.

Most of northern Australia's land and water resources have not been mapped in sufficient detail to support reliable resource allocation or to mitigate investment or environmental risks. In this project we attempt to provide information about the commercial viability of agricultural opportunities, including irrigated agriculture, horticulture and forestry in the Darwin Regional Assessment Area, defined by the Finniss, Adelaide, Mary and Wildman river basins.

Results

The project has developed milestones for future work and started to collect data.

2.7 Land Use Mapping for Biosecurity in the Northern Territory

Contact: Mila Bristow – Principal Research Scientist
Collaborating staff: Alan Niscioli and project partners.

Reference to the DPIF Industry Development Plan 2013-2017:
1.1 Provide certainty and security to encourage investment.
3.4 Respond to biosecurity incursions.

Project Status: Commenced.

This collaborative project with DLRM, biosecurity staff and others intends to develop current and accurate land use maps of existing primary industries in the Northern Territory.

A project steering committee meeting

Results

Data collection has started and it is too early to report results.

2.8 Rural Research and Development for Profit: Optimising Nutrient Management for Improved Productivity and Quality of Mangoes

Contact: Mila Bristow – Principal Research Scientist
Collaborating staff: Tony Asis, Alan Niscioli and Cameron McConchie.

Reference to the DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Commenced.

Since nitrogen (N) is an essential tree crop nutrient, the cost of fertiliser constitutes a major proportion of farm production costs and greatly influences fruit production and quality. Mangoes are a significant tree crop grown in tropical areas of Australia, annually valued at $140 million (http://www.industry.mangoes.net.au/mango-production/). However, there is little available data on the relative importance of soil N needs and total N losses under current management. Moreover, methods to mitigate losses are limited because there is limited understanding of N requirements by plants and effective methods to reduce losses. This project will use stable isotopes in an integrated approach to quantify plant N demand and cycling through the soil-plant-atmosphere system to improve mango quality and yield.

Results

Preliminary trial work with isotopes has started but it is too early for results.

2.9 Intensive Cropping Systems in the Douglas-Daly District

Contact: Peter Shotton – Farming Systems Research Officer
Collaborating staff: Robert Parker, Cameron Heeb, Callen Thompson and Ian Biggs.

Reference to the DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Commenced.

The project intends to develop a sustainable crop rotation system for grain and fodder crops in the Douglas Daly region, use dry-season irrigation to achieve all-year cropping and develop a sustainable cropping system at Douglas Daly Research Farm to encourage investment in the region. Jarrah grass and lucerne were planted. The peanut crop will be harvested soon.

The peanut crop at the Douglas Daly Research Farm

Results

The project is in its early stages and no results are available at the moment.

2.10 Irrigated Grass/Leucaena Pasture under Grazing in the Douglas-Daly Region

Contact: Peter Shotton – Farming Systems Research Officer
Collaborating staff: Robert Parker, Cameron Heeb, Callen Thompson and Ian Biggs.

Reference to the DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Commenced.

The objectives of this project are to determine the productivity and viability of an irrigated leucaena/grass pasture in the Katherine Daly Basin and provide baseline information on its management, cost, returns and sustainability.

Irrigated leucaena at the Douglas Daly Research Farm

Cattle grazing irrigated leucaena at the Douglas Daly Research Farm

Results

The cost of diesel fuel to deliver 1 ML of water was around $100 to $120; individual cattle daily live-weight gain (LWG) was 0.5 kg and LWG per hectare was between 1.4 and 4.6 kg per day.

2.11 The Central Australian Horticultural Development Project

Contact: Stuart Smith – Manager, Central Australian Horticultural Development Project
Collaborating staff: Sarah Tsai, Glen Oliver, Peter Bidgood, Dylan Williams, Aaron Braun, Simon Carr, Darren White, Debbie Roberts and Pieter Conradie.

Reference to the DPIF Industry Development Plan 2013-2017:
1.1 Provide Certainty and security to encourage investment.

Project Status: Commenced.

The project aims to lower risks due to insufficient information to Central Australian producers and investors by conducting market-focussed trials on horticultural products from Tennant Creek to the South Australian border, including cultivar evaluation of garlic, table grapes, mangoes, bush tomatoes, quinoa, stone fruit, citrus, persimmons and dates. It also intends to evaluate the use of recycled water on soil characteristics. Fifteen table grape selections from the CSIRO table grape breeding program and three commercial controls (Menindee Seedless, Midnight Beauty and Crimson Seedless), were planted in February at the Arid Zone Research Institute. Also, seven varieties of garlic were planted in May 2016. Recycled water class B was used to grow lucerne (cv. SARDI 10). Several bush tomato selections were also planted.

A Davis weather station at the grapes plot, supplied by Observant

Ninti One bush tomatoes

Results

The project started recently and current results are preliminary.

Meteorological data was analysed. Chill effects on nut and stone fruit cultivars were calculated using the Dynamic Model for Central Australian Meteorological Stations to determine their effect (see Table 1).

Table 1. Chill factors

Location	Chill Portions (CP)	Crop Opinions*	Cultivar*
Tennant Creek Airport	**1** +/- 1	Not enough Chill Portions	
Territory Grape Farm	**11** +/- 8	**Almond**	*Nonpareil – CP **23*** *Desmayo Largueta – CP **28***
		Pistachio	*Mateur – CP **36***
Jervois	**20** +/- 13	**Nectarine**	*Aprilglo* – CP ***12*** *Mayglo – CP **18***
Alice Springs Airport	**29** +/- 6	**Cherry**	*Cristobalina – CP **30***
		Apricot	*Canino – CP **25***
Yulara Airport	**26** +/- 5	**Peach**	*Flordaprince – CP **8*** *Earligrande and Maraviha – CP **12***

*http://fruitsandnuts.ucdavis.edu/Weather_Services/chilling_accumulation_models/CropChillReq/

Garlic (Domfield), 62 days after planting

Hand planting garlic

Frost is a constraint to the development of tropical fruits and vegetables in Central Australia. It killed the leaves of grape plantings and no bud-burst occurred by August. The garlic varieties have been growing vegetatively and are yet to bulb as they are in the eight to 10-leaf stage. Glen Large has shown susceptibility to the garlic herbicides ioxynil and methabenzthiazuron. The lucerne has established. The bush tomatoes were affected by frost but are expected to emerge during warmer weather. The following two figures are examples of the frost analysis work done at stations in the Red Centre. These are box and whisker plots, where the range of readings is defined by the bars, the median is in red and the box defines the readings from the first to the third quartiles.

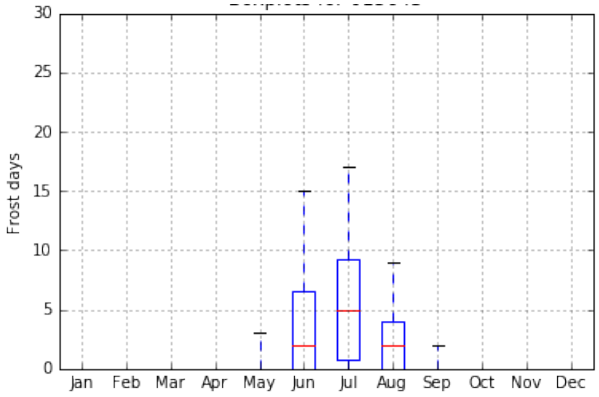


Figure 1. Frost recording at Territory Grape Farm

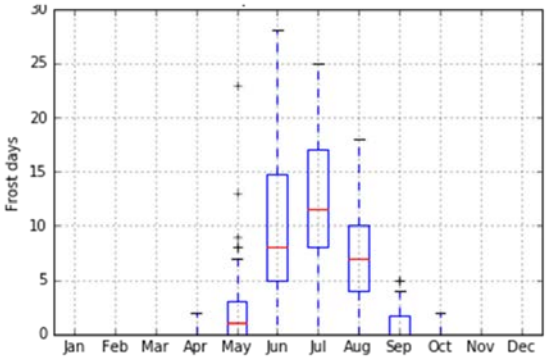


Figure 2. Frost recording at Alice Springs Airport

Table 2. Rainfall and potential evapo-transpiration data for Central Australia

Location	Annual rainfall (mm)	Annual evapo- transpiration
Tennant Creek Airport	474.9	2485
Territory Grape Farm	319.9	2419
Jervois	286.9	2510
Alice Springs Airport	282.8	2373
Yulara Airport	274.6	2441

Evapo-transpiration is between ~5-10 times average annual rainfall (see Table 2).

SARDI 10 lucerne growing using recycled water

Hand planting CSIRO table grape selections

2.12 Dynamics of Nitrogen Uptake and Mobilisation in Mango Trees: A Stable Isotope Technique

Contact: Constancio Asis - Senior Research Agronomist
Collaborating staff: Lorenzo Meschiari, Mila Bristow and Cameron McConchie.

Reference to the DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.
Project Status: Commenced.

Nitrogen (N) has the greatest effect on growth and development in mango trees because of its physiological and morphological functions. Plant responses to N are influenced by amount, timing and method of fertiliser application as well as agro-climatic conditions and phenological stages of the tree. This project will monitor the dynamics of N uptake and mobilisation at different plant growth stages using a ^{15}N labelled stable isotope tracer, which accurately partitions the different sources of N taken by the plant and helps to develop nutrient management strategies to maximise growth, yield and fruit quality. Kensington Pride mango trees were planted at Coastal Plains Research Farm in September 2015. The trial used 0, 20, 40 and 60 units of N per tree, as ammonium sulphate with 2 atom% excess ^{15}N. The trial will run for five years of sampling. At harvest, trees will be partitioned into roots, trunk, branches, leaves, and fruit (fruit bearing stage). Samples will be oven-dried, ground and analysed for total N and isotope (^{15}N) analysis.

Planting young grafted mango trees at Coastal Plains Research Farm

Foliar application of micronutrients

Results

Results will be available after the first year's harvest.

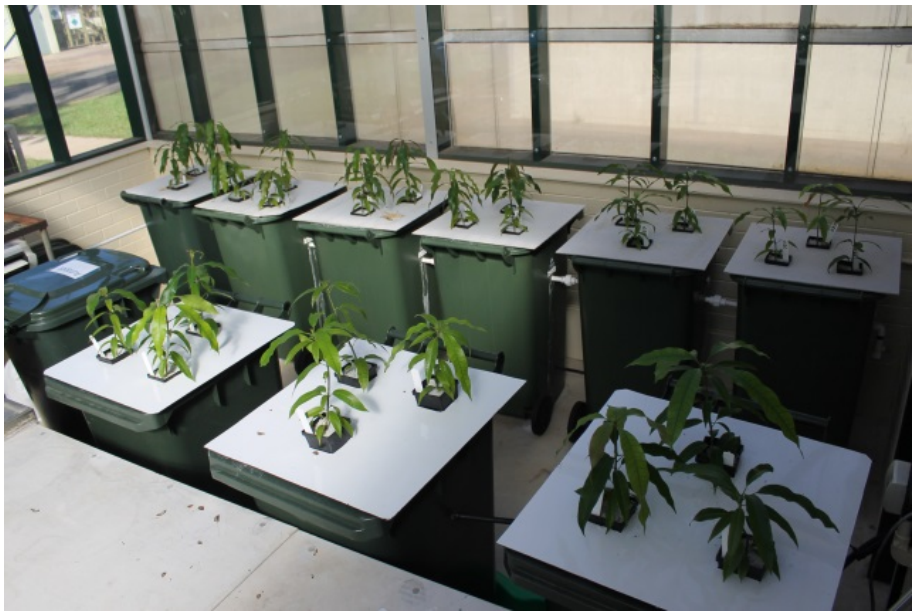
2.13 The Effect of Chloride on the Growth of Mango Trees using Aeroponics

Contact: Constancio Asis - Senior Research Agronomist
Collaborating staff: Lorenzo Meschiari and Cameron McConchie.

