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About this report

The 2012-13 Annual Research Achievements Report provides a summary of research and development activities in primary industries in the Northern Territory (NT) (excluding fisheries for which there is a separate annual report series titled Fisheries Status Reports 2012) by the Department of Primary Industry and Fisheries (DPIF). The report covers current and recently completed research in the pastoral, plant industry and biosecurity sectors. The report highlights the effort of DPIF researchers through which services are provided to primary producers to improve their productivity and profitability and to control animal and plant diseases.

DPIF's Industry Development Plan 2013-17 focuses on profitable and productive primary industries, highlighting the following emerging challenges for research and development 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. Each research project in this report addresses at least one of these challenges.

Primary industry activities in the NT focus mainly on pastoral, crop and horticultural production. Products include beef cattle, buffalo, crocodiles, field crops, pasture, hay, seeds, forestry products, mangoes, melons, vegetables and cut-flowers.

The primary industry 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	An automatic drafter being used to draft animals into different supplement enclosures (Source: Tim Schatz)
Report compilation:	Hassan Bajhau, Jason De Araujo, Cameron McConchie, Tim Schatz, Richard Weir and Christine Long

Glossary of abbreviations

ACIAR	Australian Centre for International Agricultural Research
AI	Artificial insemination
ASPIAC	Alice Springs Pastoral Industry Advisory Committee
AZRI	Arid Zone Research Institute
BASF	A German chemical company
BF	Berrimah Farm
BHF	Beatrice Hill Farm
BRAC	Barkly Research Advisory Committee
BSC	Body condition score
BVL	Berrimah Veterinary Laboratories
CDU	Charles Darwin University
CSIRO	Commonwealth Scientific Industrial Research Organisation
DAFF	Department of Agriculture, Fisheries and Forestry
DAFWA	Department of Agriculture and Food Western Australia
DAP	Days after planting
DDRF	Douglas Daly Research Farm
DMD	Dry matter digestibility
DPIF	Department of Primary Industry and Fisheries (NT)
DSITIA	Department of Science, Information Technology, Innovation and the Arts
EBVs	Estimated breeding values
F1	First filial generation (the generation of hybrids arising from a first cross (animal genetics))
HGPs	Hormonal growth promotants
KPIAC	Katherine Pastoral Industry Advisory Committee
KRS	Katherine Research Station
NT	Northern Territory
NTCA	NT Cattlemen's Association
NZIPFR	New Zealand Institute for Plant and Food Research
OEH NSW	Office of Environment and Heritage (New South Wales)
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
RLMS	Remote livestock management system
SOC	Soil organic carbon
SRM	Society for Rangeland Management
TPI	Tasmanian Poppy Industries
VRD	Victoria River District
VRRS	Victoria River Research Station

1 Biosecurity and Product Integrity

1.1 The National Arbovirus Monitoring Program

Contact: Richard Weir – Senior Scientist, Virology

Reference to DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

1.2.1 Targeted research, development and extension to address agreed industry priorities.

1.3 Expand market options for Territory products.

1.3.2 Work collaboratively with industry to identify and respond to potential and actual market disruptions.

Project Status: Ongoing.

Bleed a serologically naïve sentinel herd weekly at Beatrice Hill Farm for virus isolation. Identify isolated viruses, whilst looking for incursions of exotic viruses that may impact on Australian primary industries. Provide virological and serological information to ensure freedom of disease so as to maintain access to export markets. Through monitoring sentinel herds strategically throughout the NT, provide serological information for the determination of the "bluetongue line" annually.

Results

The results for virus isolation were as follows:

BTV serogroup	11 isolates
BTV 1	22"
BTV 7	8"
BTV 20	5"
EHD serogroup	3
EHD 5	11
EHD 7	10
BEF	3
MPOV	36
SIMBU	3
PALYAM	1
UNKNOWN	3

2 Pastoral Production

2.1 North Australian Beef Fertility Project (CashCow)

Contact: Kieren McCosker - Pastoral Production Officer, Beef Cattle

Reference to the DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

1.2.1 Targeted research, development and extension to address agreed industry priorities.

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

2.1.1 Improve production and environmental management through innovation.

Project Status: Completed.

There have been no prospective population-based epidemiological studies on the reproductive performance of commercial breeding herds in northern Australia, or of the major factors that affect their performance. The former would provide producers with a commercially achievable level of performance and the latter would enable them to focus on changes in management and investment on factors that have been shown to be contributing most to herd reproductive performance. A four-year prospective epidemiological study of region, property, mob and animal level factors affecting the reproductive performance of commercial breeding mobs was developed. About 78 000 cows that were managed in 165 breeding mobs, located on 72 commercial beef cattle properties and distributed across the major beef breeding regions of northern Australia were enrolled in the CashCow project and monitored for three or four consecutive years (2008-11) using a crush-side electronic data capture system. Participating properties were classed into four country types using broad vegetation criteria. Foetal aging was used at the time of annual pregnancy diagnosis (PD) to estimate the month of conception and calving. This enabled an assessment of the impacts of environmental, nutritional, management, animal and infectious disease factors on:

- how efficiently cows become pregnant
- the likelihood of pregnant heifers and cows rearing a calf
- the likelihood of cows going missing (i.e., dead, lost an ID tag, or moved paddocks).

Above: Recording breeder performance data, Auvergne Station, VRD

Results

The measures used to define the performance of the CashCow mobs were percentage pregnant within four months of calving (P4M) i.e. percentage of cows likely to wean a calf in consecutive years, annual pregnancy rate, percentage foetal/calf loss and annual percentage of pregnant cows missing i.e. an estimate of mortality rate. For each measure of performance, the impact of approximately 83 selected management, environmental, nutritional and infectious disease factors were assessed by univariable screening. Then, using the factors identified as having a significant impact on performance, candidate multivariable models were developed. These models enabled identification and quantification of the major factors that affect performance.

There was a marked variation in the reproductive performance of enrolled breeding mobs both within and between country types. The median performance (50th percentile) and interquartile range (25th to 75th percentile) for cows by country type are presented in Table 1. The mean annual incidence of pregnant cows missing, expressed as a percentage for the Southern Forest, Central Forest, Northern Downs and Northern Forest was 10%, 9%, 8% and 17%, respectively.

Table 1. Reproductive performance (median, inter-quartile range)* of cow mobs by country type

Measure	**Southern Forest**	**Central Forest**	**Northern Downs**	**Northern Forest**
P4M (%)	78 (65-89)	81 (69-88)	76 (69-81)	26 (14-47)
Annual pregnancy rate (%)	85 (76-92)	85 (79-92)	80 (75-90)	66 (55-73)
Foetal/calf loss (%)	5 (2-9)	6 (5-9)	8 (5-14)	13 (9-18)

*25th to 75th percentile values

A good indicator of what is a commercially achievable level of performance is the 75th percentile mob or cow performance within country type. Therefore, from Table 1, the achievable percentage P4M for cow mobs is 89% in the Southern Forest, 88% in the Central Forest, 81% in the Northern Downs, and 47% in the Northern Forest. The achievable foetal/calf losses are 2% in the Southern Forest, 5% in the Central Forest, 5% in the Northern Downs, and 9% in the Northern Forest.

Beef production from enrolled breeding mobs was calculated using three different measures: weaner production, annual net live-weight production per (retained) cow and annual net live-weight production / average live-weight of cattle in the paddock over a year. Weaner production is an easily derived measure and it was shown to be a useful indicator of annual live-weight production from breeding mobs. There was a marked variation in weaner production between country types. Achievable weaner production was 240 kg/year (Southern Forest), 220 kg/year (Central Forest), 183 kg/year (Northern Downs) and 112 kg/year (Northern Forest). Estimated average annual steer growth was very similar to average weaner production; it was concluded that achievable steer growth may be a very useful guide to breeding cattle productivity within specific situations.

Results (cont.)

The major factors that affected performance of enrolled breeding cows and mobs, and the predicted impact of each on performance, are summarised below (all percentage differences quoted below are absolute values):

Body condition score (BCS) at the PD muster: The percentage P4M for cows in poor body condition (BCS<2.5 using a 1 to 5 scoring system) was 7.8%, 13.7%, 18.1% and 21.6% lower (P<0.05) than cows in fair (BCS 2.5), moderate (BCS 3.0), good (BCS 3.5), and very good to fat (BCS 4-5) condition, respectively. However, the magnitude of the differences between body condition score categories was consistently much lower (average of 2% difference between BCS categories) for cows in the Northern Forest compared with those in the other country types. Also, cows in poor BCS had a higher incidence of mortality, and where the risk of wet season phosphorous deficiency adversely affecting performance was considered high, they were predicted to have a higher percentage foetal/calf loss than cows in good condition.

The risk of phosphorous deficiency adversely affecting performance: First-lactation, second-lactation, mature and aged (>9 years) cows considered at high risk (average wet season [Nov-Mar] FP:ME <500 mg P/MJ ME) were predicted to have 24.3%, 0.8%, 4.1%, and 9.5% lower P4M than those cows considered at low risk (FP:ME ratio ≥500 mg P/MJ ME), respectively. These differences were all significant except for second-lactation cows.

Previous calving period: P4M was significantly lower (20 to 50%) in cows calving in July-September, compared with December–March and was consistent across country types.

Seasonal pasture quality: Foetal/calf loss was 4% higher in cows that grazed pastures with a low crude protein to dry matter digestibility ratio (CP:DMD<0.125) during the dry season prior to calving. P4M was 7.5% lower in cows grazing pasture with an average wet season CP:DMD<0.125.

Seasonal environmental conditions: Prolonged hot conditions (temperature-humidity index >79 for ≥15 days) during the month of calving were associated with a 9% higher foetal/calf loss, except in the Northern Forest. A delay of more than one month in follow-up rainfall after the annual break in the season was associated with an average of 4% higher pregnant cows missing.

Country type: When all other factors were taken into account, the median P4M in the Northern Downs and Northern Forest were significantly lower (23% and 59%, respectively) than the P4M of cows in the Southern Forest. Also, foetal/calf loss was significantly higher (7%) in the Northern Forest compared with that in the Southern Forest.

Mustering: First-lactation cows mustered within two months of calving and poor mustering efficiency (>10% absenteeism) were both associated with a 9% higher foetal/calf loss.

Cow hip height: P4M was 4.8% lower and foetal/calf loss was 3.7% higher in taller cows (hip height >140 cm) compared with shorter cows (hip height <125 cm). These findings were independent of breed.

Cow age: Overall, P4M was significantly lower in first-lactation cows compared with second-lactation, mature and aged (>9 years) cows (4.9%, 12.6% and 16.1% lower, respectively).

Cow reproductive history: Cows that did not lactate in the previous year were predicted to have 3.6% to 7.6% higher foetal/calf losses in the current year.

Infectious disease: A high prevalence of recent infection with bovine viral diarrhoea virus, pestivirus, or widespread evidence of vibriosis resulted in significantly higher foetal/calf losses (8% and 7%, respectively) compared with mobs with only a low prevalence.

Wild dog presence: Foetal/calf loss was approximately 5% higher in areas where wild dogs were reported to be present (based on property manager/owner surveys).

Conclusions

The productivity of beef breeding herds in northern Australia is highly variable. Achievable beef production per cow (kg/head) is similar to expected annual steer growth within a country type. Simple measures can be used to derive indicators of productivity and a standardised herd performance recording system based on group monitoring is proposed.

Recommendations

The establishment of ongoing monitoring of performance of commercial breeder herds is critical to evaluate the effects of various management strategies designed to address the major factors that affect performance and which were identified in the CashCow project. Further, to take advantage of the findings of this project and other research outcomes relevant to breeding cow herds in northern Australia, producers must have a good understanding of how their beef breeding businesses are performing so that the cost-benefit of applying changes can be accurately gauged and efficiently implemented. An Excel spreadsheet-based method requiring a small amount of readily measured beef business inputs was developed as part of the CashCow project to generate satisfactory estimates of business indicators, such as an operating margin. This data can be utilised in the BREEDCOW program and then using the estimates of the effect of specific factors on cow performance derived from the CashCow project, estimates of the effects of each factor on gross margin for herds and partial returns per cow can be determined.

Collaborating staff: Whitney Dollemore.

2.2 Optimum Levels of Pasture Utilisation at Mt Sanford and Pigeon Hole

Contact: Robyn Cowley - Senior Rangeland Scientist

Reference to the DPIF Industry Development Plan 2013-2017:

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

2.1.1 Improve production and environmental management through innovation.

2.1.3 Continue work to optimise sustainable and productive use of NT rangelands.

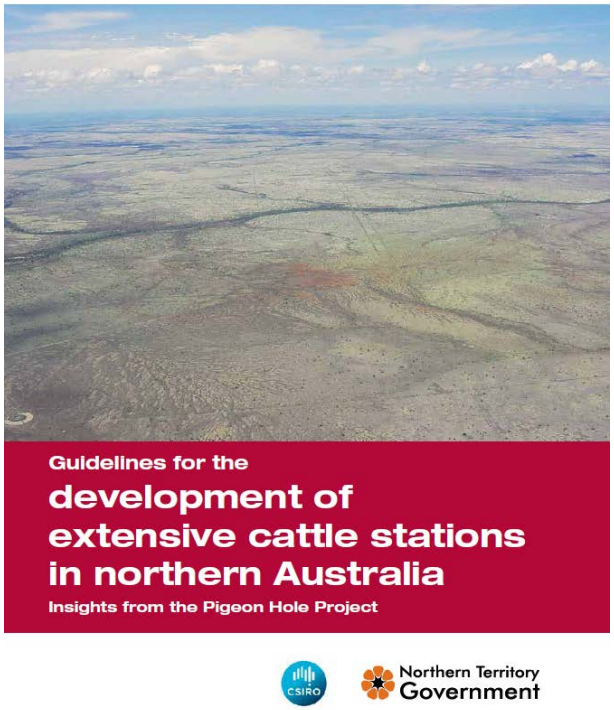
2.1.4 Effectively communicate information on the sustainability and efficiency of the Territory's primary production systems to the community.

