Northern Territory Department of Primary Industry, Fisheries and Mines

Primary Industries

Technical Annual Report 2005-06

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November 2006

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INTRODUCTION

Primary Industries in the Department of Primary Industry, Fisheries and Mines in the Northern Territory (NT) of Australia conducts research, development and extension (RD&E) projects in five specialised Divisions: Crops, Forestry and Horticulture; Pastoral Production; Biosecurity and Product Integrity; Diagnostic Services; and Research and Demonstration Farms. RD&E is conducted at the Department's headquarters at Berrimah Farm in Darwin and at several other government farms. It is also conducted at regional facilities in Alice Springs, Katherine and Tennant Creek; and on private properties, in collaboration with owners. RD&E projects and other related work are conducted in response to the needs of industry. This Technical Annual Report provides a summary of the work carried out during the 2005-06 financial year, together with results where possible, and general recommendations.

The estimated gross production value for crops, forestry and horticulture industries in 2005 was $110.9 million.

Mango production continues to dominate the horticulture industry. In 2005, 8781 tonnes of mangoes were produced, valued at $30.6 million. There are about 800 000 mango trees in the Territory with a potential to produce up to 5 million trays in the next five years. The mango industry is undergoing significant restructuring with the advent of corporate farming and farm consolidation. Many small-scale growers are leaving the industry. Several new commercial varieties such as Calypso, and some green varieties such as Keow Savoy, Falan and Nam Dok Mai, are being planted.

During the year, vegetable production reached 7667 tonnes, valued at $26.9 million. More than 50 farms now supply Asian and traditional vegetables to southern and local markets. There was a significant increase in cucumber production in shade-houses.

Pasture, field and fodder crop production reached over 88 576 tonnes, valued at $15.4 million. This included field crops such as 340 tonnes of sorghum, valued at $68 000, 58 tonnes of sesame, valued at $55 100 and 629 tonnes of peanuts, valued at $495 336. Fodder production including hay reached 49 680 tonnes, valued at $11.7 million. Silage production reached 35 000 tonnes, valued at $2.1 million. Mulch hay production reached 2790 tonnes, valued at $488 000. Seed production reached 79 tonnes, valued at $536 000.

Nurseries were valued at $14 million and cut-flowers, mainly heliconia and ginger, at $3 million. There was one major orchid grower.

Melons became a major crop in the NT in 2005 when production in the Katherine, Douglas Daly and Darwin areas reached 16 336 tonnes, valued at $8.6 million.

Table grapes are the main horticultural crop in Central Australia. In 2005, 1300 tonnes of table grapes were produced on 250 hectares, valued at $5.8 million. Root-knot nematodes were the major cause of a decline in production. Production is expected to increase as growers replace vines planted on Vinifera rootstocks with grafted vines on nematode-tolerant rootstocks. As vines on about 50 hectares were replaced in 2006, production is expected to increase over the next two years.

Banana production continued to decline due to Panama disease. Production declined from 2898 tonnes in 2004 to 2180 tonnes in 2005, valued at $3.5 million. Research is continuing to identify resistant varieties and to develop effective procedures to control the spread of the disease.

Citrus production reached only 300 tonnes in 2005, valued at $600 000. The low production was caused by average flowering in lemon and red-flesh grapefruit. Also there was some competition in the local market from Queensland limes.

Rambutan production was very low due to poor flowering, reaching only 31 tonnes, valued at $0.3 million.

Farm forestry is becoming a potential alternative for NT primary producers, land developers and for diversification of rural businesses. A strategy was developed and launched in 2004 for the production of African mahogany hard wood timber in the Top End. Further research will aim to produce high quality genetic material for this potential industry. A number of multi-million dollar private forestry enterprises are being established in the NT.

The Pastoral Division provides RD&E services to the pastoral industry to improve productivity, profitability and sustainability. In early 2006 the NT Pastoral Survey, which gives a snapshot of the industry, was released. Also, the Central Australian Grass Guide was released. The Guide assists in identifying and assessing rangeland conditions. The Division is cooperating with the Desert Knowledge CRC to improve efficiency for desert pastoralists.