Reference to the DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Commenced.

Mango trees are chloride-sensitive, particularly during the first two years. Later on, production can be affected by chloride-based fertiliser. However, chloride toxicity is often hard to diagnose since it is difficult to separate the effects of chloride from other cations. Moreover, visual symptoms, such as marginal necrosis due to chloride, may also be due to iron deficiency. Aeroponics enables the isolation of applied chlorine without interference. This clarifies the visual effects of chloride toxicity. Phenological effects on root and shoot growth in young mango trees are also clarified.



Mango plants grown under aeroponics culture

Results

Results will be available after the harvest.

2.14 Reducing Lodging in Aromatic Rice using Plant Growth Regulators

Contact: Constancio Asis - Senior Research Agronomist
Collaborating staff: Nick Hartley, Cameron McConchie, Mila Bristow, Ian Biggs, Callen Thompson and Bob Williams.

Reference to the DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Commenced.

Earlier studies have identified promising rice cultivars at Tortilla Flats on the Adelaide River. However, some of these cultivars are susceptible to lodging, which reduces the efficiency of mechanical harvesting, grain yield, grain quality and market price. Plant growth regulators (PGRs) affect plant growth and development and are now used in agricultural and horticultural crops to reduce vegetative growth and potentially modify grain yield. There is little information on the use of PGRs to reduce plant height and increase lodging resistance in aromatic rice. The project examines the effect of commercially-available PGRs on the growth and yield of promising aromatic rice cultivars in the Northern Territory. A 2 x 2 factorial experiment, arranged in a strip-plot design with three replications was conducted at Bay 1 screen house at Tortilla Flats, Adelaide River. Aromatic rice cultivars Basmati and Kyeema were assigned a horizontal factor and PGRs (control, prohexadione-calcium [PHC] and trinexapac-ethyl [TNE]) a vertical factor. PGRs were applied 35, 45, and 55 days after sowing at 100 g active ingredient/ha in each spraying. Plant population per linear meter, plant height (cm) and leaf colour were recorded at 0, 10, 20, and 30 days after spraying. Plants will be harvested at maturity.

Applying plant growth regulators at 35 days after sowing

Sensing leaf colour using a portable crop sensor at 35 days after sowing

Results

Results will be available after the harvest.

2.15 Mango Leaf Hopper Abundance over Time

Contact: Brian Thistleton – Principal Entomologist
Collaborating staff: Mary Finlay-Doney, Natasha Burrows, Lanni Zhang and Michael Neal.

Reference to DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Commenced.

This project attempts to identify how and why leafhoppers (*Idioscopus* spp.) infest mango trees so that control methods can be prepared, including the identity of effective entomopathogenic fungi that can control them. The research concentrates on three issues: 1. Biology - The biology of these pests is not well known. They are assumed to persist in low numbers year round and to build up and move into orchards during flowering. A long-term field survey of mango and other potential host plants will be used to characterise their biology and identify their counter seasonal habitat(s). 2. Host plant attraction - Leafhoppers become pestiferous during flushing and flowering. Field observations of unsprayed trees show that some plants become heavily infested whilst others remain relatively free of leafhoppers. Herbivorous insects are known to respond to changes in the secondary plant compounds of their hosts. Volatiles of infested and uninfested mangoes will be sampled throughout the season and components will be identified. Correlations will be tested with electro-antenogram trials. 3. Entomopathogens - Entomopathogenic fungi have been used to manage *Idioscopus* spp. in other countries. Although this technology has been proven, it has not been used in Australia and local pathogens have not been identified. Field populations of *Idioscopus* spp. in the Northern Territory and Queensland will be surveyed for the pathogens and, when found, will be isolated, cultured and tested in bioassays. Leafhoppers were monitored for one year to identify links between plant phenology and the life stage and abundance of the leafhoppers. Visual counts and sweep nets were used to estimate leafhopper presence. Plant phenology and an assessment of tree canopy density were recorded.

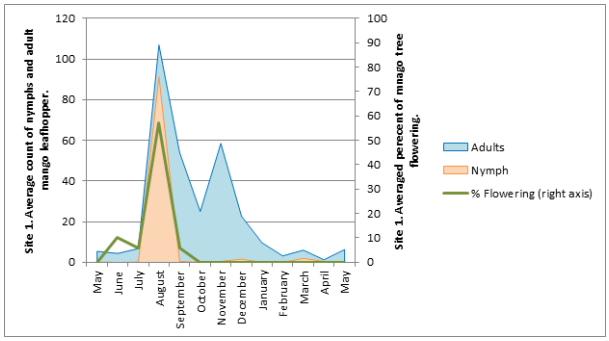


Figure 1. Site 1 flowering, nymphs and adults

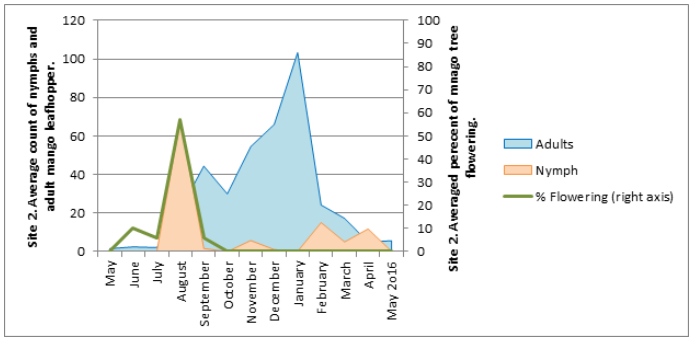


Figure 2. Site 2 flowering, nymphs and adults

Results

Only two sites on unmanaged orchards had leafhoppers. However, the two sites have different plant health status. One site has very large old trees in good health, while the other has younger and smaller trees, which suffered from termites and dieback.

A locally unknown mango leafhopper was identified at two sites. It was *Idisocopus clypealis*, which was recently recorded by NAQS in the Tiwi Islands and is present in Queensland since the 1980s. A *Metarhizium* culture is being tested.

2.16 Mahogany Plantation Measurement, Maintenance and Use

Contact: Mila Bristow – Principal Research Scientist
Collaborating staff: Paige Richter and farm staff at CPRF, KRS and DDRF.

Reference to the DPIF Industry Development Plan 2013-2017:
1.1 Provide certainty and security to encourage investment.
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Continuing.

The expansion in the production of African mahogany (*Khaya senegalensis*), which is an internationally important high-value forest tree species, is continuing in the Northern Territory. The project will identify the necessary silvicultural inputs to optimise the value of African mahogany in existing and future plantations in northern Australia.

Results

Results of older local farm trials on African mahogany have been recorded for use.

Measuring stem diameter in an African mahogany trial at Coastal Plains Research Farm

2.17 Communication of Plant Industries Development Activities

Contact: Mila Bristow – Principal Research Scientist
Collaborating staff: Paige Richter, Tony Asis, Alan Niscioli, Heather Wallace, Lorenzo Meschiari, Amy Dobell, Teagan Alexander and Chelsea Moore.

Reference to the DPIF Industry Development Plan 2013-2017:

1.1 Provide certainty and security to encourage investment.

1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Continuing.

The project aims to communicate and promote primary industry research, development and extension activities through articles in newsletters, magazines and online, such as website updates and transition to the new whole of government site (NT.GOV.AU).

Results

We have participated in the *Top Paddock* Newsletter, the *Katherine Rural Review* and the CE's Newsletter. .

Nine videos were uploaded onto the Growing Tips YouTube page

Promotional videos were prepared for the XI International Mango Symposium in Darwin,

We promoted the Science in Schools program, which ran for half a day a week over four weeks for students from transition through to year 4, including interactive science lessons on such subjects as plants, fungi and insects.

2.18 Manipulating Mango Flowering to Extend the Harvest Window

Contact: Cameron McConchie – Research Leader
Collaborating staff: Amy Dobell, Paige Richter, Amy Dobell, Alan Niscioli, Cliff Hansen and Mila Bristow.

Reference to DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Continuing.

The project is investigating on-farm management systems to increase the production period in mangoes. It evaluates existing weather data to predict inductive weather conditions so growers can then respond appropriately. The effect of paclobutrazol, ethephon and nitrate on current cultivar trees and on rootstock-scion combinations will be assessed. Aeroponics will be used to more precisely describe chemical uptake and growth responses. The appropriateness of these methods for commercial use will then be validated under orchard conditions. A selection of additional chemicals with similar actions to those currently used internationally for manipulating mango flowering will also be evaluated.

Out of season flowering chemically induced by floral promotor

Results

The weather conditions in 2016 were exceptionally warm with night temperatures in Darwin not going below 20° C until late July. These conditions were ideal for testing the capacity of chemicals to induce flowering in mango trees under non- inductive conditions. It was shown for the first time that Kensington Pride was responsive to a floral promoter. In comparison, the lack of response to potassium nitrate, which is widely used in Darwin to promote flowering, indicates that it is more suitable for use during cool inductive conditions. Thidiazuron, previously reported to induce flowering, was also shown to be ineffective and possibly more suited to manipulate fruit growth after anthesis. Prohexadione-calcium was found to be ineffective at inhibiting vegetative growth in Kensington Pride but this could change if more appropriate adjuvants were used. Trinexapac-ethyl was found to reduce growth but did not increase flowering. Surprisingly, foliar-applied paclobutrazol, which is usually applied as a soil drench, was found to promote uniform flowering with a condensed period of anthesis at low concentrations but rendering flowers sterile at higher doses.

2.19 Diversification Program – Peanut Variety Trials

Contact: Ian Biggs – Senior Research Agronomist
Collaborating staff: Callen Thompson, Kae Wegman, Teagan Alexander, Johnny Cooper, Karl Bourne and Mike Kahl.

Reference to DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Continuing.

In collaboration with the Peanut Company of Australia, 18 peanut varieties were planted in replicated small plots in the bird exclusion cage over two dry seasons (2014 and 2015) at Katherine Research Station to assess their potential.

Results

Peanut yield and quality were assessed. Potential hay yield was also assessed. The economic potential of the peanut varieties is being assessed.

The trial has provided experience in growing peanuts and in operating peanut harvesting machinery. Variety Sutherland appears to have potential as a grain and hay producing crop. The peanut varieties grew with minimum pest and disease problems. Peanut production on a larger, semi-commercial scale would provide more information on cultural practices. Water use, irrigation and weed control studies would be useful for potential commercial producers.

2.20 Diversification Program – Industrial Hemp (*Cannabis sativa*) Variety Trials

Contact: Ian Biggs – Senior Research Agronomist
Collaborating staff: Callen Thompson, Kae Wegman, Teagan Alexander, Johnny Cooper, Karl Bourne and Warren Hunt.