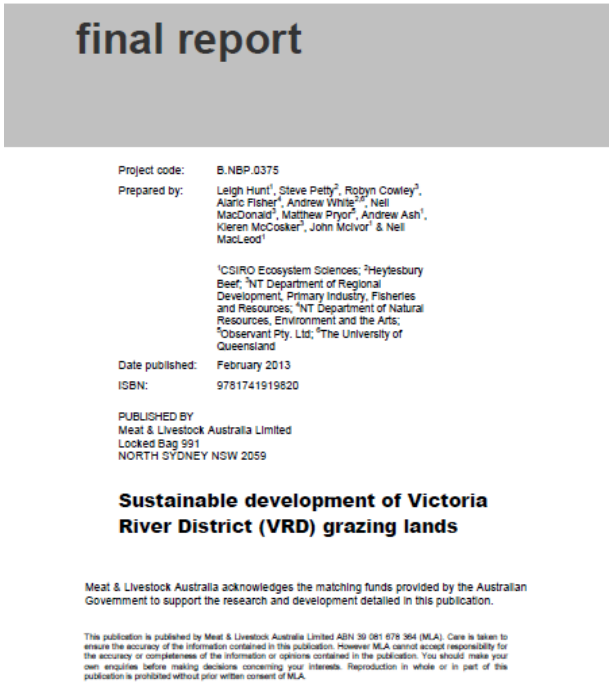
Project Status: Completed.

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

Below left: Cover page of the producer publication from the Pigeon Hole Project

***Below right*:** Cover page of the Final Report of the Pigeon Hole Project





Results

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

The keys to this are the use of sustainable pasture utilisation rates (20% for productive cracking clays) and appropriate development of paddocks and water points.

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

Cell grazing was associated with more even grazing at the paddock scale than continuous or wet season spelling, but this may reflect smaller better-watered paddocks, rather than the high density short duration grazing associated with cell grazing.

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

Conclusions

About half the properties in the VRD have the potential for intensification as they are currently operating with pasture utilisation rates below the recommended 20% level.

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

The final report was published:

Leigh Hunt, Steve Petty, Robyn Cowley, Alaric Fisher, Andrew White, Neil MacDonald, Matthew Pryor, Andrew Ash, Kieren McCosker, John McIvor and Neil MacLeod. (2013). Sustainable Development of Victoria River District (VRD) Grazing Lands. Final Report. Meat & Livestock Australia Limited, North Sydney.

http://www.mla.com.au/Research-and-development/Final-report-details?projectid=15366

Recommendations

The project identified a series of guidelines for the sustainable development of properties and also a number of recommendations for the protection of biodiversity under pastoral intensification, which have been published:

Steven Petty, Leigh Hunt, Robyn Cowley, Neil McDonald and Alaric Fisher. (2013). Guidelines for the Development of Extensive Cattle Stations in Northern Australia: Insights from the Pigeon Hole Project. Meat & Livestock Australia Limited, Sydney.

http://www.mla.com.au/News-and-resources/Publication-details?pubid=6103

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

Contact: Tim Schatz - Principal Pastoral Production Research Officer

Reference to DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

1.2.1 Targeted research, development and extension to address agreed industry priorities.

1.3 Expand market options for Territory products.

1.3.2 Work collaboratively with industry to identify and respond to potential and actual market disruptions.

Project Status: Continuing.

Australian domestic markets currently consider Brahman cattle to have poor meat tenderness. While this has not been a problem in live export markets, high grade Brahman cattle are not as sought after in southern Australian domestic markets. The aim of this project is to investigate whether crossbreeding Senepol bulls with Brahman cows will produce offspring that perform well under NT conditions and that will also have better meat quality than pure Brahman cattle. If this is shown to be the case, this strategy would increase marketing options for NT Brahman cattle producers as it would enable them to produce cattle suitable for both the live export and Australian domestic markets. The Senepol crossbreeding project began in late 2008. Following weaning, male calves are transferred to the Douglas Daly Research Farm (DDRF) where their performance over the post-weaning year is compared with that of Brahman steers managed in the same way. Heifers are retained on native pasture and their performance is compared with that of Brahman heifers grazed together.

Above left: F1 Senepol calves produced from Brahman cows and Senepol bulls at VRRS

***Above right*:** F1 Senepol x Brahman weaners at VRRS

Results

Preliminary results indicate that:

1. F1 Senepol cross calves are heavier by about 20 kg at weaning than Brahman calves due mainly to hybrid vigour.

2. F1 Senepol cross heifers appeared to grow faster than Brahman heifers post weaning and, combined with their heavier weaning weights, are heavier by about 30 kg at first joining when they are two years old. Pregnancy rates in maiden F1 Senepol cross heifers were higher by 10% in those weaned in 2010 and by 7% in those weaned in 2011. Re-conception rates in first lactation F1 Senepol cross heifers were higher by 17% (45% compared with 28% in Brahman cattle) although it should be noted that the number of heifers in each group was only 29.

3. Growth rates in the three yearly groups of steers (weaned in 2010, 2011 and 2012) grazing improved pasture at DDRF post weaning, indicated that the F1 Senepol cross steers grew slightly more than Brahman steers (by 7 kg in 2010 weaned steers, 15 kg in 2011 weaned steers and 10 kg in 2012 weaned steers). This greater growth, combined with their heavier weaning weights, resulted in crossbred calves being considerably heavier by about 30 kg at the end of the year after weaning.

4. Preliminary data showed that about 70% of crossbred heifers and 53% of crossbred steers were polled and 27% of crossbred heifers and 43% of crossbred steers were scurred. This is an advantage as considerably fewer animals will need dehorning at branding.

5. An improvement in meat quality, which is the main aim of this trial, is yet to be examined.

6. F1 Senepol crossbred heifers and steers appear to perform at least as well as Brahman heifers and steers, which is an important factor for producers in northern Australia considering crossbreeding with Senepols.

Collaborating staff: Whitney Dollemore, Kieren McCosker, Jodie Ward, Peter Shotton, DDRF and VRRS staff.

2.4 The Phosphorous Project

Contact: Tim Schatz - Principal Pastoral Production Research Officer

Reference to DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

1.2.1 Targeted research, development and extension to address agreed industry priorities.

Project Status: Continuing.

Despite the potential benefits of wet season phosphorus (P) supplements, their low use across northern Australia indicates that this advice has not been widely adopted. The reasons for this include difficulties in using P supplements during the west season, the absence of a clear demonstration of their benefits in breeders and the absence of a simple diagnostic test for P deficiency. In collaboration with the University of Queensland this project intends to address these needs. It aims to determine the response of cows and growing steers to P supplements at different times of the year, such as the wet season, the dry season and all year round. It also intends to establish a diagnostic test for P deficiency.

***Below left*:** Cattle consuming a P supplement

Bottom: The automatic drafter being used to draft animals into different supplement enclosures

Results

The field trial at Brunchilly was planned to begin in mid-2011. However, due to unforeseen problems, the trial started in the wet season in October 2011.

Preliminary results in May 2012 indicated very few differences between treatments because in 2011 and 2012, pastures were exceptionally good, resulting in good cattle growth. The project was extended for another year to see if differences in growth emerged in a more average year. Preliminary results indicate a 7% higher pregnancy rate in the P supplemented group.

Collaborating staff: Casey Collier and Jane Douglas.

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

Contact: Tim Schatz - Principal Pastoral Production Research Officer

Reference to DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

1.2.1 Targeted research, development and extension to address agreed industry priorities.

1.3 Expand market options for Territory products.

1.3.3 Identify opportunities for primary producers to participate in the climate change and carbon economies.

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

2.1.1 Improve production and environmental management through innovation.

Project Status: Continuing.

The project is comparing the effects of set stocking and cell grazing on animal and pasture production, pasture composition and sequestration of soil organic carbon (SOC) at the Douglas Daly Research Farm (DDRF).

The treatments include (a) Cell grazing, (b) Set stocking constantly at the long-term safe carrying capacity and (c) Set stocking at a variable stocking rate that is set to be the same as the effective stocking rate in the cell grazing treatment.

Young cattle enter the trial shortly after weaning and remain in it for about one year at which time they are replaced by the next year's group of weaners. The large number of animals in the cell group rotate around 26, 6-ha paddocks while the set stocked animals remain in the same 6-ha paddock.

Ten soil core samples are taken from each control paddock with the low and high stocking rates and from six randomly selected cell-grazing paddocks. Sampling from each depth (up to 1 m) is carried out twice a year towards the end of the wet and dry seasons. The samples are bulked together for each paddock and analysed for bulk density and SOC.

Above left: Cattle in the cell grazing group at DDRF

Above right: Cell grazing animals being moved to a new paddock

Results

This is a long-term study. Preliminary results indicate that individual animal performance is highest in the set stocking group with the lowest stocking rate; production per hectare is highest in the set stocking group with the highest stocking rate. The same trend has been seen in the four year groups studied so far.

Table 1. Average growth over the whole post-weaning year in the different treatment groups

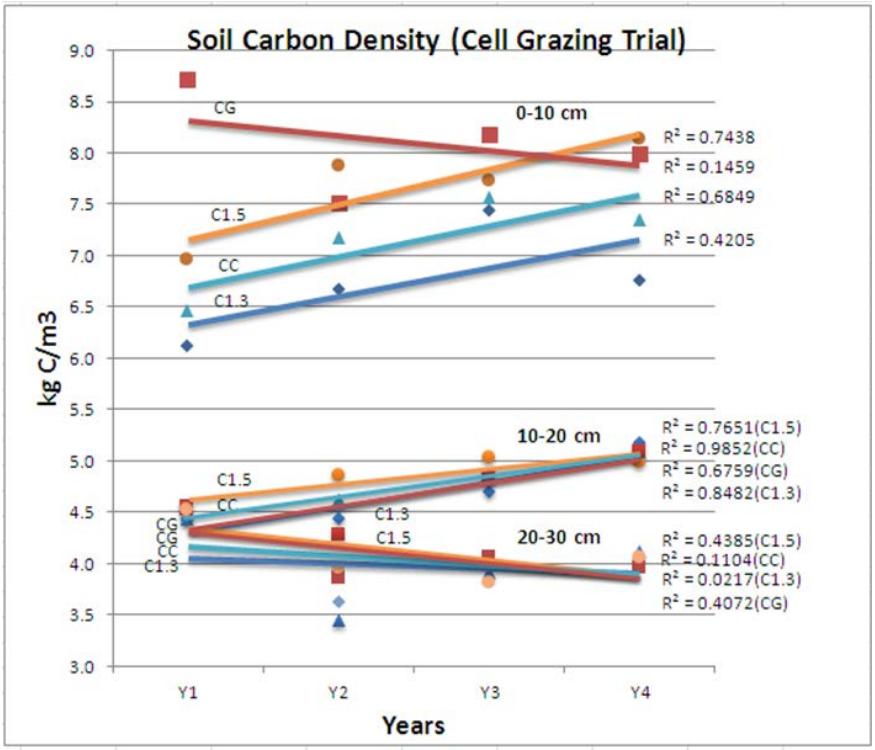
Year	Treatment	Average growth / head (kg)	Average growth / ha (kg)
2009-10	SS 1.5 head/ha	137.3	206.0
	SS 1.33 head/ha	132.7	176.9
	Cell 1.33 head/ha	114.6	152.8
2010-11	SS 1.5 head/ha	174	261.0
	SS 1.67 head/ha	186	310.0
	Cell 1.67 head/ha	161.2	268.7
2011-12	SS 1.5 head/ha	151.9	227.9
	SS 1.83 head/ha	167.7	307.4
	Cell 1.83 head/ha	119.9	219.8
2012-13	SS 1.5 head/ha	142.5	213.8
	SS 1.83 head/ha	138.0	253.0
	Cell 1.83 head/ha	122.4	224.4

Note: Weights were recorded after a 12-hour fast with no feed or water. SS = Set stocked. Cell = Cell grazing treatment.

Over three years, carbon stocks (kg C/m^3)* in the 0-10 cm soil profile are tending to increase in the combined set stock treatments (CC, r^2 = 0.69) by 0.9 kg C/m^3 from 6.5 to 7.4 kg C/m^3 while an apparent fall in C stocks in cell grazing by 0.7 kg C/m^3 during the same period is not a trend at this stage (CG, r^2 = 0.15). At the 10-20 cm profile, all treatments showed a mean increase of 0.5 kg C/m^3 (r^2 ranges 0.68-0.99); however, the 20-30 cm profile showed little evidence of any trends (r^2 = 0.11 and 0.41 for continuous and cell grazing, respectively) (see Figure below).

Based on the above trends for increasing C stocks in soils of set stocked paddocks by 0.3 and 0.2 kg C/m^3 per year at depths of 0-10 and 10-20 cm, respectively, the combined C sequestration amounts to 0.5 tonne C/ha, which is worth $12.50 with a C price of $25/tonne. The total area of the paddocks that were set stocked is 36 ha, which over three years have generated 54 C credits worth $1350.

Results (cont.)



Left: Soil C density trend lines for set stock (C1.3, C1.5, CC (1.3+1.5)) and cell grazing (CG) over three years in soil profiles to 30 cm depth

* kg C/m^3 = tonne C/ha (x 10 cm)

Collaborating staff: David Ffoulkes, Peter Shotton, Spud Thomas and DDRF staff.

2.6 Selected Brahmans - Improving the Fertility of the Brahman through BREEDPLAN EBVs and Selection

Contact: Whitney Dollemore - Pastoral Research Officer

Reference to the DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

1.2.1 Targeted research, development and extension to address agreed industry priorities.

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

2.1.1 Improve production and environmental management through innovation.

Project Status: Continuing.

DPIF has been conducting research to improve the fertility of a Brahman herd since 1986. The herd was established using females from government research stations and bulls from the local area. A high selection pressure was used. The selection included yearling mating of heifers, a strict culling policy on females more than two years old and 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 sires were selected using a selection index that placed high importance on low days to calving, high scrotal circumference and estimated breeding values (EBVs). The herd joined the Australian Brahman Breeders' Association and became a member of BREEDPLAN in 1994 and has recorded herd data from 1986 onward. This project is a continuation of previous work with selection based on EBVs and herd performance, with the additional aims of increasing herd size (while maintaining strict selection), extending the knowledge of selection practices and sharing the gene pool through the sale of bulls and semen. It is necessary to build up the herd size to allow a proper statistical comparison with industry Brahman herds for which about 270 animals are required. In 2012-13, there was renewed selection for early pubertal bulls based on both dam age at first calf and semen evaluation. The herd now includes females at Victoria River Research Station (VRRS) and 168 first and second calf heifers, 85 bulls and 111 yearlings at Douglas Daly Research Farm.

Right: Breeders from the selected Brahman herd at the VRRS field day, August 2012

Results

The project has achieved better results than the breed average for the Brahman group BREEDPLAN in days to calving and scrotal circumference (reproduction traits) EBVs, the average for the Jap Ox Index, the Northern Live Export Index, as well as most EBV traits, specifically high fertility traits.