The Biosecurity and Product Integrity Division was established in 2005. It aims to prevent the introduction of exotic pests and diseases into the NT, eradicate pests and diseases that are already present in the NT and effectively manage risks posed by pests, diseases and chemical residues to the economy, the environment and to human health. It is also responsible for ensuring continued access for NT primary industry products to domestic and international markets.

The Division covers five major areas, namely Plant Market Access, Animal Market Access, Chemical Services, Biosecurity and the National Livestock Identification System (NLIS).

Highlights for the year included the implementation of NLIS, commencement of the increased chemical residue testing program, the planning for a whole of Government Biosecurity Framework and the signing the Emergency Plant Pest Response Deed.

The Diagnostic Services Division is also relatively new and now includes the Berrimah Veterinary Laboratories, Water Microbiology in Darwin and Alice Springs, Water Chemistry, Agricultural Chemistry, Plant Pathology in Darwin and Katherine and the Seeds Laboratory.

The Division provides services for animal and plant health and export, water quality, chemical and plant analyses and seed testing including certification. It also conducts strategic and targeted research on arbo-viruses, termites, integrated pest management, Fusarium wilt in bananas and snake beans, and grapevine leaf rust.

The Division provides a quality-assured laboratory service to support the horticulture, pastoral and aquaculture industries in the NT and implements government policies on biosecurity, market access and product integrity.

PASTORAL PRODUCTION

Program: Native Pasture Management

Project: Barkly Tablelands Burning Trial

Project Officer: **C. Materne**

Location: Alexandria Station

Objectives:

To measure the impact of low intensity late wet season fires, and high intensity dry season fires, on Mitchell grasslands and woody plant species in Buchanan paddock at Alexandria station.
To demonstrate the application of prescribed burning in the extensively grazed Mitchell grasslands in Buchanan paddock.

Background:

Traditionally, pastoralists have considered the Mitchell grasslands of the Barkly Tableland as being too valuable in terms of cattle feed, to burn. Research in other regions suggests that Mitchell grasses (*Astrebla* spp.) recover rapidly after burning and that cattle grazing on burnt pasture usually perform better during the wet season, than those grazing unburnt pasture. This, along with anecdotal evidence suggesting that woody tree and shrub species are beginning to increase and encroach onto Mitchell grasslands, has intensified certain pastoralists' views that there is not enough fire used on the Mitchell grass downs of the Barkly Tableland.

The aim of the Alexandria burning trial is to determine the impact of seasonal prescribed fire on native tree and shrub species, pasture composition and quality, and cattle grazing characteristics of the Mitchell grasslands of the Barkly Tableland.

Method:

This trial consists of two parts:

- An intensively sampled plot trial to identify the response of Mitchell grasslands to burning at two different times of the calendar year, and its effect on the encroaching woody vegetation.
- A broader paddock-scale trial to demonstrate the use of fire as a pasture management tool.

Duration: 2001–2006

Developments

All practical burning and pasture data collection has been completed. Data collation and analysis is being conducted. A final report will be completed by the end 2006.

Project: Central Australian Grass Guide

Project Officers: C. Allan and D. Wilson (retired)

Location: Alice Springs

Objectives:

To publish a field guide to assist pastoralists in Central Australia to identify and assess grass and rangeland conditions.
To help increase awareness of key native perennial and annual grass species as well as introduced species in the region and what their presence means in terms of land condition in Central Australia.
To provide an educational resource to various land managers in Central Australia.

The project was initiated at the request of the Central Australian pastoral industry which expressed the need for putting together all available information on grasses in the area in a single publication for easy access by pastoralists. Funding was provided by *EnvironmeNT* Grants through the Centralian Land Management Association.

With the assistance of pastoralists and experienced extension staff, 43 of the most common pasture and indicator grass species were selected. Technical information and pictures for each species were then assembled and put together as a book. The book has been designed to be robust for outdoor use with strong wire binding and water-resistant pages.