Reference to DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Continuing.

In collaboration with Ecofibre Pty Ltd., industrial hemp was planted at Katherine Research Station's bird exclusion cage on three different planting dates. On each planting date, three varieties were planted in replicated small plots under two treatments: on either a former peanut crop area or on bare fallow land. One of the three varieties is for fibre production and the other two are for grain production. The varieties will be assessed for growth habit in response to day length, development phenology, agronomy, yield potential, yield quality, tetrahydrocannabinol drug concentration and extracted oil quality. The aim is to test selected industrial hemp varieties for suitability in farm diversification and crop rotation.

Results

The growth response to day length at Katherine was assessed. One fibre variety and one grain variety started flowering very soon after emergence and therefore did not develop a large biomass. These varieties have produced seed, which will be harvested in 2016 (approximately 90 days after sowing). The second grain variety has produced a larger plant, potentially due to delayed flowering and thus delayed cessation of growth due to flowering. Plant growth phenology has been assessed. Drug levels, grain yield and extracted oil yield will be assessed.

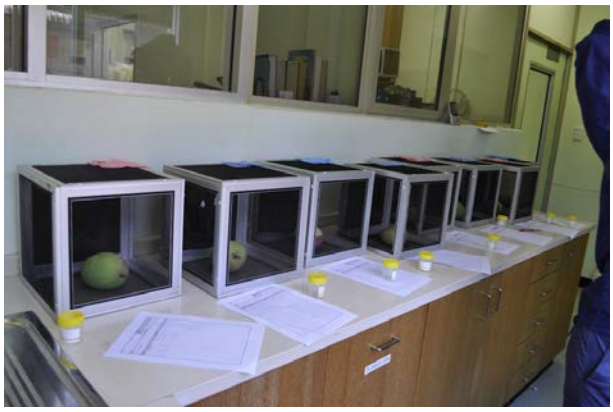
2.21 A Fruit Fly Control System for Mature Hard Mangoes and Market Access (HIA MG12017)

Contact: Brian Thistleton – Principal Entomologist
Collaborating staff: Bob Williams, Austin Mclennan, Mary Finlay-Doney, Natasha Burrows, Lanni Zhang and Michael Neal.

Reference to DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Continuing.

Extensive examination of fruit at packing sheds has shown that infestation of hard mature mangoes by the fruit flies *Bactrocera tryoni* and *B. jarvisi* is extremely rare. There is therefore a potential for new market access for hard mature mangoes as conditionally free of fruit flies, which would no longer require post-harvest disinfestation against fruit flies. Studies were conducted to confirm this assumption. Oviposition tests were conducted in over 150 Calypso (B74) and Kensington Pride mature hard fruit. Single sexually mature females were placed in a cage with a single mango fruit and observed for 2 hours. Brix and dry matter percentages in each fruit were measured and the eggs in the fruit fly ovaries were counted.



Oviposition experiments in cages in a laboratory

Cera trap for fruit fly adults

Results

Neither species of the fruit fly was able to successfully oviposit in the hard fruit, possibly because it was not possible for them to penetrate the fruit. However, when the skin was cut and eggs were artificially placed into the flesh, both species were able to complete development.

2.22 The Northern Territory Economic Insect Collection (NTEIC) and Diagnostic Service

Contact: Brian Thistleton – Principal Entomologist
Collaborating staff: Mary Finlay-Doney, Natasha Burrows, Haidee Brown, Lanni Zhang, Michael Neal and Austin Mclennan.

Reference to DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Continuing.

NTEIC has over 48 000 accessions, which are an important diagnostic resource. This helps in insect diagnosis, such as thrips, mites, scales, mealybugs termites, ants and fruit flies.

Examining insects

Results

Assistance in diagnosis and treatment of pests was provided in response to 584 enquiries from local clients; newly-found pests, such as the ants *Lepisiota frauedenfeldi* and *Monomorium dichroum*, were added to the collection list.

2.23 Selecting a Tropically Adapted Lucerne

Contact: Callen Thompson – Senior Extension Agronomist
Collaborating staff: Teagan Alexander, Karl Bourne, Johnny Cooper and David Hancock.

Reference to DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Continuing.

In cooperation with Seed Genetics International, which is a commercial lucerne breeder interested in developing tropically-adapted varieties of lucerne, a replicated variety trial was started at Katherine Research Station (KRS) in 2014. Eight varieties were sown with three replications. Persistence counts were taken during the trial. Selections from these plots were taken for breeding in future. In July 2016, 55 varieties and breeder lines were sown under pivot irrigation at the Douglas Daly Research Farm. Unfortunately, part of the trial area was damaged post-emergence and the crop is being sown again at KRS. The trial will continue for the next three dry seasons. Persistence will be monitored by plant counts at the end of each dry season. Selections will be taken from these lines for future breeding.

Lucerne growing at Katherine Research Station

Results

Trial yields at KRS were good during the dry season but were reduced during periods of high rainfall. Although not significant, the more productive varieties had higher persistence. The plants persisted relatively well over the two wet seasons. This unexpected performance was likely due to two low-rainfall wet seasons and good weed control during the trial.

2.24 Termite Control

Contact: Brian Thistleton – Principal Entomologist
Collaborating staff: Michael Neal.

Reference to DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Continuing.

The project provides plant industries with control measures against termites, such as *Mastotermes darwiniensis*.

Results

Assistance is provided to manufacturers to trial new products against termites and farmers are advised on the control of the pest.

2.25 Action on the Ground - Reducing Greenhouse Gas Emissions through Improved Nitrogen Management on Northern Territory (NT) Farms

Contact: Mila Bristow – Principal Research Scientist
Collaborating staff: Alan Niscioli, Teagan Alexander, Heather Wallace, Paige Richter, Kae Wegman, partner organisations QUT and Ord Co.

Reference to DPIF Industry Development Plan 2013-2017:
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Continuing.

The project aims to reduce nitrous oxide (N_2O) emissions from northern Australian farm soils. N_2O is a potent greenhouse gas with a global warming potential 300 times that of carbon dioxide. It is an important greenhouse gas in agricultural systems, emitted from soils following the addition of nitrogenous fertilisers to improve plant growth. It reduces fertiliser efficiency, which affects profitability for farmers and can also significantly impact on the environment. The project investigates ways to reduce N_2O emissions from soils where fertilisers, including enhanced efficiency fertiliser, are used to grow sugarcane, irrigated fodder, mangoes and bananas in the Ord River region of Western Australia and the Darwin and Katherine regions of the NT.

Measuring soil gas exchange under a mango tree

A soil gas exchange chamber in the banana gas emission trial, Kununurra, WA

1. *Gas emission trials at a Calypso farm in the top End*

Two trials were conducted in the Top End of the NT on two Calypso mango farms that investigated the effects of three N fertiliser applications: farmer practice, an equivalent rate in the form of urea and an equivalent rate in the form of an enhanced efficiency urea, each supplying 50 kg N/ha (site 1) and 25 kg N/ha (site 2) on N_2O gas emissions.

Results

At both Calypso mango farms and in all treatments soil N_2O fluxes were near zero g N_2O/ha/day during most of the trial, except during high rainfall events, such as the 170-mm rainfall in the five days to 24 December 2015 and immediately after fertiliser was added in mid-January 2016. Two weeks later, emissions were near neutral again. The trials will continue.

2. The effect of plastic mulches on gas emissions in a Top End irrigated watermelon crop

The effect of plastic mulch rows compared with inter-rows on gas emissions in an irrigated dry season watermelon crop was investigated to better understand the impact of chamber location.

Results

Peak soil N_2O emissions were correlated with regular fertigation and high rainfall events. Soil N_2O emissions were higher in the plastic mulch rows than in the adjacent inter-rows. However, the assumption that inter-row positions would have no emissions was incorrect. The cumulative fluxes in the inter-row positions were high, at 75% that in the within-row, plastic mulch positions. This highlights the importance of the location of soil chambers when measuring soil gas exchange and suggests that soil emissions in row-cropping systems could be higher than previously estimated.

3. N_2O emissions from sugarcane production, Kununurra

The effect of 400 kg/ha urea (farmer practice fertiliser), 400 kg/ha of an enhanced efficiency fertiliser (EEF) form of urea, and 200 kg/ha of EEF urea were compared with a control (no fertiliser) plot.

Results

Soil N_2O emissions following flood irrigation showed differences in the treatments when soils were exposed after the water subsided. Higher rates of N application had higher gas emissions, with considerable variation within and between treatments. Relationships and drivers of this will be explored in future. This trial is in collaboration with our partners at Ord Co., Kununurra and the Queensland University of Technology, Brisbane.

4. N_2O emissions from banana production, Kununurra

Very large amounts of N can be used during banana production and much of it is lost through N emissions or is leached. This trial aims to establish a reference point for understanding soil N_2O emissions under banana production in the Ord region. Soil gas exchange was measured but results are pending.

2.26 Tropical Tree Fruit Research and Development in the Philippines and Northern Australia to Increase Productivity, Resilience and Profitability – Jackfruit and Rambutan

Contact: Mark Hoult – Senior Horticulturalist
Collaborating staff: Mark Traynor.
External collaborators: Yan Diczbalis and Dr Kent Fanning, Queensland Department of Agriculture and Fisheries; Virgilio Loquias, Bureau of Plant Industry, Davao; Dr Carlos de la Cruz, Department of Agriculture, Leyte; Dr Lucia Borines, Visayas State University, Leyte, the Philippines; and Justin Davies and Connie Banos, ANSTO, Sydney.

Reference to DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Continuing.

The Northern Territory (NT) tropical fruits sector is worth $7 million annually (at the farm gate). It includes over 50 growers and a diverse range of products, of which jackfruit and rambutan are a significant component. The NT is a major domestic supplier of both jackfruit and rambutan; however, despite a strong demand, key constraints are restricting increased production of these crops. This ACIAR-supported project aims to overcome some of these problems to improve the production of these emerging fruit crops in the NT. The project has a holistic approach to tropical fruit production, working on nursery and disease management (such as nursery hygiene, the use of plant defence activators, rootstock disease resistance) and production (such as flower induction, crop load and nutrition management, and identification of superior genes). Tropical fruit production also contributes to the livelihood of small-holder farmers and supports village food security in the Philippines, the partner country in this project. Jackfruit is a key crop identified by the Philippines government for research and development.

Jackfruit

A shortage of selected cultivars to improve fruit quality, high yield and seasonality is a limiting factor for NT jackfruit growers. Most orchards are seedling based, resulting in large variability in commercial traits, which impacts on wholesale prices and affects the image of the NT industry as a consistent and reliable supplier of quality jackfruit. Currently, only one of 17 growers is known to have grafted selections. A key aim of the project is to develop locally-adapted commercial scion cultivars for the industry. This includes the identification and propagation of improved local selections from grower “best seedling” trees and also “backyard” or residential sources, standard seedling selection from diverse, open-pollinated seed lots and study the effect of gamma irradiation of selected seed as a potential tool for inducing mutant traits, such as reduced seeds and/or a compact form in treated seedlings.