The results were presented at the VRRS field day in August 2012 and in the Breed Leader Sustainable Genetics course in Katherine in November 2012.

2.7 A Comparison between a Multi-breed Composite and a Brahman Breeder Herd Productivity

Contact: Barry Lemcke - Principal Livestock Management Officer

Reference to the DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

1.2.1 Targeted research, development and extension to address agreed industry priorities.

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

2.1.1 Improve production and environmental management through innovation.

Project Status: Continuing.

The limitations of the Brahman breed for the Top End of the NT are well known and the search for a better alternative has been ongoing. Finding a breed that can also be suitable for a southern market is paramount should South-East Asian export markets fail, as happened temporarily in 2011. This project aims to determine the performance of a multi-breed composite under Top End conditions and 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 capture a larger amount of available heterosis in future generations than conventional two breed crossings.

The proportions of breeds in the composite are 56.3% Brahman, 12.5% Africander, 12.5% Tuli and 6.3% each of Shorthorn, Hereford and Charolais. This mix is 81% tropically-adapted Bos indicus and 19% unadapted Bos taurus. Some other breeds, such as Senepol, have been introduced to Brahman heifers via AI to see whether they can contribute to overall productivity. The composite is expected to retain 64% of heterosis in the second generation onwards.

These animals were initially located at Douglas Daly Research Farm (DDRF). In 2003 the cows were moved to Victoria River Research Station; in 2009, the cows were transferred to Beatrice Hill Farm (BHF) in the Top End Coastal Plains region. The heifers spend the first two joining periods at DDRF before being transferred as adults back to BHF where they are compared with a Brahman herd. The two breeds are run together except during mating between January and March. Their performance is assessed through BREEDPLAN, which is also used to select the bulls for breeding and annual sale by tender. Females are culled if they miss getting pregnant at two years of age or at any time as mature cows four years old or older. A yearling heifer that calves as a two-year-old is allowed one missed pregnancy, but thereafter there are no exceptions. Cows are also culled if they do not raise a calf to weaning, unless due to a known accidental cause. Herd numbers are now limited to about 80 to 90 animals at BHF at mating so over 60 pregnant animals are available for sale to industry annually.

Left: A selected composite mating bull at BHF, 2013

Next page bottom: A composite heifer calf (polled) and dam at DDRF

Results

Table 1. Herd numbers 2011-2012

	Composite breeder herd at BHF	**Brahman breeder herd at BHF**	**Composite three-year-old heifers at DDRF**	**Composite two-year-old heifers at DDRF**	**Composite yearling heifers at DDRF**	**Brahman yearling heifers at BHF**
Herd size at start of mating 2013 (head)	89	88	70	78	94	27
Pregnancy rate 2012 mating	95.4% (n=87)	85.5% (n=55)	87.7% (n=65)	83.6% (n=67)	72.3% (n=83)	#09's 85.7% (n=21) #10's 7.1% (n=14)
Culled at preg test Jun-13 / of breeders mated	4.6% (n=89)	23% (n=88)	5.7% (n=70)	2.6% (n=78)	None culled	None culled
Preg rate 2013	94.4% (n=89) all non-pregnant culled	77.3% (n=88)	94.3% (n=70)	83.3% (n=78)	72.3% (n=94) BHF = 94.7% DDRF= 57.1%	74% (n=27)
Mean birth wt. 2012-13	28.2 kg (n=84)	28.6 kg (n=66)	24.7 kg (n=61)	24.7 kg (n=55)	n/a	29 kg (n=1)
Calf mortality	6.0% (n=84)	7.6% (n=66)	9.8% (n=61)	21.8% (n=55)	n/a	100% (n=1)
Number of calves weaned	79	61	55	43	n/a	0
Weaning rate	94.0%	92.4%	90.2% DDRF Brahman = 87.7%	78.2%	n/a	
Mean weaning wt.	200.3 kg	188.6 kg	153.7 kg DDRF Brahman = 175 kg	154.7 kg	n/a	n/a
Adult mortality	3	1	0	4	0	0

Results (cont.)

Calf mortality in heifers at DDRF was higher than in previous years. There was no clear pattern and the causes were various, including dystocia, dingo predation and 'missing and never found'. Pregnancy rates at BHF remained similar to last year and weaning weights were lower than in 2012 at both farms (by 22 kg at BHF and by 40 kg at DDRF). However, they were still higher than in 2011. The low rainfall last season is probably the biggest factor that affected weaning weights.

The composite cows at BHF were again more fertile and average weaning weights of their calves were higher than those of the Brahmans, although it should be noted that they were not in the same paddock at joining and it is possible that some of the difference could be due to paddock effects.

The BHF yearling composite heifers that went to DDRF for mating were on average 23 kg heavier at the end of the mating period (308 kg vs. 285 kg) than the composite heifers that had been born at DDRF from heifers that calved there. The respective pregnancy rates were 95% vs. 57%. It is likely that calves from BHF heifers will also be heavier at weaning due to earlier pregnancy.

Adult mortalities were also higher this year and were mostly related to calving difficulties. Two composite cows that were rearing calves lost significant weight during the wet season and were both ataxic in the hindquarters. A post-mortem conducted on them after they had weaned their calves did not reveal a cause, although both had spinal cord lesions which did not reveal a pathological cause.

Collaborating staff: Grant Hamilton, Robert McDonald, Doug Dickerson, Jared Palmer, Spud Thomas, Chris Hazel, Peter Shotton, Susan Shotton and Damien Kompenhans.

2.8 Riverine Buffalo and Crossbreeding Project

Contact: Barry Lemcke - Principal Livestock Management Officer

Reference to the DPIF Industry Development Plan 2013-2017:
1.2 Facilitate continuous improvement in production quantity and quality.
1.2.1 Targeted research, development and extension to address agreed industry priorities.

Project Status: Continuing.

Riverine buffalo were imported from the USA between 1994 and 1997. They served as the foundation herd for riverine buffalo now spread through all Australian states. They laid the foundation for the buffalo dairy industry and provided the capability to expand export opportunities. Cross breeding allowed for a greater rate of expansion using existing swamp buffalo as a base. Crossbreeding also improved growth rates by 40% for meat production over that of the swamp breed, allowing for an improved 'TenderBuff®' product due to a younger age at slaughter, which improved meat tenderness and subsequent profitability. It has also allowed dairy farmers to get into buffalo milk production more rapidly, using cheaper first and subsequent crosses, while backcrossing to riverine. This project aims to build the Australian riverine buffalo population as rapidly as possible by expanding the purebred and backcross lines and making them available to the industry. Imported Italian dairy buffalo semen has facilitated the expansion of the herd whilst avoiding potential inbreeding problems that could be caused by the small starting population base. The target is a 100-animal purebred breeder herd able to turnoff around 40 purebred heifers to the industry per year.

Above left: Mixed age yearling and two-year-old purebred riverine heifers with calves

Above right: US riverine bull (OJ) at the end of his career at 18 years of age

Results

Table 1. Calving results for 2012-13 and pregnancy diagnosis (Aug 2013) for next season's calves

Breeder group	**Calving rate (%): 2012-13 calves born/cows mated**	**Pregnancy rate (%): cows preg. Aug 2013 / cows mated Jan 2013**	**Pregnancy rate(%) in wet cows: preg. wet cows / total wet cows**
F1 cows	54.5 (n=22)	72.0 (n=25)	69.2 (n=13)
3/4 cows	72.5 (n=40)	95.0 (n=40)	93.1 (n=29)
7/8 cows	61.1 (n=36)	63.2 (n=45)	77.8 (n=24)
15/16 cows	50.0 (n=14)	68.8 (n=32)	71.4 (n=21)
Two-year-old x-bred heifers (continuous mating)	87.9 (n=33)	75.0 (n=20)	80.0 (n=5)
X-bred yearling heifers(continuous mating)	n/a	38.5 (n=26) mating still continuing	n/a
Two-year-old purebred heifers(continuous mating)	14 / 22 = 63.6%	100 (n=27)	55.6 (n=9)
Purebred yearling heifers (continuous mating)	n/a	69.2 (n=26)	
Riverine cows	49.1 (n=53)	Jul '12: 40.5 (n=37) Sep '12: 46.9 (n=32) Apr '13: 25.9 (n=27)	56.5 (n=23) 30.7 (n=13) 33.3 (n=12)
Total	63.1% (n=220)	71.4 (n=241) excluding AI groups	74.3 (n=101) excluding AI groups

Pregnancy rates were higher this year compared with last year. The wet cow pregnancy rate was 24.5% higher than last year. The ¾ riverine cows achieved a 95% pregnancy rate and wet cows achieved a 93% pregnancy rate. Yearling pregnancy rates were also higher this year.

Crossbred calf losses to weaning reached 6% which are similar to those in cattle.

The 100-animal purebred breeder target will be achieved in 2014 as 90 are now available and many 2013 calves will join them next year.

Imported Italian sexed semen trials have indicated that similar conception rates occur as with normal imported buffalo semen. However, semen from a one-sexed sire produced three bull calves out of seven, whilst the other produced only four female calves in all.

Some steers and bulls were sold, mainly to Brunei. There is interest from Vietnam. Southern Australian and Indonesian demand is increasing.

The local Darwin buffalo dairy is expanding and will demonstrate the feasibility of running dairy buffalo in any location in South-East Asia and other tropical areas given certain input requirements and will lay the foundation for future exports of breeders from the NT.

Collaborating staff: Grant Hamilton, Robert McDonald, Doug Dickerson and Jared Palmer.

2.9 TenderBuff® Development and Supply

Contact: Barry Lemcke - Principal Livestock Management Officer

Reference to the DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

1.2.1 Targeted research, development and extension to address agreed industry priorities.

Project Status: Continuing.

TenderBuff® is a registered trade name held by the NT Buffalo Industry Council to provide a high quality product from a small supply base, following the Brucellosis and Tuberculosis Eradication Program. To achieve that quality, an animal must comply with five specifications: 150-300 kg hot carcase weight, 3-12 mm P8 fat, no permanent incisor teeth, the carcase must be electrically stimulated (or tender-stretched) and be below pH 5.8 after hanging overnight in a refrigerator.

To produce TenderBuff® in the Top End of the NT, it is necessary to run buffalo on improved pastures to achieve the growth rates required or to feedlot captured feral animals for at least two months to bring them up to a suitable standard. Floodplain pasture access in the dry season is also an advantage, or alternatively dry season irrigated pasture or fodder could be used.

Results

The absence of a suitable local abattoir prevented the production of TenderBuff® this year. Surplus male buffalo from DPIF farms were either exported or sold for pet meat production. There is a potential for export to Indonesia, the Philippines and Vietnam. Brunei currently imports several hundred buffalo from the NT.

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

Collaborating Staff: Grant Hamilton, Robert McDonald, Doug Dickerson and Jared Palmer.

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

Contact: Jocelyn Coventry – Pastoral Production Officer

Reference to the DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

1.2.1 Targeted research, development and extension to address agreed industry priorities.

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

2.1.1 Improve production and environmental management through innovation.

Project Status: Continuing.

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

Above: Catching 2013-branded AI calves to record their birth weights, August-October 2012 (Source: B. Gill)

Below: Droughtmaster cows and calves line up to walk through the remote livestock management system at OMPRS, October 2012

Results

The Droughtmaster database for BREEDPLAN was updated with the addition of 434 animals.

In 2013, 53 AI calves and 100 natural-bred calves were identified for potential entry onto the Droughtmaster database for BREEDPLAN.

Collaborating staff: Bryan Gill, Pieter Conradie, Chris Materne and Coral Allen.

2.11 Pasture Sustainability Kidman Springs

Contact: Dionne Walsh - Rangeland Program Manager

Reference to the DPIF Industry Development Plan 2013-2017:

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

2.1.3 Continue work to optimise sustainable and productive use of NT rangelands.

Project Status: Continuing.

The aims of this long-term research project are to monitor pastures and land condition at Victoria River Research Station, verify whether the recommended stocking rates derived by Cowley and Bryce (2003) are sustainable and refine objective carrying capacity methods to improve advice to industry.

Below: Dusty pasture samplers at Kidman Springs (Source: Jodie Ward)

Below right: Cattle at Kidman Springs

Results

Four observers completed annual pasture monitoring on 14 paddocks in May. Data from 2003 to 2013 has been compiled and quality checked. The database now contains more than 1.6 million items.

Collaborating staff: Jodie Ward, Kimberly Howard, Peter Shotton and Trisha Cowley.

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

Contact: (Natalie) Jane Douglas – Pastoral Technical Officer

Reference to the DPIF Industry Development Plan 2013-2017:

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

2.1.3 Continue work to optimise sustainable and productive use of NT rangelands.

Project Status: Continuing.

The aim of this project is to evaluate and promote grazing land management practices, infrastructure development and animal productivity improvements that will increase business resilience in the Barkly pastoral region.

Below left: Vast grass plains at Mungabroom Station

***Below right*:**A bull at Mungabroom Station

Results

Five observers completed monitoring on the Mungabroom lease in May.

2.13 Delamere Burning and Wet Season Spelling Demonstration

Contact: Jodie Ward - Rangeland Research Officer

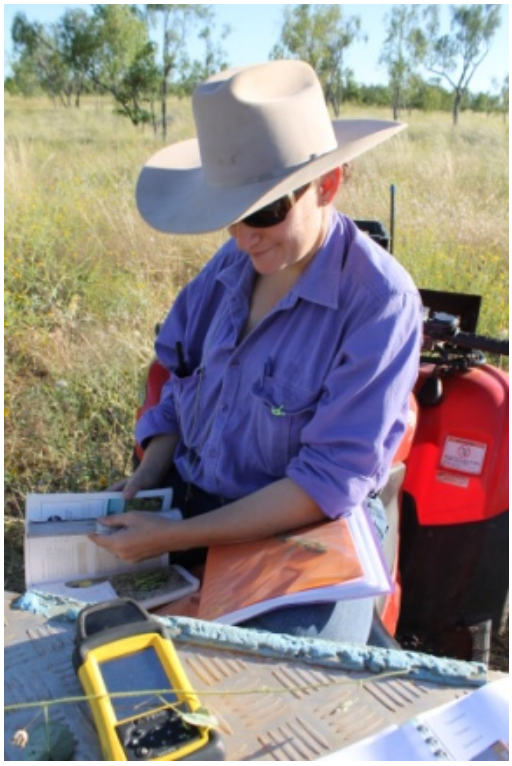
Reference to the DPIF Industry Development Plan 2013-2017:

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

2.1.3 Continue work to optimise sustainable and productive use of NT rangelands.

Project Status: Continuing.