The book can assist pastoralists and extension staff to identify the different species and also provides information on their grazing value, habitat preferences and grazing/drought/frost tolerances.

Each pastoral lease in Central Australia has received a copy of the publication following its launch by the Minister for Primary Industry, Fisheries and Mines at the Alice Springs' Show on 8 July 2006. It is also being promoted widely through radio interviews, newsletter articles, advertisement at the Olive Pink Botanic Gardens (Alice Springs) and word of mouth. Requests are flowing in steadily for copies.

Several government agencies have obtained copies for their extension staff. Future promotion activities include an article in the *NT Network Notes* newsletter and displays at the Australian Rangeland Society, Lake Eyre Basin Conferences, the Arid Zone Research Institute Open Day and the Natural Resource Management Information Exchange Seminar in Alice Springs.

Project: Desert Fire

Project Officers: C. Materne and C. Allan

Location: Alice Springs Region

Objectives:

To gain a better understanding of the relationships between fire, woody vegetation dynamics and pasture production through investigations of woodland communities that have experienced different fire regimes over the 2000-2002 period.
To initiate participation by DPIFM in the Desert Knowledge CRC Desert Fire program.

Background:

The rangelands of Central Australia are a dynamic system in which the profitability of the pastoral industry, which depends on it, can vary depending on the phase of its floristic composition at a particular time. Fire is one of nature's tools to manipulate the floristic composition of rangelands. By endeavouring to understand the relationships between fire and rangeland dynamics, it is possible to use fire to maintain rangelands in a phase that is more profitable.

During 2000 and 2001, the Alice Springs district received about 2.5 times the average rainfall. This unusual rainfall was followed by above average vegetative growth resulting in extensive wildfires that have been compared to those of the 1920s, 1950s and 1974-75. The unusual 2000-02 fires caused vast areas of country to experience varying effects due to fire frequency and soil moisture.

The project is funded by the Desert Knowledge CRC in collaboration with DPIFM and the Department of Natural Resources, Environment and the Arts, through Bushfires NT.

Method:

Study site selection

Using the DOLA (former WA Department of Land Administration) fire-scar mapping tool, the 2000-2002 fires in the Alice Springs region will be mapped according to fire frequency, timing and land system.

Fires will be classified into three main types:

- October 2001 fires north of Alice Springs with substantial follow-up rain.
- October 2002 fires north of Alice Springs without follow-up rain.
- October 2002 fires south of Alice Springs without follow-up rain.

Analysis will be conducted of three fires within each fire type using 3 x 250 m transect pairs located in both unburnt and burnt Mulga (*Acacia aneura*) communities.

Data collection

Woody vegetation data will be collected at each site on:

- Living species present.
- Living species density (stems per hectare).
- Woody vegetation cover (using the BITTERLICH method).
- Fire damage.
- Woody vegetation fire recovery method.
- Dead stem identification and count (stems per hectare).

Developments

Data collection has been completed for nine fires on eight properties across the Alice Springs region. Three more fires are scheduled on three properties by October 2006. A report will be presented to the Desert Knowledge CRC by December 2006.

Project: Grazing Regimes to Maintain Biodiversity in Mitchell Grasslands

Project Officers: R. Cowley and C. Materne

Project Location: Mt Sanford Station, VRD

Objectives:

To determine the impact of stocking rate and distribution of grazing pressure on the biodiversity of flora and bird species in Mitchell grasslands.
To formulate best practice stocking and grazing guidelines for the conservation of biodiversity values.
To improve the knowledge and understanding of land managers about maintenance of biodiversity in production systems.
To facilitate appropriate development to enhance profitability and ensure conservation of biodiversity.

Background:

Cattle grazing influences plant and animal diversity in Mitchell grasslands and in pasture lands generally, in the Northern Territory. Land managers do not have access to critical information to maximise the conservation of biodiversity within production systems. This currently constrains the development and implementation of integrated management regimes to enhance regional conservation. Diversity of plants and birds was surveyed in the Mt Sanford grazing trial in the 12%, 23%, 34% and 45% utilisation treatments.