Rambutan

Currently, rambutan orchards have mixed cultivars and hence a variable product and, when coupled with erratic pollination and phenology, can impact on supplies to markets. A key factor that limits expansion is the non-availability of quality clonal planting material and a limited nursery demand, which makes it unattractive to wholesale nurseries to produce. Earlier research identified marcotting (air-layering) of rambutan as a reliable method of clonal propagation and is one propagation method that could alleviate this constraint. The method has been adopted by the industry.

Results

Jackfruit

A preliminary survey of fruit quality highlighted a large variability in fundamental fruit quality parameters, reflecting a “seedling-based” rather than a selected clone-based industry. The best local seedling tree was identified and vegetatively propagated for field establishment at the Coastal Plains Research Farm. Standard phenology, yield and fruit quality evaluations will be conducted as this germplasm matures. A limited number of grafted trees were supplied to collaborating farmers to conduct their own evaluations. Also, some notable “backyard” trees from households around Darwin were identified and included in this germplasm collection. Preliminary observations have been recorded on the “graft take” ability of the different jackfruit selections. Eleven accessions have been established to determine performance and fruit quality.

Flowering has commenced in the three-year-old plants established in 2014 confirming previous observations that jackfruit seedlings exhibit a quick transition from the juvenile to the reproductive phase. This trait will be very useful for selection purposes and will allow rapid crop improvement. Selection parameters will include high yield, Rhizopus disease tolerance, dark coloured and firm aril, high aril sugars, a high proportion of aril recovery, low latex and early seasonality.

Irradiation was conducted on two seed accessions (NT 213 and NT 281), using three seed storage times (19, 7 and 4 days pre-transportation and irradiation treatment) and five dosage rates (0, 10, 30, 50 and 150 Gy gamma radiation cobalt-60, rate 4.23 Gy/minute, Fricke dosimeter). Limited seed restricted the number of seeds per treatment, with 30 seeds (10 from seven-day storage and 20 from 19-day storage) per treatment for NT 213 and 20 seeds (4 days storage) per treatment for NT 281.

Table 1. Transit details for irradiated jackfruit seed lots

Transit details	Day	Cumulative days
Courier picked up at Berrimah Farm, Darwin 15 November	1	
Arrived Sydney 16 November, held in-transit store	2	
Delivered to ANSTO 17 November	3	three days in-transit
Held at ANSTO 18 November	4	
Treated 19 November	5	
Held at ANSTO until 23 November	9	
Picked up by courier from ANSTO 25 November	11	8 days at ANSTO
Delivered to Berrimah Research Farm, Darwin, 27 November	13	2 days in-transit

Overall germination in treated seeds averaged 43% irrespective of accession, storage time or dose rate with most losses due to in-transit rots. Improvement in seed viability may be achieved by quick transit and treatment time, fungicidal treatment and extraction of seed from firm mature fruit rather than from over-ripe fruit. While some seeds from the highest dose rate (150 Gy) remained alive, they failed to grow with only some having a rudimentary shoot, which subsequently died.

Seedlings were measured three months after sowing for height and basal stem diameter. Dose rates did not impact on seedling diameter except for the 50 Gy rate. Radiation had more influence on seedling height; the 50 Gy rate reduced seedling height. Response also varied depending on seed lot accession (Figure 1).

Suggested future dose rates are 50, 70 and 100 Gy. In-transit rots need to be alleviated.

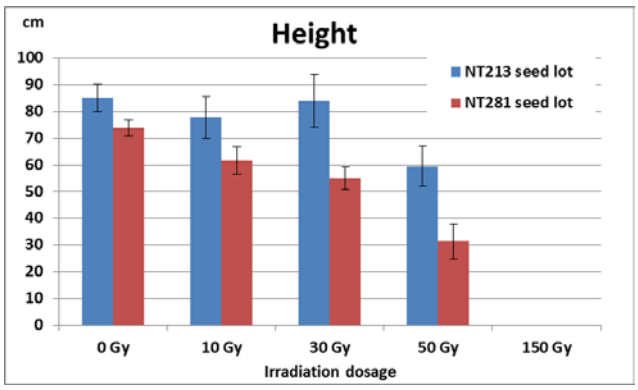


Figure 1. The impact of irradiation dose on jackfruit seedling height (n=10)

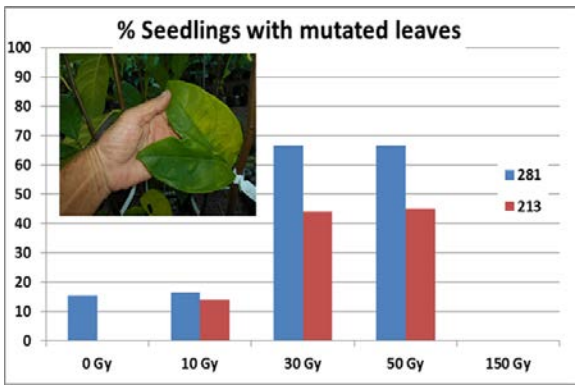


Figure 2. Jackfruit seedling leaf mutation post seed irradiation

Table 2 shows graft compatibility of the *Artocarpus* genus with several species from Berrimah Farm.

Table 2. Summary of grafting jackfruit species and *Artocarpus*

NT accession	Rootstock species	Preliminary *A. heterophyllus* scion graft observations, Berrimah Farm (2015-16)
216	*Artocarpus odoratissima*	80% graft take; 2 lots; single scion; n = 25
217	*Artocarpus hypargyreus*	70% graft take; 1 lot; n = 6; delayed incompatibility; field trees died @ 18 months
221	*Artocarpus sarawakensis?*	100% graft take; 2 lots; n = 12
223	*Artocarpus kemando*	0% graft take; 1 lot; n = 10
226	*Artocarpus integer*	10% graft take; 1 lot; n = 8
241	*Artocarpus rigidus*	82% graft take; 2 lots; n = 20
228	*Artocarpus heterophylus*	0-100% graft take i.e. scion dependant; several lots; n>200
NT accession	Rootstock species	Preliminary *A. glaucus* (NT 219) scion graft observations, Berrimah Farm (2015-16)
213	*Artocarpus heterophylus*	80% graft take; reciprocal i.e. species grafted on Jackfruit; 85%; n = 8; NT endemic species

Rambutan

We have evaluated the performance of marcott establishment in high density clonal orchard systems. Establishment of marcotts in high-density configuration has been very good with 95 to 100% survival across four commercial cultivars. Non-bearing growth rates have been very uniform with only the “R 167” cultivar being marginally more vigorous and the “Binjai” cultivar being marginally less vigorous across all cultivars. Overall, there was a threefold increase in growth between year one and year two in all cultivars (Figure 3). Full leaf nutrient analysis showed no significant differences between cultivars for all macro-elements and most micro-elements. The only micro-element with a significant difference ($P < 0.05$) between cultivars was zinc.

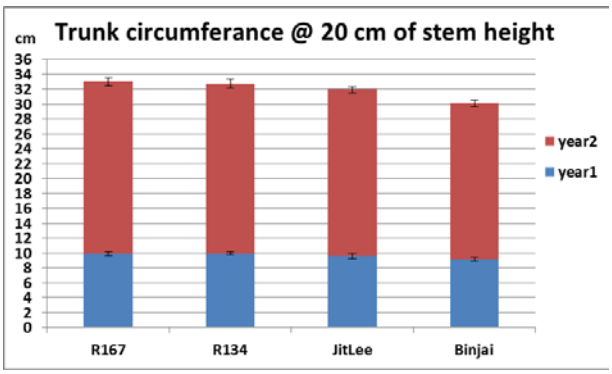


Figure 3. Early growth of rambutan marcotts at Coastal Plains Research Farm (n = 18)

Two-year-old rambutan marcotts at Coastal Plains Research Farm

2.27 Tropical Tree Fruit Research and Development in the Philippines and Northern Australia to Increase Productivity, Resilience and Profitability – Passionfruit

Contact: Mark Traynor – Senior Technical Officer
Collaborating staff: Mark Hoult and Chelsea Moore.

Reference to DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Continuing.

This ACIAR-funded project focuses on a holistic approach to increase passionfruit production by improving nursery and disease management (nursery hygiene, use of plant defence activators and rootstock disease resistance), cultural practices (flower induction, crop load and nutrition management, identification of superior genes and examining the role of trellising on yield and improved typhoon/cyclone resilience) and processing. Tropical fruit production contributes to the livelihood of small-holder farmers and village food security in the Philippines. Local passionfruit production has been restricted by a lack of suitable clones and a short vine life. Panama passionfruit from seed produces extremely variable fruit quality. Short vine life is caused by root and stem rots associated with water logging and heavy soils. A range of potential rootstocks were trialled with several "*flavicarpa*" seed lines to extend vine life. Initial screening of many local seed lines was not very successful.

"*Edulis*" types, which are highly valued, will not grow in a tropical environment. In 2014, we crossed selected "*edulis*" parents with selected Panama parents to combine desirable traits from both, principally the dark skin and flavour of "*edulis*" and the fruit size and heat tolerance for flowering and fruiting of Panama. In 2015, we grew 300 seedlings from those crosses and selected the best 10 for full evaluation in 2016.

Passionfruit flowers at pollen dehiscence

Net-protected passionfruit vineyard at Coastal Plains Research Farm

Results

Preliminary 2015 hybrid selections, Berrimah Farm

Vine 34 (average overall rating = 2.2). First harvest – 166 days.

Positives:

- Mid/dark skin colour with medium shine.
- Low “fleck” marking.
- Good size. Average fruit weight – 110 g.
- Good average pulp content – 47%.
- Average sugars – 17.2° brix.
- Consistent round shape.

Negatives:

- Some skin scarring.
- Some flat sides and skin bumps.

Vine 35 (average overall rating = 1.7). First harvest – 145 days.

Positives:

- Mid/dark skin colour with medium shine.
- Average fruit weight – 85 g.
- Average pulp content – 42%.
- Average sugars – 17.1° brix.

Negatives:

- Medium “fleck” marking.
- Medium skin scarring.
- Some flat sides and skin bumps.
- Shape a little variable – round/squat.

Vine 36 (average overall rating = 1.7). First harvest – 166 days.

Positives:

- Mid skin colour with medium shine.
- Low “fleck” marking.
- Low flat sides.
- Good size. Average fruit weight – 96 g.
- Good average pulp content – 48%.
- Average sugars – 15.9° brix.

Negatives:

- Medium skin scarring.
- Some skin bumps.
- Shape a little variable – round/squat.

Vine 53 (average overall rating = 2.7). First harvest – 141 days.

Positives:

- Dark skin colour with good shine.
- Low “fleck” marking.
- Low flat sides.
- Low skin scaring.
- Average pulp content – 43%.
- Average sugars – 16.8° brix.
- Consistent round shape.

Negatives:

- Some skin bumps.
- Smaller size. Average fruit weight – 71 g.

Vine 71 (average overall rating = 2.3). First harvest – 149 days.

Positives:

- Mid/dark skin colour with good shine.
- Low “fleck” marking.
- Low skin scarring.
- Average fruit weight – 88 g.
- Average pulp content – 45%.
- Average sugars – 16.7° brix.

Negatives:

- Medium flat sides.
- Medium skin bumps.
- Shape a little variable – round/squat.

Vine 77 (average overall rating = 1.8). First harvest – 149 days.

Positives:

- Mid skin colour with medium shine.
- Low flat sides.
- Low skin scarring.
- Average fruit weight – 79 g.
- Average pulp content – 41%.
- Average sugars – 16.6° brix.