This demonstration site commenced during the Northern Grazing Systems project (2009-12). It aims to provide recommendations on the use of wet season spelling (with and without early wet season burning) to improve pasture quality and condition on black soils in the Victoria River District.



Results

Two observers completed pasture monitoring in May. The complete data set for 2010-13 is ready for statistical analysis. Early results were presented at the Australian Rangeland Society conference in 2012.

Above: Pasture identification at Delamere Station (Source: Mark Hearnden)

2.14 Shruburn (VRRS Long Term Fire Trial)

Contact: Robyn Cowley - Senior Rangeland Scientist

Reference to the DPIF Industry Development Plan 2013-2017:

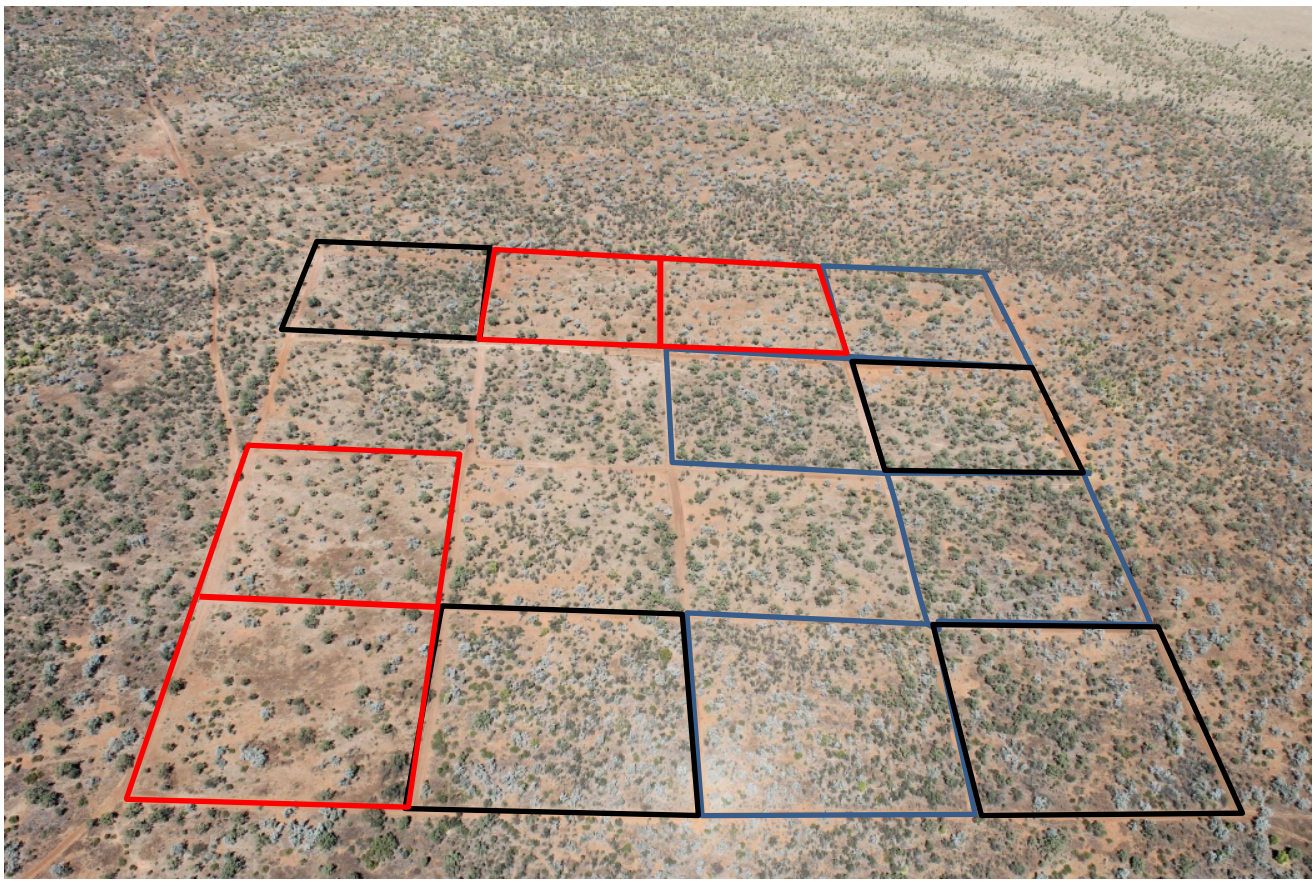
2.1 Develop and promote more efficient and environmentally sound production systems.

2.1.3 Continue work to optimise sustainable and productive use of NT rangelands.

Project Status: Continuing.

The long-term Kidman Springs Fire Trial (established in 1993), assessed the impact of fire management on woody cover and pasture condition. The trial is replicated on red and black soil sites, with grazed experimental plots burnt early or later in the dry season every two, four and six years, as well as unburnt control plots. A bio-economic modelling of the fire trial results was applied to a Victoria River District (VRD) representative property to assess production and economic implications of fire management. A GIS analysis of fire frequency in the VRD for different land types and land uses was used to interpret the management implications of project results in the context of current fire regimes and potential opportunities in a carbon economy. In addition to work by DPIF at the site, external research agencies (CSIRO and Qld DERM) with expertise in soil carbon, soil respiration and above-ground carbon storage, have recently collected data to enhance our understanding of the carbon implications of fire management in a grazed savanna. Trial results were reviewed at a fire session at the Australian Rangeland Society conference in Kununurra in September 2012.

Below: An aerial view of VRRS fire trial treatments on the red earth site, June 2013. More densely-treed plots have been burned less frequently over the last 20 years (blue outline – unburned, black outline – six yearly burns). More open plots have been burnt more frequently (red outline - two and four yearly late burnt)



Results

Late season fires were required every four years on the red earth soil to manage woody cover, whereas on cracking clay, early fires every four years were adequate to manage woody cover.

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

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

GIS analysis of fire frequency in the VRD found that fire frequency on pastoral land was currently less than required to manage woody cover for the moderate and high productivity land types. However, for the non-productive pastoral land types, fire frequency was higher than recommended and there may be the potential to reduce fire frequency and reduce carbon emissions in these situations.

A review of the project found that woody cover change through time should be determined by analysis of aerial imagery.

Collaborating staff: Jodie Ward, Kimberly Howard, Dionne Walsh and Trisha Cowley.

2.15 Central Australia Grazing Strategies Partnership - P3 (Quality Graze Trial)

Contact: Chris Materne - Pastoral Production Officer

Reference to the DPIF Industry Development Plan 2013-2017:

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

2.1.3 Continue work to optimise sustainable and productive use of NT rangelands.

Project Status: Continuing.

Demonstrate and test various long-term grazing strategies on land condition and animal production in Central Australia.

Results

Pasture assessment was completed in April 2013. Cattle performance data was collected in September 2012, December 2012, March 2013 and May 2013. The performance of steers that were born in 2011 was monitored in June 2013 and meat quality and quantity data was collected.
A promotional poster was presented at the annual NTCA conference in 2013.

Collaborating staff: Coral Allen.

Above: Dionne Walsh collecting pasture data

2.16 Precision Pastoral Management Tools (PPMT) Project

Contact: Sally Leigo – Research Leader

Reference to the DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

1.2.1 Targeted research, development and extension to address agreed industry priorities.

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

2.1.1 Improve production and environmental management through innovation.

Project Status: Continuing.

PPMT is one of 12 projects by the CRC for Remote Economic Participation (CRC-REP) and is led by DPIF. It aims to develop a commercial precision pastoral management system (PPMS) based on integrated modules that are compatible with existing software and hardware. PPMS will integrate precision data on cattle and pasture performance using minimal labour.

Below left: Her Honour the Administrator visits the Remote Livestock Management System installed at Old Man Plains Research Station

***Below right*:** Sally Leigo and fellow presenters at the Society for Rangeland Management (SRM) International Symposium of Women as change agents in the world's rangelands, Oklahoma City, USA

Results

A prototype and a business plan were developed for PPMS. A working paper was published on new, emerging and existing technology products for the northern beef industry, which was well received by the industry. Expressions of interest to participate in the project were received from 25 producers. Presentations were made on the project to the Kimberley Beef Research Committee, the Katherine Pastoral Industry Advisory Committee, the Barkly Research Advisory Committee and the Alice Springs Pastoral Industry Advisory Committee. Presentations were also made at the SRM annual conference (http://www.rangelands.org/internationalaffairs/2013_symposium.shtml) and to staff and students at Texas A&M and New Mexico State universities.

2.17 The Effect of Hormonal Growth Promotants (HGPs) on Cattle Profitability

Contact: Jocelyn Coventry – Pastoral Production Officer

Reference to the DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

Project Status: Commenced.

This project is intended to provide information on the effect of using HGPs on cattle carcase prices in the Alice Springs district. It will compare the effect of Compudose 200 (ELANCO ®) on cattle weight, carcase quality and gross returns using 30-month-old steers.

Above: Loading trial steers to an abattoirs

Results

Preliminary results indicate a higher live-weight gain in the HGP-treated steers compared with the control group.

There was no significant effect of HGPs on carcase value.

Collaborating staff: Bryan Gill and Pieter Conradie.

2.18 Northern Grazing Carbon Farming - Integrating Production and Greenhouse Gas Outcomes (Climate Clever Beef 2)

Contact: Dionne Walsh – Rangeland Program Manager

Reference to the DPIF Industry Development Plan 2013-2017:

1.3 Expand market options for Territory products.

1.3.3 Identify opportunities for primary producers to participate in the climate change and carbon economies.

Project Status: Commenced.

The aim of this project is to identify practices that improve both animal productivity and emissions performance, trial and demonstrate practices that can reduce emissions from cattle and/or increase carbon sequestration in soils and vegetation, assess the economic performance of the practices and determine whether there is a business case for northern beef producers to participate in “carbon farming” projects.

Above left: Cows at Alexandria Station (Source: Jodie Ward)

Above right: A curious onlooker watching soil sampling

Results

This large-scale project is conducted in the NT and Queensland. It follows a previous project titled ‘On-farm Demonstration of Adaptation and Mitigation Options for Climate Change across Northern Australia - Climate Clever Beef 1’. It has an industry collaborator in the Barkly, Victoria River District and Douglas Daly regions. Systematic benchmarking and scenario testing are used to evaluate the current and potential animal productivity, profitability, land condition and greenhouse emissions performance on these pastoral businesses. Soil carbon sampling was conducted on participating properties in the Douglas Daly and Barkly regions. Pasture assessments were conducted on the demonstration site at Alexandria Station that is evaluating wet season spelling and stocking rate management.

Collaborating staff: David Ffoulkes, Jodie Ward, Casey Collier, Peter Shotton and Trisha Cowley.

3 Plant Industries

3.1 An Investigation of Growth Regulators for the Control of Termites

Contact: Brian Thistleton – Principal Entomologist

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

Project Status: Continuing.

DPIF was asked to conduct trials on three BASF termite bait and active ingredient candidates against *Coptotermes acinaciformis* and *Mastotermes darwiniensis*. The products are based on insect growth regulators and are potential candidates for the control of these termites in horticultural crops. The research is also expected to provide new knowledge on the biology of these species that will assist in the development of other control measures.

Results

Initial results are encouraging. Details will be discussed with BASF before publication.

Below left: A bait container linked to a mound, showing feeding damage and active *Coptotermes acinaciformis*

Below right: A *Coptotermes acinaciformis* mound opened for the final assessment; the tube contains a temperature probe connected to a Tiny tag recorder in the outer container

Collaborating staff: Michael Neal.

3.2 Biological Control of the Papaya Mealybug and Oriental Scale on Papaya in East Timor and Australia (ACIAR project)

Contact: Brian Thistleton – Principal Entomologist

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

Project Status: Continuing.

An outbreak of mealybugs was discovered on papaya in East Timor in August 2010 and was identified as the papaya mealybug (*Paracoccus marginatus*), a native of Central America, which has spread to the USA and a number of South Pacific and Asian countries since 1994. Three encyrtid wasp parasitoids from Mexico were introduced to many of these countries where they have effectively controlled the mealybug. This project is designed to assist East Timor to obtain the parasitoids. Another pest of papaya, the oriental scale (*Aonidiella orientalis*), has been controlled in Queensland using an encyrtid parasitoid introduced from China in 1988. The project will also investigate the presence of this parasitoid in the Northern Territory and, if necessary, will obtain it from Queensland.

Below left: Using a digital microscope to examine papaya mealybugs in East Timor

Below right: *Acerophagous papayae* adult on a papaya mealybug in the field at Bacau

Results

The parasitoid *Acerophagous papayae* (Hymenoptera: Encyrtidae) reached East Timor through natural dispersal, probably with the mealybug, and an introduction was not required. East Timorese authorities reported in May 2103 that papaya mealybug populations were low. This was confirmed through a field trip to four sites in the Dili area where the mealybug had previously been abundant. In three of these sites no papaya mealybugs were found and at the fourth, mealybugs were present on a number of hosts but were being controlled by the parasitoid. On a second field trip to Bacau, about 150 km from Dili, high populations of the papaya mealybug were found on a small plot of papaya, but parasitoid adults were observed and material subsequently examined in the laboratory showed a high percentage of parasitised mealybugs.

Morphological examination of the parasitoid has confirmed its identity as *A. papayae*. This identification is currently being verified by DNA analysis. East Timor produced two posters and a 24-page booklet on the papaya mealybug through the project for public awareness of the pest.

Collaborating staff: Michael Neal and Lanni Zhang.

3.3 Impacts of Deforestation and Afforestation on Greenhouse Gas Emissions and Carbon and Water in the Daly River Catchment

Contact: Don Reilly – Forestry Research Officer

References 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.

North Australia has 70% of the country's freshwater resource. The Daly catchment in the Northern Territory is largely an intact ecosystem that is earmarked for agricultural development. This will include clearing of native savanna vegetation for growing improved pastures; a new plantation forestry industry is also likely to develop. The greenhouse gas emissions from clearing events will be tracked through time and shifts in carbon and nitrogen pools will be examined over time since clearing. The water resource implication of deforestation and subsequent afforestation with potentially high water usage by exotic tree species will also be assessed. Data will enable calibration of modelling tools for these land systems to develop sustainable production systems.

Results

The overall difference between uncleared and cleared savanna sites is approximately equivalent to 12 years of carbon sequestration in this ecosystem. Further work will refine these estimates. These emissions do not include enhanced soil CO_2 efflux that will occur once further site preparation (tillage) is undertaken, nor does it include soil derived non-CO_2 fluxes (CH_4 and N_2O) that are not captured by the flux tower and the total emission may reach 150 t CO_2-e ha-1 for the event.