Method:

Plant and bird diversity surveys were conducted in April and October in 2002 and 2003. Plant surveys were conducted in May 2006. A final bird diversity survey was planned for October 2006.

Results:

Plant cover and composition had responded to utilisation treatments by 2003. Similarity between sites in plant composition was initially unrelated to utilisation rate in April 2002 (Figure 1), but by April 2003 sites

were beginning to align in order of utilisation rate (Figure 2), although there was still much overlap in composition between treatments.

Bird diversity, abundance and composition showed few initial patterns in response to grazing intensity. Total ground cover was negatively correlated with utilisation rate by 2003. Plant species richness varied across sites and times, but was not related to grazing intensity. The number of palatable plant species that were significantly more frequent in the lowest utilisation paddocks, and the number of unpalatable species that were significantly more frequent in the higher utilisation treatments, increased between 2002 and 2003. By April 2003, some bird species were significantly negatively correlated with utilisation rate and some groups positively correlated with total ground cover. However, these species and groups were not the dominant grassland species. It appears that bird abundance and diversity had a lagged response to changes in plant composition and structure resulting from cattle grazing.

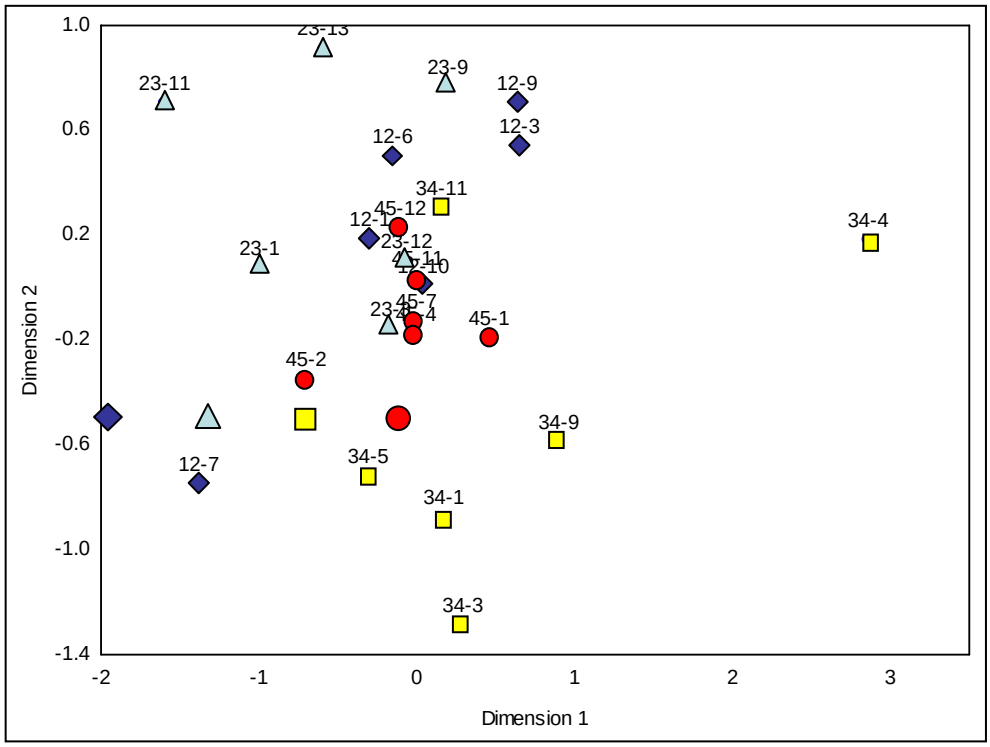

Figure 1. Multi-dimensional scaling of plant species composition April 2002. Sites are labelled by utilisation rate 12% 23% 34% 45%. Sites that are closer together are more similar in composition.