Negatives:

- Medium “fleck” marking.
- Medium skin bumps.
- Shape a little variable – round/squat.

Vine 78 (average overall rating = 1.8). First harvest – 149 days.

Positives:

- Mid/dark skin colour with medium shine.
- Average fruit weight – 97 g.
- Average pulp content – 46%.
- Average sugars – 16.2° brix.

Negatives:

- Medium “fleck” marking.
- Medium skin bumps.
- Some skin scarring.
- Some flat sides.
- Shape a little variable – round/squat.

Vine 83 (average overall rating = 1.9). First harvest – 180 days.

Positives:

- Mid/dark skin colour with good shine.
- Average fruit weight – 86 g.
- Very good average pulp content – 57%.
- Average sugars – 15.2° brix.
- Consistent round shape.

Negatives:

- Medium “fleck” marking.
- Medium flat sides.
- Medium skin bumps.
- Some skin scarring.

Vine 241 (average overall rating = 1.9). First harvest – 153 days.

Positives:

- Mid/dark skin colour with good shine.
- Low “fleck” marking.
- Low skin bumps.
- Low skin scarring.
- Average fruit weight – 79 g.
- Good average pulp content – 50%.
- Average sugars – 16.7° brix.

Negatives:

- Some flat sides.
- Consistent oval shape – negative?

Vine 279 (average overall rating = 1.9). First harvest – 169 days.

Positives:

- Mid skin colour with good shine.
- Low “fleck” marking.
- Low skin bumps.
- Low skin scarring.
- Average fruit weight – 75 g.
- Average pulp content – 41%.
- Average sugars – 15.7° brix.

Negatives:

- Medium flat sides.
- Shape a little variable – round/oval.

Some hybrids exhibited the “*edulis*” trait of good self-pollinating ability and are precocious with only around five months from planting to harvest compared with the standard Panama Red types, which typically take around nine to 10 months from planting to harvest. While the “woodiness” virus complex is rampant in passionfruit throughout Queensland and NSW, recent testing for the viruses in this complex of the selected Department of Primary Industry and Resources 2015 hybrids was negative. Changes to the NT Plant Health Act prevent the importation of passionfruit plant material into the Territory to ensure virus freedom for a potential local industry.

Selected hybrids were grafted onto rootstocks and distributed to two growers in Katherine and three around Darwin. These hybrids have also been established at Berrimah Farm and the Coastal Plains Research Farm. Data will be collected on phenology (vigour, flowering intensity and precocity), fruit quality (size, shape, colour, defects, % pulp and brix/acid), post-harvest storage (cool-store, weight loss and fungal rots) and potential yield. Pollination and the role of various pollinating insects and hand pollination will be investigated. Preliminary nutrition management to control vine vigour and optimise flowering has also commenced.

2.28 Cool Season Grasses

Contact: Arthur Cameron – Principal Pastures Agronomist
Collaborating staff: Ben Beumer, Caroline Pettit, Paige Richter and Amy Dobell.

Reference to DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Continuing.

Eight tropical pasture grasses are grown under irrigation at Coastal Plains Research Farm to find an alternative to Fine-cut Rhodes grass, which is not palatable to cattle and is difficult to grind, which makes it unsuitable for cubing or pelleting. Seven of the grasses were established by seed sown on 22 December 2014. Strickland grass was planted using runners on 9 February 2015. Establishment was good except for Premier digit. Plots were sampled for yield on 6 May, 25 June, 11 August, 29 September and 17 November, 2015 and 6 April and 31 May, 2016.

Results

Table 1. First year dry matter (DM) yields

Grass	DM (kg/ha) 2015					Total DM (kg/ha)
	6 May	25 Jun	11 Aug	29 Sep	17 Nov	
Fine-cut	5980	5500	3000	6900	7080	28 450
Gulf-cut	6980	4720	2690	7350	6990	28 720
Reclaimer	7730	4990	2850	6570	7500	29 640
Premier	940	1540	2110	4940	7120	16 640
Strickland	4690	4360	2450	6030	6770	24 370
Gatton	7340	6510	2230	4930	6340	27 350
Nucal	8980	4630	3590	6538	7880	31 320
Splenda	9280	5870	2290	6210	6320	29 980
Mean	**6490**	**4760**	**2660**	**6180**	**7000**	**27 100**

Table 2. Second year dry matter (DM) yields

Grass	DM (kg/ha) 2016		Total DM (kg/ha)
	6 April	31 May	
Fine-cut	3850	4520	8370
Gulf-cut	3590	4990	8580
Reclaimer	4060	5120	9170
Premier	4110	3130	7240
Strickland	4790	3710	8500
Gatton	4370	3950	8320
Nucal	6380	4020	10 390
Splenda	2720	4920	7640
Mean	**4230**	**4300**	**8530**

2.29 Optimising Pollination in Dates (*Phoenix dactylifera*)

Contact: Cameron McConchie – Research Leader
Collaborating staff: Glen Oliver, Douglas MacDougall, Vivek Bhat, Mark Hearnden and Alan Niscioli.

Reference to DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.
2.1 Develop and promote more efficient and environmentally sound production systems.

Project Status: Completed.

The project worked with current date palm growers to optimise pollen collection and storage to facilitate artificial pollination. Pollen from different parents was used to identify optimal pollen parents for major commercial date cultivars. Pollen parents affected fruit size, flesh and seed development. Techniques for manual pollination and pollen dilution were investigated. The results will improve the productivity of current date farmers and enable optimal use of the extensive germplasm collection that has been assembled with support from the Rural Industries Research and Development Corporation.

Results

Male palm flowering time and the quantity of pollen produced by male inflorescences has been determined. Fard 4 had the longest duration of flowering and was the first and last variety to undergo anthesis, producing some of the highest mean number of male inflorescences per palm and yielded some of the highest weight of pollen per inflorescence.

Fard 4 provided an elite source of pollen for pollinating major commercial date cultivars. It produced the largest seed and, on occasions, the largest fruit. Dried Fard 4 pollen could be stored at 4° C in a domestic refrigerator.

Flowering in *Phoenix sylvestris* was highly variable, perhaps reflecting the origin of its seedling. *P. sylvestris* appeared to flower later than *P. dactylifera* and produced about half the amount of pollen per inflorescence. Individual palms of *P. sylvestris* produce many more inflorescences than others, suggesting improvement could be made through selective propagation of such individuals. The ability to produce small-seeded large fruit attributed to this species when used on *P. dactylifera* could not be demonstrated.

A local male palm referred to as “Oliver” after Glen Oliver who found it, produced large amounts of pollen but did not contribute to fruit quality.

Fard 4 would provide the Central Australian date industry fresh pollen as it flowered for the longest period compared with other cultivars examined, minimising the need for pollen storage. However, if stored pollen is required during the absence of coincidence of male and female palm flowering, long-term stored dried Fard 4 pollen can be used. Fard 4 male palm pollen also improved fruit quality in all the commercial date cultivars investigated.

Conclusions

Fard 4 will reduce the effects of poor pollination in date production making investment in the production of this crop more attractive.

Recommendations

Nurseries supplying growers with planting material should be aware of the potential demand for Fard 4 plants.

Further research is needed to improve pollination methods in date palms to simplify comparison of pollen effects on fruit quality.

2.30 Mapping the Mango Orchards of the Northern Territory

Contact: Mila Bristow – Principal Research Scientist.
Collaborating staff: Marije ten Napel (project lead), Alan Niscioli and Tony Asis.

Reference to DPIF Industry Development Plan 2013-2017:
1.1 Provide certainty and security to encourage investment.

Project Status: Completed.

This project was conducted to provide an overview of over 6500 hectares of mango farms in the Northern Territory (NT) that annually produce more than 33 000 tonnes of fruit worth over $80 million.

Results

A digital mango 'map' was created by visually identifying the location of all mango plots in the NT on Google Earth. Individual mango plots were outlined by drawing polygons on Google Earth. The map was then validated with the help of mango experts and provided to Charles Darwin University (CDU) and other partners.

Conclusions

The results of this desktop study have helped to improve the spatial understanding of the mango industry to support on-farm decision-making and highlighted the need for more research.

Recommendations

Renew collaboration with DLRM, CDU and the University of New England to develop a new map of primary production land in the NT.

2.31 Reducing Mango Industry Losses from Resin Canal Discolouration

Contact: Cameron McConchie – Research Leader
Collaborating staff: Chris Kelly, Khamla Mott, Paige Richter, Monique Smith, Alan Niscioli, Constancio Asis, Warren Hunt and Bob Williams.
External collaborators: Tim Elliott, Philipa Johnson, and Katrina and Ian Gray (W. E. Pack Pty Ltd.).

Reference to DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Completed.

The aim of this project was to identify the precise causes of resin canal discolouration (RCD), survey growers and mango packers about their experience with RCD, develop a standard procedure for accurately diagnosing and quantifying the defect, monitor fruit from the tree to the market to identify production and post-harvest practices that cause RCD and identify bacteria that contribute to the development of RCD.

Mild resin canal discolouration

Results

Twenty-one out of the 26 surveyed growers and packers from the Darwin area were affected by RCD. Nine growers considered RCD an economic issue for their businesses. Four growers and two packers estimated that RCD accounted for a 10 to 30% loss in production and a 5 to 25% loss during packing. There was considerable variation in production and post-harvest practices.

We developed a standard procedure for accurately diagnosing and quantifying RCD. In Kensington Pride mangoes, the first signs of RCD appeared during the early stages of fruit ripening and reached a maximum at the ripe stage. This highlighted the need to assess fruit for RCD at the (eating) ripe stage.

Monitoring fruit from the tree to the market showed that the effect of RCD on Kensington Pride mangoes varied markedly among nine orchards. In six out of the nine orchards, RCD was significantly higher in commercially transported and ripened fruit relative to fruit ripened off the tree. Fruit affected by RCD had significantly lower total soluble solids at the eating stage compared with unaffected fruit. This provides a potential lead in understanding underlying causes of RCD.

The bacterial organism (*Pantoea agglomerans*) and an *Enterobacter* species were consistently recovered from mangoes exhibiting RCD symptoms. No such bacteria were isolated from asymptomatic resin canals.

P. agglomerans was also detected in mango wash and in water dump solutions at several mango orchards and packing sheds. Kensington Pride mangoes exposed to solutions containing bacteria tended to develop more RCD than those processed with bacteria-free solutions. Foliar applications of copper hydroxide and post-harvest hot water treatment of inoculated fruit reduced RCD.

Conclusions

This study has shown that RCD is a serious economic problem for the mango industry. While several factors have been identified as potential contributors to RCD, the underlying cause is still largely unknown. Further research is needed to confirm these preliminary leads, identify precise causes and develop reliable control measures.

Recommendations

Additional research will be crucial to pursue existing leads to develop improved practices to reduce the incidence of RCD. Some of the key recommendations include additional research to confirm the possible association between fruit total soluble solids content and the presence of RCD, and the role of bacteria.

2.32 Cultural Requirements for the Production of Curcuma Selections as Flowering Potted Plants

Contact: Doris Marcsik – Research Horticulturalist
Collaborating staff: Mark Hoult, Chris Kuo, Heather Wallace and Paige Richter.