3.4 Progress in Domestication of African Mahogany (*Khaya senegalensis*) in Australia

Contact: Don Reilly – Forestry Research Officer

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

Project Status: Continuing.

Conservation and improvement of African mahogany began in the Northern Territory (NT) and Queensland in 2000 based on 1970s NT plantings and collaboration between the two governments. Outputs include promising clones and seed lots from orchards and good trees suitable for commercial testing/pilot-scale planting and inclusion in breeding and propagation populations. This germplasm should improve profitability of new plantings.

Below left: Second generation progeny trial – Katherine Research Station

***Below right*:** Cuttings trial (established 2006 on left), seedlings on right

Results

Private sector R&D commenced in the mid-2000s and included wood, silvicultural and management studies, provision of test sites for government material and establishment of over 90 African provenances in plantations and, with many single-tree seed lots, in multisite provenance and family trials. These accessions greatly extend and complement the governments' genetic base. Recent public sector research includes aspects of the established program and a five-agency project undertaken during 2009-12 resulting, inter alia, in advanced propagation technologies, more 'tools' and greater knowledge of biology, wood properties and processing.

Australia leads the world in ex situ conservation and improvement of African mahogany based on c.120 provenances and many families from 15 of the 19 African countries of its range. Having built up very valuable genetic resources, expertise, technologies and knowledge of the species, every effort should be made to exploit the comparative advantage these assets provide.

3.5 Quantifying Interception Associated with Large Scale Plantation Forestry in the Northern Territory (National Water Commission)

Contact: Don Reilly – Forestry Research Officer

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

Project Status: Continuing.

Under CSIRO's Water for a Healthy Country National Research Flagship, Charles Darwin University and DPIF are making a preliminary assessment of the potential impacts of a proposed expansion of the water resources of the Daly River region. African mahogany plantations currently represent a small proportion of the total catchment (<1%); however, it is anticipated that this area could increase at a rate of approximately 2000 ha per annum up to a total of 50 000 ha. To assess the impacts of the plantation expansion on the water resources of the region, preliminary parameterisation of the growth model, 3-PG2 was used to predict growth of *K. senegalensis* (African mahogany) in the region. The model also does a reasonable job of predicting the major components of the water balance for savanna and pasture communities within the region. Annual evapo-transpiration (ET) from mahogany plantations was similar to that observed in the surrounding savannas, although there were marked differences in the partitioning of total ET and the seasonal dynamics of ET.

Results

With the incorporation of the spatial information on climatic variation and variation in soil properties, a scenario was modelled in which an annual plantation expansion rate of 2000 ha for 20 years was assumed and estimated annual components of the water balance for the total catchment area were assessed. The scenario predicts that the projected expansion of the mahogany estate in the Stray Creek catchment would have little impact on the water resources of the catchment.

Below: Six and 11 year-old tree plantation sites (Fox Rd, Venn and Why Not Station (Daly River))

3.6 Studies on Pheromones of Mango Fruit Borers

Sequence below: The photographs show a trap in the field, one of the rubber pherocaps containing the pheromone and an adult mango fruit borer moth

Bottom right: Mango fruit borer larva in Darwin

Contact: Brian Thistleton – Principal Entomologist

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

Project Status: Continuing.

The mango fruit borer is the caterpillar of a small moth, *Citripestis eutraphera* (Lepidoptera: Pyralidae), which bores into mango fruit. The insect was originally described from Indonesia and was first discovered in the Northern Territory in 2008. Surveys in 2009 showed that the pest is widespread but at a low frequency in the Darwin and Katherine regions. DPIF is collaborating with the New Zealand Institute for Plant and Food Research (NZIPFR) to develop a pheromone for this pest.

Results

Initial trials in Australia and Indonesia did not catch any moths. NZIPFR reanalysed the pheromone extracts and discovered an extra component. New blends were provided for testing, which were to be tested in 2013 in Australia and/or Cambodia.

Collaborating staff: Michael Neal and Lanni Zhang.

3.7 Action on the Ground "Reducing Greenhouse Gas Emissions through Improved Nitrogen Management on NT Farms"

Contact: Stuart Smith – Senior Research Officer

Reference to the DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

1.2.1 Targeted research, development and extension to address agreed industry priorities.

1.2.2 Develop effective research partnerships that support innovation and efficient delivery of extension information to clients.

1.2.4 Support industry to understand, and adapt to, changes in climate.

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

2.1.1 Improve production and environmental management through innovation.

Project Status: Continuing.

The project aims to trial and demonstrate on farm practices/technologies to reduce agricultural greenhouse gases by reducing nitrous oxide (N_2O) emissions through better understanding and management of inorganic nitrogen (N) in the vegetable, melon and hay industries in the wet/dry tropics. In addition, it addresses the priority of increasing carbon stored in the soil with the use of green manure/cover and legume crops. For vegetable and melon crops, it will do this by improving the understanding of N movement during rotations of these crops in soil, soil water and emissions to the atmosphere, and conversion to organic forms in the part. Cover crop trials will investigate the best way to trap N to minimise N_2O emissions throughout the wet season. Legume cover crops will be included in this trial to determine whether N fixed from the atmosphere over the wet season is a sufficient substitute for applied N fertilisers in subsequent melon or vegetable crops. The impact of non-leguminous cover crop species on converting non-utilised N fertiliser from the previous season's melon or vegetable crop into organic forms will also be measured. Regular soil and plant sap testing for N will also be demonstrated as a management tool to maximise N use efficiency in vegetables and melons. All these practices have the potential to lower N_2O emissions, which will be directly tested as part of the project. In addition, cover and green manure crops are a proven method for increasing soil carbon. In hay crops, new enhanced efficiency fertilisers will be demonstrated and tested, and N_2O emissions will be recorded. The role of legumes in the rotation will also be assessed. Hay growers will be intimately associated with these demonstration trials to improve their understanding and uptake of this new technology to lower N_2O emissions.

Above left: Gas flux sampling from a manual chamber – fallow plot

Above right: Collecting soil samples for analysis, rockmelon trial 2012 dry season

Results

Cover crops in melons and vegetables

Nitrates were elevated in 0-10 and 10-30 cm depths in the soil where a chemical fallow was kept, in comparison with lab-lab, sweet sorghum or Fumig8or™ sorghum, meaning that a cover crop is necessary to immobilise nitrate and prevent leaching during the wet season.

Water taken from Full Stops™ at 20-40 cm in the soil showed elevated nitrate levels in fallow plots compared with cover-crop plots, which backs up the data from the soil sampling.

N_2O emissions tended to be higher under cover crops compared with fallow plots. This may have been due to a shading effect, as fallow crops had lower surface moisture levels on many sampling occasions compared with cover crops, whose soils were more shaded and moist.

Levels of ammonia to nitrate were consistently low in all soil samplings, suggesting rapid nitrification of ammonia to nitrate in moist wet soils. This means the risk of loss of N through nitrate leaching in the soil is high.

Both Fumig8or™ and sweet sorghums had similar biomass production (8.4-8.6 t/ha). Biomass production from lab-lab was 4.6 t/ha, but the nutrient content in the lab-lab was higher for most elements compared with the two types of sorghum.

Both lab-lab and sorghum were effective in covering and protecting the soil.

Gas emissions were not high after incorporating cover crops.

There were no appreciable changes in soil organic carbon for any of the cover crops or fallow treatments over the wet season.

Emissions in dry season melons and vegetables

After monitoring greenhouse gas emissions, leaf N, sap nitrate, soil nitrate and soil ammonia for cucumber, rockmelon and watermelon over the dry season, it appears that N_2O emissions are correlated to nitrate in the soil, more at the 10-30 cm than at the 0-10 cm level.

Nitrate is added periodically to melon and vegetable crops in the soluble form of calcium nitrate or potassium nitrate. These pulses of high nitrate are risky for N_2O production.

It is unclear at this point how plastic mulch limits N_2O emissions to the atmosphere.

There were good correlations between soil nitrate at 0-10 cm and 10-30 cm and leaf N as a percentage of the dry weight of whole, first fully expanded leaf blades. There was a poor correlation between these soil nitrate measures and petiole sap nitrate, suggesting that petiole sap nitrate is a poor indicator of plant N status.

3.8 Optimising Pollination of Dates (*Phoenix dactylifera*)

Contact: Cameron McConchie – Research Leader

References to the DPIF Industry Development Plan 2013 2017:

1.2 Facilitate continuous improvement in production quantity and quality.

1.2.1 Targeted research, development and extension to address agreed industry priorities.

Project Status: Continuing.

Pollination and fruit thinning are critical processes in date production. Pollen in dates affects fruit quality, yield and annual productivity. As date palms are dioecious, artificial pollination allows for the number of non-fruit producing males in an orchard to be reduced. The aims of the proposed project are to work with existing date palm growers in Central Australia to optimise pollen collection and storage to facilitate artificial pollination. Pollen will then be used to identify optimal timing of pollination and pollen parents for major commercial date cultivars. Different pollen parents are expected to affect fruit size, flesh and seed development, and time to fruit maturation. Techniques for manual pollination and pollen dilution will be described. These results will assist to improve productivity in existing date farms while enabling optimal use of the extensive germplasm collections that have been assembled with RIRDC support. These collections are now at a suitable age to allow refining management techniques. These investigations will assist existing growers to improve production techniques while ensuring future producers of appropriate information for deciding appropriate polleniser cultivars.

Results

Following supplementary pollination using different pollen sources, mature dates were harvested, weighed and the flesh and seed were measured. It was evident from the results that *Phoenix sylvestris* pollen does produce full size dates but these are seeded and not seedless as suggested in the literature. *P. sylvestris* may still be economically important as it flowered before all the other male palms. The precise pollination date and the harvest date were recorded for 47 inflorescences. The ranking in order of heat sum required to mature from low to high was Medjool, Barhee, Zahili, Deglet Noor and Thoory. There were no obvious pollen parent effects on the heat sum required to mature fruit. The effects of different bags used to protect dates from bird damage were assessed. These included a white polyethylene bag, a bi-layered polyethylene banana bag, woven shade cloth, insect mess based on cloth sourced from Israel and calico cotton cloth bag. Both polyethylene bags caused a rise in temperature and humidity that resulted in premature rotting of the fruit. The shade cloth bag was too open and small birds were able to access the fruit and damage the bag. The cotton bags blocked vision of the fruit making it difficult to judge development. The extensive germplasm of date varieties planted at the Arid Zone Research Institute has been expanded with further plantings of 18 varieties supplied by Dave and Anita Reilly under a material transfer agreement.

Far left: Date pollen

Left: Pollinating a date palm

3.9 Evaluation of the Potential Commercial Development of Poppy Production in the Northern Territory (NT)

Contact: Stuart Smith – Senior Research Officer

Reference to the DPIF Industry Development Plan 2013-2017:

1.3 Facilitate continuous improvement in production quantity and quality.

1.2.1 Targeted research, development and extension to address agreed industry priorities.

Project Status: Commenced.

The purpose of this trial is to assess the viability of growing poppies (*Papaver somniferum*) in the NT. Poppies are currently grown at two locations in the NT under secure conditions and a permit from the Department of Health, issued under the *Misuse of Drugs Act*. The project is sponsored by the Tasmanian company TPI Enterprises. Poppy production is being trialled in the NT because land is becoming scarce in Tasmania and wet weather at harvest in Tasmania washes away alkaloids from seed heads. Growing poppies in the NT during the dry season would avoid wet weather damage to seed heads at harvest. Large tracts of undeveloped land in the NT could potentially be used for the cultivation of poppies.

Below left: Poppy seedlings emerging at location 2, 2 June

Below middle: Poppy seedlings at location 2, 8 July 2013 and poppies at location 2, 19 August 2013

Below right: Poppies at location 2, 26 August

Results

Poppies were planted at location 1 on 3 May and at location 2 on 14 May, 2013. The sowings did not emerge, most likely due to inhibition of germination by high temperatures. Poppies were re-sown on 13 and 14 June, emerging within a week. On 27 June, plant density was measured at location 1 using quadrats. The average density at location 1 was 297 plants per square metre. The density at location 2 was 162 plants per square metre on 8 July when the press-foot on the small drill was down, and 108 per square metre when the press-foot on the small drill was up.

Agronomic practices used in the cultivation of the poppies are not described here due to confidentiality issues related to the legal production of the crop.

Poppy heads had formed by late August at both trials. The 2013 trial crop was expected to be harvested in early October and morphine content was to be determined at that time.

The trial plots were hand-harvested in the second week of October and the analysis of the capsules for alkaloid content was favourable and supports the continuation of commercial validation of growing trials in 2014.

3.10 Degradable Mulch Trials

Contact: Stuart Smith – Senior Research Officer

Reference to the DPIF Industry Development Plan 2013-2017:

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

2.1.1 Improve production and environmental management through innovation.

Project Status: Commenced.

As part of the Caring for our Country Project "Increase the adoption of sustainable farming practices in the Top End of the NT", a number of commercially available degradable mulches were trialled at Berrimah Farm over the wet season in 2012-13, the dry season 2013 and the build-up to the wet, 2013. It is estimated that 200 tonnes of plastic mulch is used annually in melon and vegetable production in the NT. A number of commercial manufacturers have been tackling the disposal problem for this plastic by developing plastic mulch that will maintain its integrity through the growing cycle, but would then degrade into the soil and atmosphere. Seven types of degradable mulch were trialled at Berrimah Farm, which are used in such crops as corn, pumpkin, watermelon, eggplant, tomato and cucumber.

Below top left: Econverte three-month white/black 17 May 2013, 11 days after laying, with tomato seedlings

Below top right: Econverte three-month white/black 19 September 2013, 134 days after laying, watermelons were harvested

Below bottom left: Agnova e-film 17 December 2012, 11 days after laying

Below bottom right: Agnova e-film 7 January 2013, 32 days after laying

Results

Econverte Degricover three month and six month (black) was useful in the wet season of 2012-13, and remained intact from when it was laid on 6 December 2012 with only small amounts of splitting until watermelons were harvested in February 2013. It did eventually split during and after harvest of the watermelons and continued to break down until 22 April 2013, when the remaining mulch was pulled up so that the ground could be reworked for a dry season crop. There was no observable difference between the three-month and six-month Degricover. According to the manufacturer, the three month rolls were designed to break down after three months and the six month rolls after six months. Our experience indicated that appreciable, but not total, breakdown occurred after five months in both. It should be noted that the wet season had below average rainfall, which may have affected what would normally be expected in a Top End wet season. However, crops were watered twice daily, so there was always moisture under the mulch.