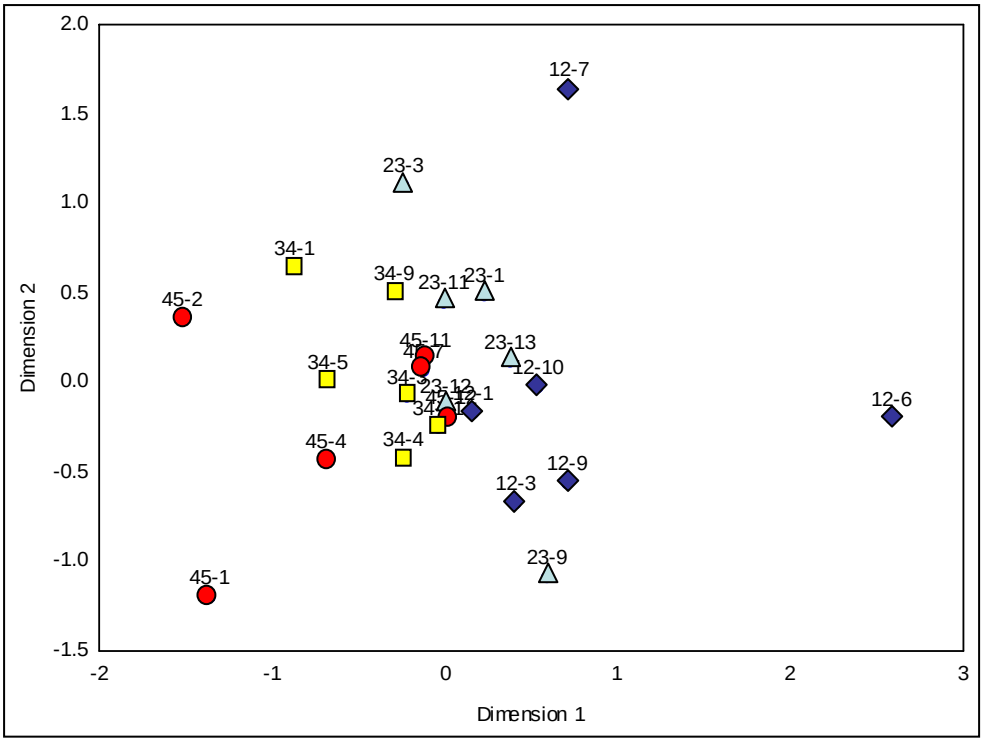

Figure 2. Multi-dimensional scaling of plant species composition April 2003. Sites are coloured by utilisation rate 12% 23% 34% 45%. Sites that are closer together are more similar in composition.

Analysis of the 2006 data will give a more complete picture of biodiversity trends with grazing intensity.

Program: Grazing Management

Project: Rockhampton Downs Alternating Water Points Trial

Project Officer: A. Bubb

Location: Rockhampton Downs Station

Objectives:

To establish the feasibility of managing the grazing of cattle through methods other than increased fencing within the extensive production systems of the Barkly region.
To investigate the cost benefit relationship in converting a paddock from a traditional continuous grazing system to a water point controlled rotational grazing system that incorporates wet season spelling.
To investigate the effects of increased watering points and periods of plant rest on pasture utilisation and condition.
To improve grazing management of Mitchell grasslands by increasing watering points to better control cattle grazing behaviour and to spread grazing pressure across the entire paddock.

Method:

Cattle grazing behaviour is being manipulated by operating only one of five watering points in a paddock at any one time during the dry season (April to November). A control paddock operates under traditional grazing management. Extensive pasture and cattle data has been collected from the Rockhampton Downs Station site which indicates that cattle performance is reduced initially by the alternating water management regime, but pasture composition is improved. The investigation is ongoing and has successfully demonstrated that cattle grazing can be managed by alternating watering points in the Barkly Region.

Rockhampton Downs Station is located on the black cracking clay soils of the Barkly Tableland. Mitchell grass is the predominant perennial species across the vast treeless plains. The region experiences distinct wet and dry seasons with 95% of the average annual rainfall of 400 mm falling from November to April. Average annual minimum and maximum temperatures are 19°C and 34°C, respectively.