Reference to DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Completed.

This project follows on from the Rural Industries Research and Development Corporation-funded project "Investigating closed production systems for ornamental ginger production". The focus of this project was to further examine the effect of timing of fertiliser applications and subsequent use of foliar or controlled-release fertiliser on growth and flowering of specific Curcuma varieties in pots. In addition, an in-vitro propagation system was trialled to produce tissue cultured (TC) plantlets for planting. As part of this work, a protocol for the de-flasking of TC Curcuma plantlets was investigated. A preliminary pot trial of TC planting material was then conducted to evaluate plants for growth and marketability.

Tissue cultured Curcuma plantlet growing in a plug

Potted tissue cultured Curcuma plants

Results

Results showed that containerised production is feasible for a range of Curcuma hybrid selections. When grown as potted plants they may differ in their requirements, depending on the parents used in the initial crossing. The type of fertiliser and timing of application needs to be monitored, particularly when using controlled-release fertiliser so as to provide the optimum release of nutrients to plants over the critical production phase. In addition, CRF formulations need to match growing conditions, notably temperature.

Preliminary in-vitro development work showed that two to three varieties produced from tissue culture were suitable for commercial pot production.

The chemical properties of the growing media at the early stage of plug establishment and growth were found to be critical for TC plantlet establishment and growth. High electrical conductivity (EC) >900 µs/cm resulted in severe browning of the leaves and in some instances entire shoots declined due to salt toxicity. For growing of plugs to pots, weekly liquid fertiliser at EC levels of between 600 – 800 µs/cm is important for quicker plug production.

Conclusions

There is better knowledge now of the cultural requirements and suitability of growing specific Curcuma varieties in pots. There is now an established protocol for in-vitro propagation of Curcuma and a suitable de-flasking methodology. We have successfully produced saleable plants from TC plants and established baseline agronomy for TC Curcuma plants for plug production.

Recommendations

Further developmental work is recommended on TC plug production and pot culture agronomy for the commercial production of specific Curcuma varieties as flowering potted plants.

3 Market Enterprise Development

3.1 The Feasibility of Commercially Harvesting Agile Wallabies in the Northern Territory (NT)

Contact: Warren Hunt – Agricultural Policy and Analysis
Collaborating staff: Cameron Heeb, Ben Beumer and David Frost.
External collaborators: Dr Geert Geesink (University of New England), Mr Aaron Van Den Heuvel (University of New England), Ms Julie Bird (RIRDC), Mr Keith Saalfeld (Department of Land Resource Management), Dan and Sarah Thompson (Ceres Downs), Joe and Catherin Scottney (Garibaldi), and Phillip and Chris Howie (Maneroo).

Reference to DPIF Industry Development Plan 2013-2017:
1.3 Expand market options for Territory products.

Project Status: Commenced.

This Rural Industries Research and Development Corporation (RIRDC)-assisted project is investigating the feasibility of harvesting Agile wallabies from developed agricultural land in the Top End of the Northern Territory (NT). It includes a desktop economic feasibility study, the harvesting of wallabies for selected meat cut studies and an attempt to develop a policy for a potential wallaby meat industry in the NT.

Wallaby carcasses at Douglas-Daly for meat analysis

Results

The desktop feasibility study has been completed.

The harvesting of wallabies for meat cut analysis has started.

3.2 Monitoring Mango Fruit Quality through the Supply Chain to the United States

Contact: Michael Daysh – Market Development Officer
Collaborating staff: Jose Liberato and Plant Industries Development staff.

Reference to DPIF Industry Development Plan 2013-2017:
1.3 Expand market options for Territory products.

Project Status: Completed.

The Horticulture Innovation Australia project monitored 13 shipments of about 75 tonnes of Australian mangoes (varieties Calypso, Keitt, Honey Gold, R2E2 and Kensington Pride) that were airfreighted from Brisbane to Los Angeles during the 2015-16 season (January and February). Monitoring started from fruit treatment through to retail sale. Air and pulp temperatures were recorded using USB air temperature recorders. The time taken in the various logistics stages was noted, such as treatment to freight forwarder, freight forwarder to the airport, to the flight, from the airport to inspection, from inspection to the importer, from the importer to the retail distribution centre and then finally to the retail store. Fruit quality was examined across such parameters as stage of ripeness, colour, taste, appearance and damage. Interviews were conducted with supply chain personnel and consumers in Dallas and Fort Worth, Texas. US consumers and retail staff were very keen to talk about their experience with Australian mangoes, their interest in Australia and sometimes their surprise at the reasonable price of Australian mangoes. Most of the mangoes were from Mareeba and some were from Burdekin, Queensland.

In a US importer's warehouse in Los Angeles during the arrival of Australian mangoes

A typical display of Australian mangoes (varieties R2E2, Calypso and HoneyGold) at a US retailer in the 2015–16 season

Results

The mangoes arrived at destination in very good condition most of the time and sold well at retail. However, some mangoes were too ripe when exported from Brisbane, while some were not fully cooled when exported, arriving warm and soft and too ripe for handling. Two of the 13 consignments were not shipped due to suspected pest issues. However, no compliance issues were reported on arrival in the US. No variety preferences were identified.

While there were some quality issues with overheated, overripe, old, out of grade and lenticel- discoloured fruit, most of the Australian mangoes at retail had a very attractive appearance and good flavour, and were very popular with US retailers and consumers. Average price (across varieties and counts) was around A$47 per box.

Following the study, a handbook was produced for growers, fruit monitors, packers and exporters in preparation for the 2016-17 export season. The handbook provides detailed guidelines on all the necessary steps to comply with the requirements of the US market.

An end-of-season workshop was held in Brisbane in February 2016 for exporters and other stakeholders. About 20 people attended and were very happy with the reporting and feedback that the project provided, along with the recommendations for the future.

Conclusions

There are attractive market opportunities for well-flavoured and well-coloured Australian mangoes in the US market.

Recommendations

More work is needed to improve the consistency of supply and the condition of fruit at arrival in the US.

It is recommended that the quality of Australian mangoes is monitored during the cool chain process from farm to retail to identify more problems and suggest solutions.

External Recognition

The following is a summary of the 2015-16 internal and external awards and invitations to significant meetings and conferences.

Constancio Asis	Best Poster (co-author) awarded by the Philippine Rice Research Institute for the paper: Determining Ammonia Volatilisation and Efficacy of Urease Inhibitor-treated Urea on Grain Yield of Irrigated Lowland Rice, 28th National Rice R&D Conference, 9-10 September 2015 at Maligaya, Science City of Muñoz, Nueva Ecija, The Philippines.
Arthur Cameron	Guide for the XI International Mango Symposium tour 2 October, 2015. Presenter at the Nitrogen Management of Tropical Pasture Grasses Field Day, 12 November 2015. Invited speaker at the Food Futures Roadshow, 7 -8 December 2015, in Kununurra. Invited to the official opening of the Food Futures Conference in Darwin, 11 April 2016. Thanked by DLRM for collaboration in the Weed Spread Prevention Program.
Jocelyn Coventry	Received the Knowledge Seminar Award (2014) for presenting: 'Review of Aspects of Breeding Herd Performance' based on beef cattle projects on the arid rangelands of the Alice Springs district'.
Robyn Cowley	Invited speaker at the Territory NRM Conference in Darwin, November 2015.
Barry Lemcke	Forty years' service milestone in the Northern Territory Public Sector.
Ali Sarkhosh	Endeavour Fellowship, Australian Government.
Tim Schatz	DPIF Minor STAR Award 2015. Chief Minister's Medal 2015.
Stuart Smith	Southern Territory NRM Forum – "How easy will it be to develop sustainable food production in Central Australia?" Skilling Her Enterprise Forum – "Overview of the work of the Department of Primary Industry and Resources". Plant Industries Development Forum – "Constraints to horticultural development in Central Australia."

External Recognition

The following is a summary of the 2015-16 internal and external awards and invitations to significant meetings and conferences.

Brian Thistleton	HIA Pollination Strategy Meeting, 28 July 2015.
	Joint Queensland and Northern Territory Regional Prioritisation Workshop for the National Fruit Fly RD&E Plan, Brisbane, 28-30 July.
	Member of the Sub-Committee for Plant Health Diagnostics and Diagnostic Standards Working Group.
	Participated in a TACC meeting to review the eradication program of the electric ant (*Wasmannia auropunctata*), Cairns (June, 2016).
Callen Thompson	Selected to attend the RIRDC GrowAg Summit 2016.
Lucy Tran-Nguyen	Presented results and information on CGMMV research at the 2016 Australian Melon Association Meeting in Mildura, Victoria.
	Presented the details of the CGMMV outbreak and research at the 13th International Plant Virus Epidemiology Symposium in Avignon, France followed by an invited trip to the University of California, Davis and the California Department of Food and Agriculture to share research findings and CGMMV diagnostics with researchers, service providers, seed companies and US regulators.
	Was awarded 'Researcher of the Year', a joint industry award (AusVEG 2016 National Awards for Excellence) for work on CGMMV.
	Was awarded a laboratory residential scholarship to visit AgriBio in Melbourne to conduct next generation sequencing of Australian CGMMV isolates.
	Presented a poster "Outbreak of cucumber green mottle mosaic virus in the Northern Territory, Australia)" at the 2015 Australasian Plant Pathology Conference in Fremantle.
Jodie Ward	Nominated for the Star Award, Australian Rangeland Society Conference Team, 2015.
	Nominated for the Star Award, Grazing Land Management Course Team, 2015.

Staff and Students

Science Staff	Graduate Students
Pastoral Production	
Casey-Anne Collier (Pastoral Production Officer)	
Jocelyn Coventry (Pastoral Production Officer)	
Robyn Cowley (Senior Rangeland Scientist)	Gabrielle Lebbink (Honors student): Effect of fire on plant diversity in tropical savannas – University of Queensland (Biological Sciences).
Whitney Dollemore (Pastoral Research Officer)	
Jane Douglas (Pastoral Production Officer)	
Barry Lemcke (Principal Livestock Management Officer)	
Kieren McCosker (Livestock Industry Development Regional Manager)	Tiago Alves Correa Carvalho da Silva (PhD student): Post-weaning growth in heifers – University of Queensland (Animal Studies). Ilyas Mumu (PhD student): Reproductive performance of beef cows in Indonesian village systems - University of Queensland (Animal Studies).
Chris Materne (Pastoral Production Officer)	
Caroline Pettit (Rangeland Program Coordinator)	
Tim Schatz (Principal Pastoral Production Research Officer)	
Dionne Walsh (Rangeland Program Manager)	
Jodie Ward (Pastoral Production Officer)	
Plant Industries	
Teagan Alexander (Technical Officer)	
Constancio Asis (Senior Research Agronomist)	
Ian Biggs (Senior Research Agronomist)	
Mila Bristow (Principal Research Scientist)	Ms Kamy Melvani (PhD student): Valuing forest gardens in Sri Lanka – Charles Darwin University, RIEL. Ms Pippa Featherston (PhD student): Water use in *Khaya senegalensis* plantations – Charles Darwin University, RIEL.
Arthur Cameron (Principal Pastures Agronomist)	
Mark Hoult (Senior Horticulturalist)	

Staff and Students

Science Staff	Graduate Students
Cameron McConchie (Research Leader)	Enoche Menge (PhD student): Biology of an invasive milkweed, *Calotropis procera* (Ait.) R. Br. (Apocynaceae) – Charles Darwin University.
	Julian Gorman: Indigenous enterprise development, population ecology and phenotype variation of the tropical tree, *Terminalia ferdinandiana*, in the Thamarrurr Region of the Northern Territory, Australia – Charles Darwin University.
Austin McLennan (Senior Entomologist)	
Doris Marcsik (Research Horticulturalist)	
Ali Sarkhosh (Senior Research Horticulturalist)	
Peter Shotton (Farming Systems Research Officer)	
Stuart Smith (Manager – Central Australian Horticultural Development Project)	
Brian Thistleton (Principal Entomologist)	
Callen Thompson (Senior Extension Agronomist)	
Lucy Tran-Nguyen (Principal Molecular Scientist)	Victor Puno (PhD student): Fusarium wilt of watermelon - University of Sydney.
	Stacey Cook (PhD student): Mango flowering targeting flower molecular markers - University of Queensland.
Market Enterprise Development	
Michael Daysh (Market Development Officer)	
Warren Hunt (Agricultural Policy and Analysis)	Amelie Corriveau (PhD student): Understanding the aggregation behaviour of magpie geese in mango orchards in the Darwin production region and assessing novel mitigation techniques - Charles Darwin University (Research Institute for the Environment and Livelihoods).