Agnova efilm was noted to be not robust during the wet season of 2012-13 as it started to break apart after 18 days. It was not useful as an alternative to normal mulch. The buried portion of the mulch did, however, last longer and could still be found 10 months after it was laid down. The supplier advised DPIF that the batch that was supplied had problems. We have not yet tested any new product.

Econverte Degricover three month black/black and black/white was useful in the dry season of 2013, when it was used to mulch watermelons, sweet corn, eggplants, tomatoes and pumpkins. It was robust through the duration of all these crops and was intact between 8 May and 19 September (134 days or just over four months). This period was enough for all the crops to go through their cycle until harvest. There has been some splitting and breakdown, more in the black mulch than the in white mulch.

Novomont Mater-Bi CE04P and EF04P were laid with Econverte three month black/black in a new trial which started on 2 August 2013 on rough ground. The sticks and stones in the rough ground damaged the Novomont products and one row has been further damaged by wind and magpie geese. The Econverte product was more resilient in this tougher environment. Pumpkins, water melons and sweet corn were planted in this trial and will be assessed during the ‘build-up’.

A field day was held at Berrimah Farm in April 2013 to extend the results of the wet season trials.

3.11 An Investigation into the Potential Pest Status of the Recently Discovered Tawny Coster Butterfly *Acraea terpsicore* (Linnaeus, 1758) in Australia

Contact: Brian Thistleton – Principal Entomologist

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

Project Status: Commenced.

In April 2012 the exotic Tawny Coster butterfly (*Acraea terpsicore*) (Lepidoptera: Nymphalidae: Heliconiinae: Acraeini) was recorded at three sites at Wagait Beach breeding on *Hybanthus enneaspermus* (Violaceae), a native perennial herb, which grows in savanna woodland, especially in disturbed areas. Overseas reports indicate that the butterfly also uses plants from Passifloraceae and Cucurbitaceae, and is considered a major pest of gourds. In a joint research project with Dr Michael Braby of the Department of Land Resource Management, DPIF investigated its occurrence and the extent to which it can exploit melons and passionfruit based on laboratory trials because there is a potential risk to the tropical horticultural industry and residential garden vegetable crops.

Results

Young larvae which were placed on seedlings of various commercial Cucurbitaceae (cucumber, *Cucumis sativus* (var. *lebonese*), watermelon, *Citrullus lanatus* and rockmelon, *Cucumis melo* and Passifloraceae (*Passiflora edulis*) in the laboratory did not feed and died after a few days.

At present, the risk to the horticultural industry in northern Australia appears minimal because larvae failed to survive to adulthood on Cucurbitaceae in captivity. Furthermore, the early stages were not located on these plants in the field.

Above left: *Acraea terpsicore* larva

Above right**:** *Acraea terpsicore* adults

Collaborating staff: Michael Neal and Lanni Zhang.

3.12 Agronomic Options for Profitable Rice-based Farming Systems in the Ord and Adelaide River Regions

Contact: Nick Hartley – Technical Officer

Reference to the DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

1.2.1 Targeted research, development and extension to address agreed industry priorities.

Project Status: Commenced.

The project aims to identify locally-adapted rice varieties (including hybrid and blast disease-tolerant rice) with the required quality characteristics for wet and dry season production on raised beds compared with flood and upland production, identify an ideal establishment technique, sowing time, optimum sowing rate and plant population for each variety, identify crop nutrition (amount and strategy) requirements, determine irrigation requirements and weed/pest/disease control strategies and evaluate the potential of rice ratoons.

Results

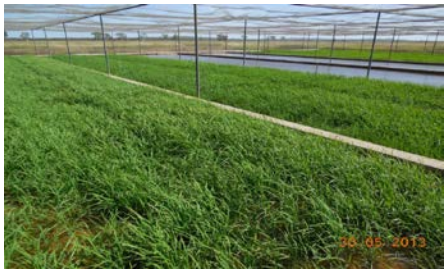
A trial was conducted in the 2013 dry season at Tortilla Flats near the Adelaide River in the Northern Territory to compare differences in yield when the same varieties were planted at different times. Viet 4 early-maturing (shorter season) and NTR 587 late-maturing (longer season) were planted five weeks apart and were replicated three times. Both varieties were aerial-sown under paddy conditions. The hot dry season led to quicker earlier growth over a shorter growing period, which may have also contributed to lower yields. Viet 4 had more than 50% panicle emergence 86 days after planting (DAP) and NTR587 had more than 50% panicle emergence 107 DAP. On average, the harvest was two to three weeks earlier than in previous seasons. Harvest commenced 128 DAP for Viet 4, and 142 DAP for NTR 587. Lodging was a problem, particularly in planting two.

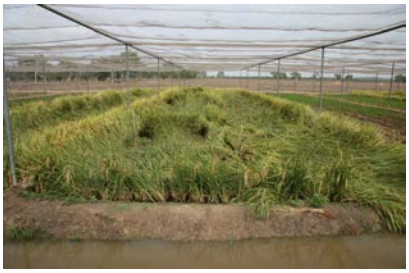
Strong winds during the second half of the growing season through to harvest and heavy storms just prior to the second harvest badly affected second planting yields. The Basmati variety was planted in a separate bay for observation and it also suffered from bad lodging and rain. Yields of 2 t/ha were recorded for Basmati. Site x season x cultivar effects will be assessed after the completion of analysis.

Table 1. Hand harvest yields

Time of sowing	Variety	Average (kg/ha)
Time 1	VIET 4	6618
Time 1	NTR 587	8086
Time 2	VIET 4	6212
Time 2	NTR 587	6373

Time 1 = Planting 1
Time 2 = Planting 2





Above left: Basmati 36 DAS in Bay 1 and Half VIET 4 + NTR 587 in bay 2, Bays 3 + 4 about to be planted

Above middle: 97 DAS second sowing, bay 4 in front VIET 4 left NTR 587 right VIET 4 in first sowing has been harvested and NTR 587 in bay 5, 6 about to be harvested

Above right: Bay 4. second sowing VIET 4 on left, NTR 587 on right, received storm damage two weeks prior to harvest

3.13 Enhancing Rice Germplasm Development for Transforming Production Systems in Cambodia and Australia

Contact: Nick Hartley – Technical Officer

Reference to the DPIF Industry Development Plan 2013-2017:

1.2 Facilitate continuous improvement in production quantity and quality.

1.2.1 Targeted research, development and extension to address agreed industry priorities.

1.2.2 Develop effective research partnerships that support innovation and efficient delivery of extension information to clients.

Project Status: Commenced.

For the last 70 years, the overwhelming majority of rice production in Australia has been under irrigation in the temperate environment of southern NSW, using japonica types. The previous eight years of drought triggered the industry to consider limited rice production in tropical and subtropical regions, where water is more plentiful. An alternative form of direct-seeded rice production has recently been trialled in these areas, in rotation with other high-returning cash crops thereby making aerobic rice culture the preferred irrigation strategy. Despite promising commercial (4 to 6 t/ha) and trial yields (8 to 10 t/ha), there is a need to re-visit the agronomic packages utilised under aerobic production systems starting with a sound base of adapted germplasm. Several common abiotic and biotic constraints exist between Australia's tropical north and Cambodia, most notably drought, flood and bacterial disease. Australian production has targeted medium grain (*japonica* type) and speciality type (fragrant) varieties as they attract lucrative international markets. In this project, through exchange of germplasm with the International Rice Research Institute and Cambodian collaborators, Australian partners will be able to access and undertake collaborative assessment of *tropical japonica* and *indica* germplasm relevant to both the agronomic and production requirements of an evolving rice industry in tropical regions of Australia. The Australian drought has also motivated Sunrice, an Australian company owned by all Australian rice-growers, to explore production options in other countries so it can continue to supply its markets with high quality rice.

Right: Cultivation with a rotary hoe prior to application of pre-plant fertiliser

Next page left: Solid set sprinkler irrigation

Next page right: Variety trial in a Katherine enclosure

Results

The trial was conducted in the 2012-13 wet season at Katherine Research Station (KRS) under upland conditions using a randomised complete block with 34 varieties replicated four times under two treatments as ‘multiple lines’. The multiple lines seed was from the KRS 2011 dry season pot experiment. Irrigation was set up as a backup and was utilised more than intended due to the unusual hot and dry wet season. There were significant differences in the time to panicle emergence between cultivars, with Tachiminori being the earliest (58 days after sowing (DAS)), and PW 10 the longest (87 DAS); the majority of the cultivars had panicle emergence between 70 to 80 DAS. Viet 4 was the highest yielder producing 7.5 t/ha and Tachiminori 7 t/ha.

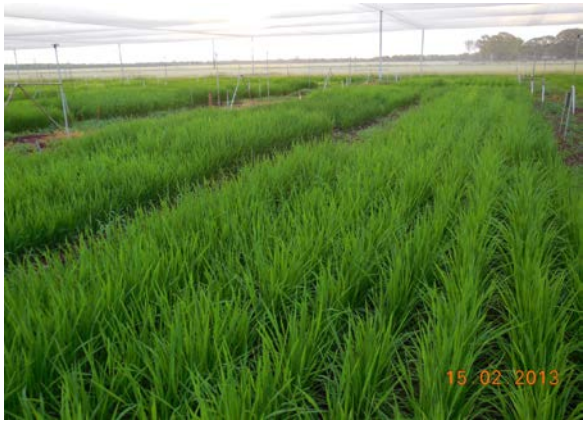
The harvest period was from 22 April (104 DAS) until 9 May (120 DAS). The earliest cultivars from sowing to harvest were IR 64, VIET 4 and Takanari, which required only 104 days. Most varieties showed some form of lodging. Yunlu 29 appears to be the most suitable variety for an upland rice production system in the Katherine region, with relatively high yields (grain 6.5 t/ha and good biomass), with a short growing season of 105 DAS. It is suitable for the shorter wet season around Katherine compared with farther north around Adelaide River. Seed has been stored from a number of the top performing lines that have shown potential for good plant vigour and grain yields, suitable for upland conditions. Variety interaction will be assessed more fully when a complete analysis of site x season x cultivar is made.

Table 1. Cultivar grain yield

*Cultivar ID	Final grain yield (kg/ha)	Harvest index
17#61	2685	0.30
Cica 6	2771	0.30
7#37	2806	0.25
7#187	3531	0.34
1#68	3792	0.37
2#27	3814	0.36
Labonnet	4253	0.40
10#35	4589	0.33
10#136	4847	0.39
2#34	4894	0.34
10#51	5112	0.37
7#162	5418	0.45
10#116	5516	0.34
2#58	5600	0.39
7#46	5694	0.40
Ceysvoni	5711	0.39
IR 45	6211	0.36
10#153	6784	0.43
10#134	6828	0.32
Tachiminori	6954	0.50

*Cultivar ID	Final grain yield (kg/ha)	Harvest index
VIET 1	4483	0.34
PW 10	4605	0.30
Sen Pidao	5035	0.41
ULP 17	5192	0.36
IR 64	5367	0.43
Takanari	5367	0.45
7#192	5403	0.41
BIRGA	5691	0.35
PW 7	5867	0.37
B 6144-F	5867	0.37
NTR 426	5877	0.39
Azucena	5962	0.38
10#182	6084	0.39
PSBRc-9	6282	0.37
Yunlu 29	6494	0.42
NTR 587	6514	0.39
VIET 4	7568	0.52

*Hand harvest grain yields and harvest indexes for single row varieties (left) and main plot varieties (right)



3.14 Characterisation and Management of Fusarium Wilt of Watermelon

Contact: Lucy Tran-Nguyen – Molecular Scientist

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

Project Status: Commenced.

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

The project aims to identify the NT *Fusarium oxysporum* f. sp. *niveum* race(s) and compare it with other *Fon* races in Australia and overseas, screen rootstocks and grafted watermelons for resistance to *Fusarium oxysporum* f. sp. *niveum* [all race(s)], assess the temperature effect on Fusarium wilt of watermelon under a controlled environment and field trials, assess the effect of rotational cropping options (e.g. Fumig8tor sorghum) on the suppression of Fusarium wilt of watermelon, extension strategies to raise awareness of Fusarium wilt of watermelon, deliver outcomes to industry and propose management strategies.

Below left: Fusarium wilt of watermelons in the field (Source: B. Condé)

***Below right*:** Pathogenicity trials of watermelon seedlings (Source: B. Condé)

Results

Preliminary race differential trials on “Kalahari” seedlings indicate that the NT *Fon* isolates may be race 2. Extension material is published in the Primary Industry newsletter and the Australian Melon Industry Association newsletter.

External Recognition

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

Coral Allan	Part of the Star Award Certificate of Recognition group for the OMPRS Droughtmaster cattle project team.
Ben Beumer	Star Award for the Pastoral Production Technical Services Team for Vietnamese import market development.
Jocelyn Coventry	Part of the Star Award Certificate of Recognition group for the OMPRS Droughtmaster cattle project team.
	Speaker at the 2013 Darwin Conference of Australian Cattle Veterinarians.
Robyn Cowley	Invited speaker at the 17th Australian Rangeland Society conference, September 2012. The session reviewed Shruburn and other fire trials to synthesise northern Australian fire research to determine best practice fire management in a carbon economy and future research requirements.
David Ffoulkes	Star Award for the Pastoral Production Technical Services Team for Vietnamese import market development.
Bryan Gill	Part of the Star Award Certificate of Recognition group for the OMPRS Droughtmaster cattle project team.
Sally Leigo	Invited to present at the USA Society for Range Management's International Symposium: "Women as change agents in the world's rangelands".
	Invited to contribute to the North Australia Beef Research Committee's working group into future research and development on technology in the industry.
	Invited to present the PPMT project to Her Excellency the Governor-General in Adelaide in July 2012.
	Invited to present at the 16th Precision Agriculture Symposium in Perth 2013; not able to attend.
	Invited to present at a Sheep CRC event to discuss technology uses in the Australian rangelands; not able to attend.
Barry Lemcke	Star Award for the Pastoral Production Technical Services Team for Vietnamese import market development.
Don Reilly	Presented a paper at the AFG conference in Gympie in October, 2012.
Tim Schatz	Invited to speak on heifer research at a senior staff meeting for S. Kidman and Co. Pty Ltd, November 2012.
	Invited to speak at Zoetis Northern Vets conference, March 2013.
	Invited to speak at the Indigenous Cattlemen's conference, April 2013.