A 530 km^2 paddock was divided into two. In the control paddock 880 head of cattle are managed under traditional continuous grazing. All watering points within the control paddock are operational at all times, while cattle graze freely. The treatment paddock operates under an alternating watering location system with 730 head of cattle moved around the paddock by having only one of five watering points operating at any one time. New watering points have been established by turning off existing troughs at bores and pumping the water to new troughs about 4 km away in traditionally un-grazed areas. Cattle are held at the water for six weeks, which allows each watering point to be grazed once during an average dry season. During the wet season, when surface water is available, grazing is uncontrolled.

The pasture is monitored using an intensive double sampling method at the beginning and end of the dry season. All transects originate at watering points and extend to a distance of 3 km from new watering points and 5 km from existing watering points. Sampling occurs at 250 m-intervals within 2 km of the watering point and then at 500 m-intervals beyond that. Cattle weights, pregnancy status and weaner weights are collected in May. An extensive management diary is kept to evaluate the impact of this grazing system on overall station operations, allowing for a greater understanding of its impact.

Developments

The early onset of the wet season allowed the collection of sufficient dry season pasture data in 2005.

Cattle behaviour was modified to reduce labour needed to move the animals from one watering point to another.

Results:

Low re-conception rates for lactating first calf heifers is a recognised problem in the Barkly region, with the average estimated at 62%. Pregnancy test data in 2005 indicates re-conception rates of 30.2% for the treatment group and 50.6% for the control group, which is low compared with the regional average. While a long dry season in 2004 contributed to this poor performance, the re-conception rate in the treatment group was significantly lower than that in the control group. Pregnancy test data for 2006 was unavailable at the time of publishing due to the late wet season.

There was no significant difference between average weights of weaners turned off from the two groups over the two years of the investigation.

Initial observations have indicated an increase in the perennial pasture species Mitchell grass within 250 m of watering points.

Project: Identifying Optimum Levels of Pasture Utilisation

Project Officer: R. Cowley

Project Location: Mt Sanford Station, VRD

Objective:

To identify optimum levels of pasture utilisation at the paddock level.

Background:

A 1997 survey in the VRD of 134 paddocks found stocking rates averaged 11 animal equivalents per square kilometre (AE/km^2), ranging from 5-35 AE/km^2. Forty percent of paddocks were stocked at less than 10 AE/km^2. Based on modelled pasture growth, 11AE/km^2 is equivalent to 25% utilisation on red and 15% utilisation on black soils in a median rainfall year. At the time of the survey however, this represented utilisation rates of just 13% on black soil or 21% utilisation on red soil.

However, while average utilisation rates were low to moderate, paddock sizes are large. On 40% of the VRD distances to water are more than 4 km. This causes areas close to water to be overgrazed, while pasture utilisation far from water is very low. Cattle producers in the region recognise the potential for improvement in pasture utilisation. In a recent survey of cattle producers in the Katherine region, producers estimated that carrying capacity could be increased by 25% in the next five years and 42% in the next 10 years with current development plans, with 80% of producers having immediate plans to install more water points and subdivide paddocks.

Prior to this study there was little local information on sustainable carrying capacity of the region. This study will provide objective estimates of sustainable utilisation and facilitate infrastructure development based on realistic production capacity estimates, which will hopefully avoid the over-development of rangeland that has occurred in the eastern savannas.

Method:

The trial was conducted at Mt Sanford Station, about 500 km south west of Katherine, in an open savannah dominated by (in order of yield) *Astrebla* spp. (19%), *Aristida latifolia* (18%), *Iseilema* spp. (12%), *Chrysopogon fallax* (11%) and *Dichanthium* spp. (11%) on basalt derived black cracking clay soils. The paddocks ranged in size from 4-8 km^2 and were roughly square or rectangular in shape.

May 1993 - May 2000

Six paddocks were set-stocked with 54 cows, 10-13 steers, two bulls and associated calves. Stocking rates varied from 5-15 head/km^2 (1 head/km^2 is equivalent to 1.3 AE/km^2) depending on paddock size. Utilisation rates varied seasonally with pasture growth and averaged 7-20%.