Research Visitors

Visitor	Affiliation	DPIR Contact
Dr. Cameron Jose at the Mini Field Day (Quality Graze) Steer Challenge at OMPRS.	Murdoch University	Jocelyn Coventry
The General Manager, the Group Manager and five head stockmen visited Berrimah Farm in August 2015.	Heytesbury Beef	Dionne Walsh
Indonesian delegation tour of Beatrice Hill Research Farm: Prof. Ali Agus, Dr. Chusnul Hanim, Prof. Mukh Arifin and Prof. Charles L Kaunang.	Gadjah Mada University,.Jogjakarta. Diponegoro University, Semarang. Samratulangi University, Manado.	Arthur Cameron
Indonesian student visit showcasing the selected Brahman program.	University of Adelaide	Whitney Dollemore
Visiting Scientist.	Tropical Research and Education Centre and Horticultural Sciences Department, the University of Florida, Homestead FL, USA	Ali Sarkhosh
Dr Phul Subedi	Central Queensland University.	Cameron McConchie
Dr Tony Pattison and Stewart Lindsay	QDAF	Lucy Tran-Nguyen
Dr Francisco Dayap	Department of Agriculture, Leyte, the Philippines.	Mark Hoult
Dr Dario Linas	Visayas State University, Leyte, the Philippines.	Mark Hoult
Dr Dave Rowlings to conduct training on the automated gas sampling chambers in Darwin.	QUT	Mila Bristow
Dr Nigel Swarts to develop the new RD4P project.	UTAS	Mila Bristow
Dr Andrew Robson to develop the new RD4P project.	UNE	Mila Bristow

Research Visitors

Visitor	Affiliation	DPIR Contact
Dr Karen Joyce and Dr Stefan Maier to introduce staff to new drone-mounted sensors and collect preliminary imagery to support project development in mango nutrition.	JCU and MaiTec	Mila Bristow
Dr Neil Sims, Dr Neil Macleod, Dr Andrew Ash and Dr Tony Webster.	CSIRO	Mila Bristow
Dr Slade Lee.	Ninti One (bush tomatoes).	Stuart Smith

Research Service

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

Constancio Asis	Editorial Board Member and Reviewer, *Philippine e-Journal of Applied Research and Development*, Saint Louis University, Baguio City, the Philippines.
	Reviewer, *S & T Journal*, Mariano Marcos State University, Batac, Ilocos Norte, the Philippines.
Mila Bristow	DPIR representative on the national Climate Change Strategy in Primary Industries (CCRSPI) committee.
	Member of the National CCRSPI Strategy Development 2017-2022 working group.
	DPIR representative on the Steering Committee for the National Environmental Science Program: Northern Australian Environmental Resources Hub project '*Cost-effective Methods in Estimating Soil Carbon Change*'.
	Member of the NTG Senior Officers Innovation and Science Working Group.
	Member of the editorial committee of the *Australian Forest Growers Magazine*.
	Member of the Institute of Foresters Australia 2017 Conference organising committee.
	DPIR representative on the Montreal Process Implementation Group for Australia (Forestry).
	DPIR representative on the selection panel for NT's RIRDC Rural Woman of the Year.
Arthur Cameron	Member of the NT Native Vegetation Assessment Panel.
	Member of the Weed Risk Technical Committee.
	Member of the editorial panel for the *Top Paddock* Newsletter.
Casey-Anne Collier	Editor of the quarterly *Barkly Beef* newsletter.
	Secretary of the Barkly Research Advisory Committee.
	DPIR representative at the NT Cattlemen's Association, Tennant Creek.
	DPIR representative at the Barkly Landcare and Conservation Association meetings, Tennant Creek.
Robyn Cowley	Reviewed a paper for *The Rangeland Journal*.
Michael Daysh	Trade Assessment Panel, Horticulture Innovation Australia.

Research Service

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

Warren Hunt	Member of the management committee of the Australasia Pacific Extension Network (APEN). Member of the organising committee for the 2017 APEN International Conference, Townsville: 12 to 15 September, 2017. National advisory committee member of the RIRDC project extension and adoption services for Australian farmers and fishers.
Barry Lemcke	Honorary Member of Australian Buffalo industry Council. Associate member of NT Buffalo Industry Council.
Cameron McConchie	Member of the NTG Senior Officers Innovation and Science Working Group.
Ali Sarkhosh	A reviewer for *Physiology and Molecular Biology of Plants*, *The Journal of Horticulture Science and Biotechnology*, *Scientia Horticulturae* and *Tree Genetics and Genomes*.
Tim Schatz	Attended Katherine Pastoral Industry Advisory Committee meetings. NT representative on the North Australian Beef Research Council. Member of the NABRC management committee.
Stuart Smith	Significant input to the development of DPIR policy on working holidaymakers, in conjunction with the Department of Business. Significant input to land capability assessment conducted by the Department of Land Resource Management for Central Australia, in conjunction with Mark Hoult.
Brian Thistleton	Participated in the ACIAR project HORT 2012-003 “Building a resilient mango industry in Cambodia and Australia through improved production and supply chain practices”.

Research Service

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

Lucy Tran-Nguyen	Senior Editor for Australasian Plant Disease Notes
	Reviewer for the 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.
	A member of the cucumber green mottle mosaic working group.
	A member of the mango malformation disease working group.
	A member of the national banana plant protection working group.
	A member of the melon necrotic spot virus scientific advisory group.
	A member of the national plant biosecurity diagnostic network.
Dionne Walsh	Guest Editor (2016). Special Issue of *The Rangeland Journal*, **38(3):** "Climate Clever Beef: Practical measures to improve business performance and reduce greenhouse gas emissions in northern Australia."
	Reviewed a manuscript by Harrison et al. (2016). The concordance between greenhouse gas emissions, livestock production and profitability of extensive beef farming systems. *Animal Production Science*, **56:** 370–384.
	Council Member – Australian Rangeland Society, from May 2015 to now.
	Member - NT Weeds Advisory Committee.

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
Constancio Asis	(R) Links with researchers at the Philippine Rice Research Institute. (R) Collaborated with Dr Juan Jose Egozcue from Universitat Politecnica De Catalunya and Dr Vera Pawlowsky-Glahn from University de Girona, Spain on compositional data analysis in agriculture.
Mila Bristow	(I) Collaborated with Horticulture Innovation, Cotton RDC, Sugar RDC and Dairy Australia on the development and implementation of the Rural Research and Development for Profit project. (I) Collaborated with Territory NRM and the NT Farmers' Association on proposals to the National Landcare Program – Sustainable Agriculture small grants round. (I) Project manager for "Nitrogen fertiliser management strategies for emerging plant industries in Northern Australia". (I) Collaborated with NT plantation companies and DCM to strengthen economic development of forest plantation industries. (I) Participated in the XI International Mango Symposium in Darwin. (I) Participated in hosting thee ACIAR scholars (Feb 27 – Mar 2, 2016). (R) Collaborated with the University of New England on our RD4P project, by providing remote sensing data and information to improve our understanding of the effect nitrogen in mango production. (R) Links to Charles Darwin University through guest lectures, PhD student supervision and undergraduate student placements (hosted eight students in 2015-16). (R) Collaborated with the Department of Land Resource Management and the Commonwealth Department of Agriculture and Water Resources, and NT Farmers on the project "Land use mapping for improved biosecurity outcomes".
Arthur Cameron	(I) Presented a webinar to Indigenous Land Corporation and Indigenous Pastoral Program Property staff through Regional Skills Training. (I) Provider of a pasture/hay/seed extension service for the NT. (I) Member of the DPIR carrying capacity assessment team.
Casey-Anne Collier	(I) Attended regular NT Cattlemen's Association meetings.

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
Jocelyn Coventry	(R) Collaborated with Dr. Gehan Jayawardhana (consultant veterinarian) and Mr. Jack Allen (ABRI – University of New England) on BREEDPLAN records for project proposals on meat quality and selected fertility EBVs. (R) Collaborated with Mr. Tim Driver (Precision Pastoral Pty Ltd) on the use of the Remote Livestock Management System for an MSA pre-trucking trial. (R) Dr. Peter McGilchrist and Dr. Cameron Jose (Murdoch University) - reporting on an MSA pre-trucking trial. (R) Ms Hong Duong (Animal Genetics Laboratory, University of Queensland) - results of DNA testing in cattle at OMPRS. (R) Technical veterinarians - Dr. Susan Swanney (Virbac) and Dr. Vanessa Watson - advice on anthelmintic treatment in cattle and anthelmintic resistance. (R) Dr. Mathew Ball (Virbac) - Multimin® and botulism vaccination.
Robyn Cowley	(R) Collaborated on the Spatial Hub project with the CRC for Spatial Information and Queensland Department of Agriculture, Forestry and Fisheries.
Michael Daysh	(I) Industry export development, Australian Mango Industry Association.
Whitney Dollemore	(I) Animal Welfare and Handling course for Indonesian students. (R) AGBU: Intensive genotyping and phenotyping for accelerated genetic improvement of reproduction in northern Australia.
Natalie Jane Douglas	(I) Collaborated in the spelling, stocking rate and infrastructure development demonstration trial at Beetaloo-Mungabroom Station.
Mark Hoult	(I) NT Farmers - Rambutan growers group. (R) Yan Diczbalis and Neal Wiltshire, Queensland Department of Agriculture and Fisheries.
Warren Hunt	(I) Member of the organising committee for the 2nd Northern Australia Food Futures Conference, 11-13 April, 2016. (R) Chair of the steering committee of a project funded by Horticulture Innovation Australia and hosted with Charles Darwin University titled ‘Understanding the aggregation behaviour of magpie geese in mango orchards in the Darwin production region and assessing novel mitigation techniques’.
Barry Lemcke	(I) Technical services to cattle/buffalo importers in Asia. (R) Agricultural Business Research Institute for Buffalo BREEDPLAN development.