Stuart Smith	Presented a paper on the identification of soil and water resources: “Food for the Territory” at the Australian Soil Symposium in Sydney in April 2012.
	Invited to speak at a carbon farming forum by CSIRO, Darwin, April, 2012.
Brian Thistleton	Received the 2012 Knowledge Seminar Award.
Lucy Tran-Nguyen	Participated in the International Banana Symposium in Kaohsiung City, Taiwan, November 2012.
	Presented NT mango research results at Guangxi University, Nanning, China, November 2012.
	Was invited to participate in the Annual Diagnosticians workshop, Melbourne, February 2013.
	Presented a mango flowering talk at the Australian Mango Conference, May 2013.
Dionne Walsh	Session Chair at the “Fire in a carbon economy” session at the Australian Rangeland Society Conference, Kununurra, September 2012.
	Primary Industry Science Excellence Award winner 2011-12.

Staff and Students

Science Staff	Graduate Students
Biosecurity and Product Integrity	
Richard Weir (Senior Scientist – Virology)	
Plant Industries	
Nick Hartley (Technical Officer)	
Cameron McConchie (Research Leader)	Michele Greenfield – The reproductive biology and breeding system of the invasive weed *Calotropis procera* (Asclepidacaeae) – Charles Darwin Universtiy, Research Institute for the Environment and Livelihoods
Don Reilly (Forestry Research Officer)	
Stuart Smith (Senior Research Officer)	
Brian Thistleton (Principal Entomologist)	
Lucy Tran-Nguyen (Molecular Scientist)	Victor Puno – Fusarium wilt of watermelon – University of Sydney
Pastoral Production	
Coral Allan (Pastoral Technical Officer)	
Pieter Conradie (Manager Pastoral Production)	
Jocelyn Coventry (Pastoral Production Officer)	
Robyn Cowley (Senior Rangeland Scientist)	
Whitney Dollemore (Pastoral Research Officer)	
(Natalie) Jane Douglas (Pastoral Technical Officer)	
Bryan Gill (Pastoral Production Officer)	
Chris Materne (Pastoral Production Officer)	
Kieren McCosker (Pastoral Production Officer – Beef Cattle)	Whitney Dollemore – Master's in phosphorus nutrition in beef cattle – University of Queensland
Sally Leigo (Research Leader)	Collin Marshall – Precision Pastoral Management System Interface – Charles Darwin University
Barry Lemcke (Principal Livestock Management Officer)	
Tim Schatz (Principal Pastoral Production Research Officer)	
Peter Shotton (Systems Research Officer)	
Dionne Walsh (Rangeland Program Manager)	
Jodie Ward (Rangeland Research Officer)	

Research Visitors

Visitor	Affiliation	DPIF Contact
Tim Driver and James Christian	Precision Pastoral Pty Ltd.	Jocelyn Coventry
Government delegation	CSIRO, DAFF, DAFWA, DPI Victoria, OEH NSW and DSITIA Qld representatives visited the Old Man Plains Research Station in August 2012 and a presentation was made for them on the Central Australian Quality Graze project.	Chris Materne
International delegations	Delegations from Indonesia and Vietnam were received this year to view buffalo and cattle research.	Barry Lemcke
Dr Lisa Kidd	University of Queensland	Tim Schatz
Dr Simon Quigley	Senior Animal Research Officer at Animal Studies, University of Queensland.	Tim Schatz
Dr Nigel Tomkins	CSIRO	Tim Schatz
Western Australian Farmers	Tour of Beatrice Hill Farm.	Barry Lemcke

Research Service

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

Robyn Cowley	Guest editor (together with Dionne Walsh and Jeremy Russell-Smith) for the Special Issue of the Rangeland Journal (Fire management in a carbon economy), due for publication in early 2014.
	Reviewed two scientific papers for the Rangeland Journal and Tropical Grasslands journal.
Sally Leigo	Associate editor for a Special Edition of the Society for Range Management's Journal Rangelands.
Tim Schatz	DPIF's representative on the North Australia Beef Research Council (NABRC). Two meetings are held per year.
	Member of the NABRC management committee.
Brian Thistleton	Member of the NT Mango Advisory Panel.
	Served on the national scientific advisory panels for emergency plant pests.
	Served on the national panels to categorise emergency plant pests for the Emergency Plant Pest Response Deed.
Lucy Tran-Nguyen	Senior Editor of the *Australasian Plant Disease Notes Journal*.
	Reviewer for the following Scientific Journals: *Australasian Plant Pathology*, *Federation of European Microbiological Societies*, *Plant Pathology*, *Plasmid*, *Journal of Phytopathology*, *Annals of Applied Biology*, *Australasian Plant Disease Notes* and *Public Library of Sciences*.
	Member of the Scientific Advisory Panel for the Department of Agriculture, Fisheries and Forestry.
	Member of the mango malformation disease working group.
	Member of the national banana plant protection working group.
	Australasian Plant Pathology Society Regional Councillor for the NT.

Dionne Walsh	Guest Editor (with Robyn Cowley and Jeremy Russell-Smith) – Special Issue of the Rangeland Journal (Fire management in a carbon economy), due for publication in early 2014.
	NT representative on a committee to develop an operations plan for "Improving the Feed Base" section of the Strategic RD&E plan for the northern Australian beef industry. (North Australian Beef Research Committee).
	Representative on a committee of the Australian Rangeland Society to report on the status and future of the Rangelands Australia Tertiary Education Initiative.
	Representative on a Carbon Farming Initiative Methodology Development Advisory Group (Agricultural Methodologies Development Section, Land Division, Australian Government Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education).
	Invited to the Joint Livestock Technical Group meeting as NT project leader for the Climate Clever Beef project (Agricultural Methodologies Development Section, Land Division, Australian Government Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education).

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
Pieter Conradie	(I) DPIF representative on the Alice Springs Pastoral Industry Advisory and Barkly Research Advisory committees.
	(I) DPIF representative on the NT Cattlemen's Association meetings in Alice Springs and Tennant Creek.
	(I) DPIF representative on the Centralian Land Management Association Committee.
	(I) Collaborated with Land Councils and other partners to progress Indigenous pastoral production in the NT.
	(R) Collaborated with the Cooperative Research Centre for Remote Economic Participation (NintiOne) as co-supervisor with the project leader for the Precision Pastoral Management Tools Project.
Robyn Cowley	(I) The Pigeon Hole utilisation trial is collaborating with Heytesbury Beef.
	(R) The Pigeon Hole utilisation trial is collaborating with CSIRO, DNRETA and the University of Qld.
	(R) The Northern Beef Scoping Project is collaborating with CSIRO and Qld DAFF.
	(R) The Northern Grazing Systems Project is collaborating with Qld DAFF and CSIRO.
Jocelyn Coventry	(I) Collaborated with Elanco Animal Health and the Alice Springs Pastoral Industry Advisory Committee.
	(R) Collaborated with the School of Veterinary and Life Sciences, Murdoch University on benchmarking breeding herd performance in the Alice Springs district.
Whitney Dollemore	(I) Completed the embryo transfer program with AACo in 2012.
	(I) Presented the NTCA –Indonesian animal welfare, handling and management course in 2012 and 2013.
	(R) The ACIAR - StrawCow project.
	(R) The vitamin Hy-D rumen bolus and its effect on phosphorus absorption under extensive situations at KRS.
Jane Douglas	(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, DPIF and the Australian Government.

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
Sally Leigo	(I) The PPMT project has four contracted industry partners: the North Australia Pastoral Company, the NT Cattlemen's Association, Observant P/L and Precision Pastoral P/L. (I) The project has established an advisory committee made up of nine members from predominantly pastoral properties in the NT, Queensland, South Australia and Western Australia. (I) Presentations were also made to the Kimberley Beef Research Committee, the Katherine Pastoral Industry Advisory Committee, the Barkly Research Advisory Committee and the Alice Springs Pastoral Industry Advisory Committee about progress to date in the PPMT project. (R) The PPMT project has five contracted research partners: the NT Department of Primary Industry and Fisheries, the Queensland Department of Agriculture, Fisheries and Forestry, the WA Department of Agriculture and Food, the SA Department of Environment, Water and Natural Resources, and The University of New England. (R) In addition, relationships have been established with the Qld Department of Science, Information Technology, Innovation and the Arts, Meat & Livestock Australia, Charles Darwin University and Land gate.
Barry Lemcke	(I) MLA-funded overseas cattle export in- country assistance (Vietnam 2012). (I) Honorary member of the Australian Buffalo Industry Council Board. (I) An associate member of NT Buffalo Industry Council. (I) A vice-president for Oceania on the International Buffalo Federation.
Chris Materne	(I) Presented the Barkly Rangeland Management Course on Walhalla Station in April 2013. (I) Assisted Walhallow/Cresswell Downs stations in an annual forage budgeting in April 2013. (I) Represented DPIF and made a presentation at the Weed Advisory Committee in Alice Springs.
Cameron McConchie	(I) Dave and Anita Reilly, Gurra Downs Date Company Pty Ltd.
Kieren McCosker	(R) A collaborating scientist on the $1.6 million ACIAR-funded project StrawCow, which is being conducted in villages in Indonesia and includes an Australian component through DPIF, the University of Qld, QAAFI, and ACIAR. (R) Invited as a collaborating scientist on the $22 million ACIAR-funded project IndoBeef to investigate the productivity of different market streams of beef cattle in Indonesia.

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Research Collaboration - details of specific collaborative research projects or consortia.

Name	(I) Industry Collaboration / (R) Research Collaboration
Don Reilly	(I) African mahogany Australia – Wallaroo Station.
	(I) The Huntley Group.
	(R) Charles Darwin University, CSIRO and Melbourne University.
Tim Schatz	(I) Participant at Regional Beef Research Committee meetings (KPIAC, BRAC and ASPIAC).
	(I) Collaborated with the manager of Brunchilly Station to conduct research on P use.
	(I) Collaborated with the manager of Helen Springs Station to conduct a bull breeding PDS.
	(R) Project leader for the collaborative Phosphorus project with the University of Queensland.
	(R) Collaborating with CSIRO to develop a Hy-D rumen bolus.
Stuart Smith	(I) The project “Evaluation of the potential commercial development of poppies in the NT” is funded by Tasmanian Poppy Industries Ltd.
	(I) The project “Characterisation and Management of Fusarium Wilt in Watermelon is supported by seed companies and Horticulture Australia.
	(R) Dr Lindsay Hutley and Dr Mila Bristow are collaborating on the project “Reducing Greenhouse Gas Emissions through Improved Nitrogen Management on NT Farms” through participation on the steering committee and through mutual data sharing.
Brian Thistleton	(R) Collaborating with the Australian Forest Research Company on termite research.
	(R) Collaborating with the New Zealand Institute for Plant and Food Research Limited on pheromone research for several species of moths.
Lucy Tran-Nguyen	(I) Improve identification of *Fusarium* species associated with mango malformation disease and identify mango anthracnose.
	(I) Molecular identification of *Fusarium oxysporum* f.sp. *niveum* causing Fusarium wilt in seedless watermelon seedlings.
	(I) Increase knowledge of *Fusarium oxysporum* f.sp. *cubense* in bananas.
	(R) Horticulture Australia Limited.
	(R) Australian Centre for International Agricultural Research.

External Linkages

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

Name	(I) Industry Collaboration / (R) Research Collaboration
Dionne Walsh	(I) Spelling and stocking rate demonstration trial at Alexandria Station. Collaborative project between the North Australian Pastoral Company, DPIF and the Australian Government.
	(I) Prescribed burning and spelling demonstration trial at Delamere Station. Collaborative project between the Australian Agricultural Company, DPIF, Team Savanna and the Australian Government.
	(I) Spelling, stocking rate and infrastructure development demonstration trial at Beetaloo-Mungabroom Station. Collaborative project between the Dunnicliff and Armstrong families, the Barkly Landcare and Conservation Association, DPIF and the Australian Government.
	(I) Benchmarking and on-ground option testing demonstration at Limbunya Station. Collaborative project between Limbunya Station, DPIF and the Australian Government.
	(R) NT Project Manager for “Northern grazing carbon farming - integrating production and greenhouse gas outcomes (Climate Clever Beef 2)”, a collaborative project between DPIF, Qld DAFF and the Australian Government.
	(R) DPIF representative on the multi-state “Rubber Bush Scientific Advisory Committee” with members from the NT and Qld pastoral industry, Charles Darwin University, Qld DAFF and NT DLRM.
Jodie Ward	(I) Spelling and stocking rate demonstration trial at Alexandria Station - a collaborative project between the North Australian Pastoral Company, DPIF and the Australian Government.
	(I) Prescribed burning and spelling demonstration trial at Delamere Station - a collaborative project between the Australian Agricultural Company, DPIF, Team Savanna and the Australian Government.
	(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, DPIF and the Australian Government.

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
Richard Weir	(R) Collaborated with the Australian Animal Health Laboratory by providing novel isolates. (R) Collaborated with Charles Darwin University by providing samples for a medical laboratory science course and the classification and identification of novel arboviruses. (R) Collaborating in the formative stages of a joint research project with the Defence Science Technology Organisation on arboviruses encountered by military personnel in tropical environments. (R) Collaborated in remotely training an army scientist based at the Australia Army Malaria Institute in the basics of arbovirus isolation and identification.

Overseas Travel

Date	Destination(s)	Officer(s)	Purpose
August 2012	Vietnam	David Ffoulkes	Provide technical services to Vietnamese cattle importers and introduce new live export regulations.
	Vietnam	Scott Wauchope	Trade mission to progress livestock export market opportunities.
September 2012	Solomon Islands	Brian Thistleton	To conduct a workshop in Honiara on the cocoa pod borer for DAFF.
October 2012	Vietnam	Barry Lemcke and David Ffoulkes	Service to first time client receiving NT cattle shipment.
	Timor Leste	Lorna Melville and Neville Hunt	To attend the wind up workshop for the FAO biosecurity project.
November 2012	Vietnam	David Ffoulkes	Provide technical services to Vietnamese importer.
	Vietnam	Barry Lemcke	Provide technical services to Vietnamese importer.
	Indonesia	Kieren McCosker	Attend StrawCow annual meeting and conduct a junior scientist training day.
	China	Bob Williams, Lucy Tran-Nguyen and Andrew Daly	To attend banana symposium in Taiwan and discussions on collaborative banana research projects in China.
	The Philippines	Mark Hoult	ACIAR Small research and development activity. A scoping study of tropical exotic fruit research and industry development requirements was conducted in the Philippines with emphasis on production, postharvest and processing opportunities for durian, jackfruit, pomelo and other underutilised tropical fruits.