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
Cameron McConchie	(I) Collaborated with Ross and Monica Maxwell of Jabiru Tropical Orchards. (R) Collaborated with Dr Andrew Macnish, QDAF.
Kieren McCosker	(I) Secretary of Katherine Pastoral Industry Advisory Committee. (R) Collaborating scientist on: Development of candidate management interventions to reduce foetal and calf loss in beef herds in northern Australia (DPIR, the University of Queensland, QAAFI, AusVet Pty Ltd and QDAFF).
Chris Materne	(I) Provided modelled carrying capacity estimates to Wally Klein from Orange Creek Station. (I) Provided station-specific AussieGRASS total standing dry matter images to Anningie Station.
Caroline Pettit	(R) Collaborated on the Spatial Hub project with the CRC for Spatial Information and Queensland Department of Agriculture, Forestry and Fisheries.
Tim Schatz	(I) Collaborated with manager of Helen Springs Station to implement the bull breeding PDS. (I) Attended Katherine Pastoral Industry Advisory Committee meetings. (R) Participated in MLA meetings on future directions in reproduction and calf loss research. (R) Key participant in a collaborative genetics research project (UNE, AGBU, QDAF, the University of Queensland and QAAFI). (R) Collaborating with Ridley and the University of Queensland for VRRS heifer P trial at VRRS. (R) Collaborating with the University of Queensland on the Cull Cow Value Adding project.
Peter Shotton	(I) Collaborated with the Peanut Company of Australia to grow, monitor and trial several peanut varieties and assisted in the extension and promotion of peanut production in the NT. (R) Collaborated with the Queensland Alliance for Agriculture and Food Innovation in the project “Diet selection and growth in steers grazing *Leucaena leucocephala* - grass pastures in a seasonally dry tropical environment”. (R) Collaborated with the Queensland Alliance for Agriculture and Food Innovation in the project “Diets selected and growth in steers grazing buffel grass (*Cenchus ciliarus* cv Gayndah) - Centro (*Centrosema brasilianum* cv Oolloo) pastures in a seasonally dry tropical environment”.

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**
Stuart Smith	(I) Collaborated with CSIRO, table grape growers of Australia and HIA on the evaluation of table grape selections.
	(I) Collaborated with garlic producers in Central Australia.
	(I) Collaborated with Ninti One and Southern Cross University on bush tomato evaluation.
Brian Thistleton	(I) BASF – termite trials.
	(I) Australian Timber and Pest – termite trials.
	(I) TFS Corporation Ltd - termite control in sandalwood in the NT and WA.
	(R) Collaborated with Northern Australian Quarantine Strategy, Department of Agriculture and Water Resources, on various research projects.
Callen Thompson	(I) Collaborated with NT farmers to introduce ‘Application Technology Workshops’ funded by Landcare and the Commonwealth Government.
	(I) Working with Seed Genetics International to screen lucerne varieties in the NT.
	(R) Collaborated with DAFWA in the quinoa project.

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
Lucy Tran-Nguyen	(I) Horticulture Innovation Australia (VG15013): “Improved management options for CGMMV”.
	(I) Horticulture Innovation Australia (VM12001): “Characterisation and management of Fusarium wilt of watermelon”.
	(I) ACIAR’s project “Building a resilient mango industry in Cambodia and Australia through improved production and post-harvest practices”.
	(I) Horticulture Innovation Australia (BA14013): “Facing Fusarium: Better banana biosecurity”.
	(I) Horticulture Innovation Australia (BA14014): “Fusarium wilt Tropical Race 4 Research Program”.
	(I) AusVeg.
	(I) The Australian Melon Association.
	(I) The Australian Mango Industry Association.
	(I) The Australian Banana Growers Council.
	(R) Department of Economic Development, Jobs, Transport and Resources, Victoria (Fiona Constable).
	(R) Department of Agriculture and Food, Western Australia (Brenda Coutts).
	(R) Queensland Department of Agriculture and Fisheries (Denis Persley).
	(R) NSW Department of Industry, Skills and Regional Development (Len Tesoriero).
	(R) NT Farmers (Greg Owens).
	(R) The University of California, Davis (Dr Bryce Falk and Dr Tera Pitman).
	(R) The Department of Food and Agriculture, California (Dr Tongyian Tian).

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) Spelling, stocking rate and infrastructure development demonstration trial at Beetaloo-Mungabroom Station. A collaborative project between the Dunnicliff and Armstrong families, the Barkly Landcare and Conservation Association, DPIR and the Australian Government. (I) Spelling and stocking rate demonstration trial at Alexandria Station. A collaborative project between DPIR and the North Australian Pastoral Company (NAPCO). (I) Liaised with senior management at NAPCO to publish a research paper on business performance assessment and modelling at Alexandria Station as part of the Climate Clever Beef project. (I) Collaborated with the prescribed burning and spelling demonstration trial at Delamere Station. (R) Project Manager (NT) for “Northern grazing carbon farming - integrating production and greenhouse gas outcomes (Climate Clever Beef 2).” (R) Initiated a desktop project with QDAFF and Bush Agribusiness (Ian McLean) to derive cattle intake and/or adult equivalent tables for different regions of northern Australia using the data collated for the desktop research project to provide information on live-weight and live-weight gain in beef cattle in Queensland and the NT.
Jodie Ward	(I) Collaborated with the Department of Land Resource Management and the Heytesbury Cattle Company to prepare and present three Rangeland Management courses in the Victoria River District. (I) Collaborated with Territory Natural Resource Management and the Victoria River District Conservation Association to organise a soil conservation workshop at Kidman Springs later this year. (I) Working with Territory Natural Resource Management to host a series of animal behaviour and paddock utilisation workshops across the NT in early 2017 to reduce over-grazing close to watering points. (I) A member of the Katherine Weeds Advisory Reference Group. (I) An advisory member of the Gulf Rivers Landcare Group.

Overseas Travel

Date	Destination	Officer(s)	Purpose
July 2015	China	Scott Wauchope and Jenny Hill	Undertake market opportunity sensing and exploration that will include analysis of: • Relationship development - pathways necessary for market development. • Investigate the supply chain and production systems - opportunities and constraints for northern producers. • Identify competitive advantage - in the NT industry context. • Consumer trends / market segmentation what are the markets looking for. • Political and cultural considerations. • Trade and other barriers. • Promote northern Australia as a potential supplier of live cattle and beef to China.
	United States	Tim Schatz	Attended the joint annual meeting of the American Society of Animal Science and the American Dairy Science Association in Orlando Florida and a study tour.
	Indonesia	Neil MacDonald	Follow up visit to Kalimantan.
August 2015	Sri Lanka	Bob Williams	Participate in International Tropical Fruits Symposium and 6th Session of International Tropical Fruits Network (TFNet) General Assembly, Colombo.
	The Philippines	Mark Hoult	Implement the ACIAR tropical fruits project objectives and activities with Philippine partners.

Overseas Travel

Date	Destination	Officer(s)	Purpose
August 2015 cont.	Indonesia and Thailand	Scott Wauchope and Jenny Hill	A courtesy visit to further strengthen existing relations between northern Australia and industry in Indonesia and Thailand. Introduction and relationship building in Indonesia and Thailand and to promote northern Australia as a supplier of choice for live cattle. Undertake a field trip in Thailand with industry. Explore future opportunities for the potential for other agricultural commodities that could be exported from the Northern Territory.
	Indonesia	Neil MacDonald and Grant Hamilton	Demonstrate NT Government support for the live export trade and in particular, East Kalimantan livestock industry development aspirations. Work with IrDadang Sudarya, Head of Livestock Services, Provincial Government of East Kalimantan, Livestock Services and the project stakeholders in the provision of technical advice, training and support services for their LIDP.
	Egypt	Michael Daysh	Deliver lecture on mango export marketing to Egyptian Horticulture Export Improvement Association mango fair.
September 2015	China	Michael Daysh	Attend China FVF to support AMIA and their market development effort into China.
	Indonesia	Neil MacDonald and Grant Hamilton	Assist with the Kalimantan Livestock Industry Development Project.
	Thailand	Scott Wauchope	Attend the 15th meeting of the Thailand-Australia joint working group on Agriculture.
October 2015	Brazil	Jose Liberato	Attend the 3rd International Symposium on Fruit Culture: Quarantine Pests and Pre-Emptive Breeding, as an invited speaker. Visit the nearby National Research Centre of Cassava and Tropical Fruits, Brazilian Agricultural Research Corporation.
October 2015 cont.	Timor Leste	Neville Hunt	Participate in program activities of the Timor Leste Village Poultry Health and Biosecurity Program.

Overseas Travel

Date	Destination	Officer(s)	Purpose
	Indonesia	Neil MacDonald	Assist with the Kalimantan Livestock Industry Development Project.
November 2015	Indonesia	Kieren McCosker	Deliver conference presentation and continue on to Balikpapan to assist in internal project with Neil MacDonald.
	Indonesia	Lorraine Corowa	Attend the Indonesia Australia Business Week.
	Vietnam	Neil MacDonald	Attend a workshop on cattle movements through south east Asia in Vietnam.
December 2015	Cambodia	Cameron McConchie and Brian Thistleton	Work on ACIAR funded mango project in Cambodia.
	China	Jenny Hill	Accompany the Chief Minister on trade mission to China to assist with the day-to-day organisation of the trade delegation.
	Indonesia	Barry Lemcke and Grant Hamilton	Accompany four gifted buffalo bulls to their destination at Lembang AI Centre West Java, to ensure they are well settled and appropriately handled by Indonesian staff.
January 2016	United States	Michael Daysh	Monitor arrival of Australian mangoes in US market - second season.
	Thailand and Indonesia	Cameron McConchie	Participate in a Japanese Ministry of Agriculture, Forestry and Fisheries mission.
February 2016	United States	Michael Daysh	Inspect Australian mangoes on arrival and at retail in the US. Horticulture Industry of Australia project MG15004.
March 2016	Indonesia	Neil MacDonald	Visit Balikpapan to assist with the East Kalimantan Project.
	Papua New Guinea	Lorna Melville and Neville Hunt	Facilitate the setting up of a sentinel herd in PNG and make arrangements for transport of samples to Darwin.
	New Zealand	Dionne Walsh	Attend the follow up workshops and meetings in New Zealand related to my Emerging Pacific Leaders Dialogue.

Overseas Travel

Date	Destination	Officer(s)	Purpose
April 2015	Indonesia	Robert MacDonald	Presentation at the Meat and Livestock Australia - Gabungan Perusahaan Pembibitan Sapi Potong Indonesia livestock export program expo and seminar to be held at Tangerang
	Cambodia	Bob Williams, Cameron McConchie, Brian Thistleton and Lucy Tran-Nguyen	Activities on the ACIAR mango project in Cambodia.
	Indonesia	Neil MacDonald	4th partnership meeting in Jakarta for the East Kalimantan Breeder project
June 2016	France and the United States	Lucy Tran-Nguyen	Present at the 13th International Plant Virus Epidemiology Symposium. Then to the University of California, Davis, USA for work on the Cucumber Green Mottle Mosaic Virus project, VG15013.
	Timor Leste	Lorna Melville and Neville Hunt	Scoping visit to set up sentinel herd monitoring in Timor Leste.

Publications

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