Overseas Travel

Date	Destination(s)	Officer(s)	Purpose
December 2012	Vietnam	Barry Lemcke	Provide technical advice and support for new cattle shipment of 1500 head.
	Cambodia	Bob Williams and Cameron McConchie	To finalise a 9-month scoping study of the mango industry and to commence the development of a four year mango research program.
	Vietnam	David Ffoulkes	Meet new Vietnamese cattle importer and provide technical support for Red Star Cattle Project.
January 2013	United States	Sally Leigo	Present and attend at the Society of Range Management conference and visit leading universities.
February 2013	Vietnam	David Ffoulkes	Provide technical assistance to Vietnamese importers of NT cattle.
	Nepal	Greg Maguire	National Foot and Mouth disease training coordinated by DAFF.
March 2013	Indonesia	Scott Wauchope and David Ffoulkes	Combined Government/Industry delegation travelling to Indonesia to establish relations on live export.
April 2013	New Zealand	Malcolm Anderson	Attend the Animal Health Committee meeting in Wellington.
	Indonesia	David Ffoulkes	Provide technical support to Vietnamese cattle importers and new clients.
May 2013	The Philippines	Mark Hoult and Mark Traynor	ACIAR Small research and development activity. Final project submission.
	Indonesia	Scott Wauchope	Attend meetings regarding buffalo bulls to enhance the Indonesian breeding program.
June 2013	Timor Leste	Brian Thistleton	Work on ACIAR project HORT/2011/006 on papaya mealybug in East Timor.

Seminars and Lectures

Date	Officer	Seminar/Lecture
May 2013	Dr Brendan Murphy	Principles of Biosecurity Surveillance for Phytophagous Pest
June 2013	Robert Carne	Good Governance, First Nation Fisheries Enterprises

Publications

Scientific Papers, Peer reviewed and other Publications.

Bithell, S. L., Hartley, N., Martin, C. C., Hearnden, M., Smith, S. H. and Owens, G. (2012). Importance of a wet season cover crop to nitrate recovery in tropical vegetable production. *Acta Hort*. 958: 105-111.

Bithell, S. L., Shotton, P. and Hearnden, M. N. (2013.) Effects of Agricultural Management on Soil Carbon and pH in the Douglas Daly Region of the Northern Territory, *Technical Bulletin* No. 343.

Bithell, S. L., Tran-Nguyen, L. T. T., Herdina, Hearnden, M. N., Hartley, D. M., McKay, A. C. (Submitted). Quantifying mango (Mangifera indica L.) root in soil using quantitative PCR. *Plant and Soil.*

Bithell, S. L., Tran-Nguyen, L. T. T., Hearnden, M., Hoult, M. D., Hartley, N. and Smith, M. W. (Submitted). First in-field study of feeder roots of mango (Mangifera indica) rootstocks: fine root mass differs relative to scion size and productivity. *Scientia Horticulturae*.

Boyle, D. B., Bulach, D. M., Amos-Ritchie, R., Adams, M. M., Walker, P. J. and Weir, R. (2012). Genomic sequences of Australian bluetongue virus prototype serotypes reveal global relationships and possible routes of entry into Australia. *Journal of Virology* **86(12)**: 6724-31. doi: 10.1128/JVI.00182-12.

Braby, M. F., Thistleton, B. and Neal, M. (in press). Host plants, biology and distribution of the Tawny Coster, *Acraea terpsicore* (Linnaeus, 1758) (Lepidoptera: Nymphalidae): a new butterfly for northern Australia with potential invasive status. *Austral Entomology*.

Bray, S. G., Walsh, D., Phelps, D., Rolfe, J., Rohan, P., Daniels, B., Stokes, C. and Ffoulkes, D. (in publication). Climate Clever Beef. On-farm Demonstration of Adaptation and Mitigation Options for Climate Change in Northern Australia. Final Report to Meat & Livestock Australia B.NBP.0564. (Meat & Livestock Australia, North Sydney), 181 pp.

Bray, S. G., Walsh, D., Gowen, R., Broad, K. and Daniels, B. (2012). Producing climate clever beef in northern Australia, p. 17. *In*: Proceedings Australian Rangeland Society 17th Biennial Conference, Kununurra WA. (Australian Rangeland Society, Perth).

Coventry, J. (2013). Keeping the eye on the bull…balancing issues for herd bull selection, *Alice Springs Rural Review*, Vol. 52, March pp.1-2.

Coventry, J. and Conradie, P. (2013). A database expedition for knowledge on cow mortality in Central Australia. *In*: Proceedings of the Australian Cattle Veterinarians 2013 Conference (Darwin), pp. 97-104.

Coventry, J. and Saville, P. (2013). Breeder cow losses in Central Australia. *In*: Proceedings of the Northern Beef Research Update Conference, Cairns 12–15 August 2013, p.161. (North Australia Beef Research Council, Gympie, Qld.).

Cowled, C., Melville, L., Weir, R., Walsh, S., Gubala, A., Davis, S. and Boyle, D. (2012). Persistent and recrudescent infection in cattle following natural infection with Middle Point orbivirus. *Archives of Virology* **57(6)**:1161-5.

Cowley, R. A., Pettit, C. L., Cowley, T. M., Pahl, L. I. and Hearnden, M. H. (2012). Optimising fire management in grazed savannas. *In*: Celebrating diversity: people, place and purpose. Proceedings of the Australian Rangeland Society 17th Biennial Conference, 23-27 September.

Douglas, J. and Walsh, D. (2013). Making production and conservation gains through adaptive grazing at Beetaloo Station, pp. 1-3, *Barkly Beef*, March.

Fordyce, G., Anderson, A., McCosker, K., Williams, P. J., Holroyd, R. G., Corbet, N.J. and Sullivan, M. S. (2013). Live-weight prediction from hip height, condition score, foetal age and breed in tropical female cattle. *Animal Production Science* **53**: 275-282.

Hobson-Peters, J., Yam, A. W., Lu, J. W., Setoh, Y. X., May, F. J., Kurucz, N., Walsh, S., Prow, N. A., Davis, S. S., Weir, R., Melville, L., Hunt, N., Webb, R. I., Blitvich, B. J., Whelan, P. and Hall, R. A. (2013). A new insect-specific flavivirus from northern Australia suppresses replication of West Nile virus and Murray Valley encephalitis virus in co-infected mosquito cells. *PLoS One* **8(2)**:e56534. doi: 10.1371/journal.pone.0056534 . Epub 2013 Feb 27.

Hunt, L., Ash, A., McDonald, C., Scanlan, J., Bell, L., Cowley, R., Watson, I., McIvor, J. and MacLeod, N. (2012). Seeking sustainable productivity improvements in the northern beef industry. *In*: Celebrating diversity: people, place and purpose. Proceedings of the Australian Rangeland Society 17th Biennial Conference, 23-27 September.

Hunt, L., Petty, S. Cowley, R., Fisher, A., White, A., MacDonald, N., Pryor, M., Ash, A., McCosker, K., McIvor, J. and MacLeod, N. (2013). Sustainable Development of Victoria River District (VRD) Grazing Lands. Final Report. Meat & Livestock Australia Limited, North Sydney.

Karan, M., Evans, D. S., Reilly, D., Schulte, K., Wright, C., Innes, D., Holton, T. A., Nikles, D. G. and Dickinson, G. R. (2013). *Khaya senegalensis* Genetic Diversity – Final Report for the Molecular Breeding Initiative, Smart Forests Alliance Queensland Project. Department of Agriculture Fisheries and Forestry, Queensland Government, Brisbane, 27 pp.

Leigo, S. (2013). Shifting into the driver's seat – women of the Australian rangelands driving change. *In*: Society for Range Management Oral-Abstracts, Society for Range Management, Wheat Ridge, Colorado, USA. http://rangelands.org/oklahoma_city2013/program.html

Leigo, S., Brennan, G., Beutel, T., Gray, A., Phelps, D., Driver, T. and Trotter, M. (2012). Overview of Technology Products for the Beef Industry of Remote Australia. CRC-REP Working Paper CW009. Ninti One Limited. Alice Springs. http://www.crc-rep.com.au/resource/CW009_PrecisionPastoralManagementTools_ProductReview.pdf

Lemcke, B. (2012). Enhancing Productivity Improvements in the Australian Water Buffalo Industry (July 2012). RIRDC Publication No.12/055 RIRDC Project No.PRJ-000042.

Lemcke, B. (2012). ABIC Buffalo News articles in Volume 11, No. 2, July 2012 and No.3, December 2012.

Lemcke, B. (2013). ABIC Buffalo News articles in Volume 12 No. 1, April 2013.

Materne, C. (2012 & 2013). DPIF Seasonal Update, September 2012, December 2012 and March 2013, *Alice Springs Rural Review*.

Materne, C., Jenner, D. and Walsh, D. (2012 & 2013). *NT Pastoral Advisory Bulletin*, September 2012, December 2012, March 2013 and June 2013 editions.

McCosker, K. D., O'Rourke, P. K., McGown, P. and Schatz, T. J. (2012). Timing of first pregnancy influenced the cumulative productivity of commercial beef heifers in north-west Australia. *In*: Proceedings of the 29th Biennial Conference of the Australian Society of Animal Production, Lincoln University, Christchurch, 2-5 July 2012. (Eds. M. A. Friend and G. L. Krebs) p. 48.

Meldrum, R. A., Daly, A. M., Tran-Nguyen, L. T. T. and Aitken, E. A. (2013). Are banana weevil borers a vector in spreading *Fusarium oxysporum* f.sp. *cubense* tropical race 4 in banana plantations? *Australasian Plant Pathology* DOI 10.1007/s13313-013-0214-2.

Meldrum, R. A., Fraser-Smith, S., Tran-Nguyen, L. T. T., Daly, A. M. and Aitken, E. A. (2012). Presence of putative pathogenicity genes in isolates of *Fusarium oxysporum* f.sp. *cubense* from Australia. *Australasian Plant Pathology*. DOI 10.1007/s13313-012-X.

Morgenthal, T. and Conradie, P. (2013). Improving grassland quality in communal arable lands in the Eastern Cape Province, South Africa. *In*: Proceedings of the International Grasslands Congress (Sydney).

Nikles, D. G., Reilly, D. F., Dickinson, G. R., Lee, D. J. (2012). African mahogany (*Khaya senegalensis*) plantations in Australia – status, needs and prospects. *In*: Wood, K. (ed.). Diverse sub-tropical forestry. Proceedings of the Australian Forest Growers Conference, 14-17 October, Gympie, Queensland, 8 pp.

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Niscioli, A. and Smith, S. H. (2013). Nitrogen and greenhouse gases in melons update. *DPIF Factsheet*, Department of Primary Industry and Fisheries.

Petty, S., Hunt, L., Cowley, R., Fisher, A., White, A., MacDonald, N., Pryor, M., Ash, A., McCosker, K., McIvor, J. and MacLeod, N. (2012). Sustainable development of VRD grazing lands. *In*: Celebrating diversity: people, place and purpose. Proceedings of the Australian Rangeland Society 17th Biennial Conference, 23-27 September.

Petty, S., Hunt, L., Cowley, R., McDonald, N. and Fisher, A. (2013). Guidelines for the Development of Extensive Cattle Stations in Northern Australia: Insights from the Pigeon Hole Project. Meat & Livestock Australia Limited, Sydney.

Phelps, D., Broad, K., Cowley, R., Emery, T., English, B., Hamilton, J., Jones, P., Karfs, R., MacLeod, N., Matthews, R., Pahl, L., Paton, C., Rohan, P., Rolfe, J., Stockdale, M., Scanlan, J., Walsh, D. and Whish, G. (in publication). Developing Improved Grazing and Related Practices to assist Beef Production Enterprises across Northern Australia to adapt to a Changing and More Variable Climate (Climate Savvy Grazing). Final Report to Meat & Livestock Australia B.NBP.0616. (Meat & Livestock Australia, North Sydney).

Reilly, D.F., Dickinson, G. R., Nikles, D. G., Wright, C. and Lee, D. J. (in prep). Genetic variation in growth, bole length and straightness among seed orchard families of African mahogany (*Khaya senegalensis*) in the Northern Territory, Australia.

Schatz, T. (2012). Articles in the VRRS Field Day Handbook. A report on research at the Victoria River Research Station.

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Schatz, T. (2012). The genetics of polledness. *Katherine Rural Review* and *Barkly Beef* newsletters.

Smith, S. H. (2012). Action on the ground: Investigating nitrous oxide cycling in Northern Territory farming systems. The *Plant Industries NT Newsletter*, December, p. 3-4.

Smith, S. H. (2013). Degradable mulch trial update. *DPIF Factsheet*, Department of Primary Industry and Fisheries.

Smith, S. H. (2013). Going under cover – cover crops tie up nitrate nitrogen in the wet season. *Grow NT* no 5, August, p 5. NT Farmers Association.

Smith, S. H. and Hunt, W. (2013). The continuous improvement and innovation model can reinvigorate horticultural extension in the Northern Territory, but requires an understanding funding agency. (Abstract – Poster Presentation). Australasia Pacific Extension Network International Conference, 25 – 27th August.

Smith, S. H. Tran Nguyen, L. T. N. and Conde, B. D. (2013). Fusarium wilt: The deadly malady of melons. *Melon News* Volume 1, the Australian Melon Association.

Smith, S. H., Tran Nguyen, L. T. N. and Conde, B. D. (2013). Characterisation and management of Fusarium wilt in watermelon. *Grow NT* no 5, August, pp 18-19. NT Farmers Association.

Tran-Nguyen, L. T. T. Conde, B. D. and Smith, S. H. (2012). Outbreak of Fusarium wilt in seedless watermelon seedlings in the Northern Territory, Australia. *Australasian Plant Disease Notes*, 2 May.

Tran-Nguyen, L. T. T., Smith, S. H. and Liberato, J. R. (2012). Sweet potato little leaf strain V4 phytoplasma associated with snake bean in the Northern Territory, Australia. *Australasian Plant Disease Notes* 7(1):147-150.

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Walsh, D. (2012). Managing woody vegetation using fire in the Victoria River District, pp. 50-51 *In*: Victoria River Research Station, Kidman Springs Field Day Handbook.

Walsh, D. (2012). Is there a business case for NT beef producers to “farm carbon”? pp. 6-7, *Barkly Beef*, December.

Walsh, D. (2012). Is there a business case for NT beef producers to “farm carbon”? pp. 2-3, *Katherine Rural Review*, December.

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