October 2000–October 2005

Following the first eight years of the trial, treatments were changed to set utilisation and variable stocking. Animal numbers were adjusted each May to achieve a constant utilisation rate (the proportion of the pasture that grows each year that is consumed by cattle). The lowest utilisation treatments (average of 6-7%) were abandoned and higher utilisation rates (35 and 45%) added. Planned (and actual average adjusted utilisation rates) were 12 (13)%, 16 (19) %, 22 (24) %, 28 (31)%, 35 (41)% and 45 (49)%. A late wet season in 2002-03 meant that actual utilisation was much higher than aimed for, which increased the average utilisation over the trial.

Pasture was assessed for percent bare ground, total standing dry matter and percent composition of the top four species contributing to yield at the end of the wet season in late April/early May and the end of the dry season in October each year, except where access was not possible due to rain. There were 12 datasets for 1994-2000 and 11 datasets for 2001-2006.

Statistical analysis

Each utilisation treatment was usually represented by a single paddock. Hence variables could vary significantly between paddocks due to inherent paddock differences. For this reason, it is the effect of utilisation treatment on change through time that was often of interest as a way of differentiating utilisation effects. This was detected through repeated measures using ANOVA and time x utilisation interactions of April/May datasets.

Results:

During 1994–2000, only one year had below average rainfall (1997-98) with four years in the top 20%, and one year in the top 30%. There was median to above average rainfall from 2001-06, although the 2002-03 growing season was very short and hence poor, with no substantial rainfall until the second half of the wet season.

Most variables varied significantly through time, following seasonal fluctuations (Table 1). From 1994 to 2000 utilisation had no discernable negative effect on land condition. From 2001 to 2006 there was beginning to be some indication that utilisation levels above 30% were leading to reduced land condition.

The proportion of bare ground was higher, with higher utilisation from 1994 through to 2006. From 1994 to 2000, the average proportion of bare ground at the end of the wet season and the dry season ranged from 16% to 23%, and 28% to 43%, respectively at 7% and 20% utilisation, respectively. From 2001 to 2006, the proportion of bare ground in May and October increased up to 31% utilisation (at 26% and 56% bare ground, respectively), but did not increase with higher utilisation.

Table 1. Effect of utilisation treatment and time on land condition indices and plant composition - May 1994–2006, Mt Sanford. Repeated measures of ANOVA. P< 05, **P<.01, *** P<.001. * In (x+1) transformations were applied to the dependent variable.

	Utilisation	**Time**	**Time * utilisation interaction**	**Utilisation**	**Time**	**Time * utilisation interaction**
Variable	(7-20%)	1994-2000		(13-49%)	2001-2006	
% bare ground	*	***	**	*	***	***
Total standing dry matter		***	***		***	***
Aristida latifolia yield	**	***	***		***	***
Astrebla spp. yield	**	***	**	**	***	***
Brachyachne convergens yield*		***	***	**	***	***
Chrysopogon fallax yield		***	***		***	
Iseilema spp. yield *	***	***	***	***	***	***
*Panicum decompositum**		***			***	**

Total standing dry matter did not significantly vary between utilisation levels from May 1994 until 2006. However, it was significantly negatively correlated with utilisation in May 2002, 2003, 2004 and 2006 (Spearman's correlation -.43***, -.30*, -.39** and -.27* respectively), but this represented recent grazing as growth estimates were not influenced by utilisation rate.

From 1994 to 2000 *Astrebla* spp*.* yield was significantly higher at the highest utilisation level of 20%, increasing more through time, while in the two lowest utilisation treatments *Astrebla* spp*.* started out highest, but decreased through time. From 2001 through to 2006, *Astrebla* spp. yields through time varied with utilisation treatment; increasing at 13% of the, highest and fluctuating at 24 and 31% and relatively low and flat at 19%, 41% and 49%. *Panicum decompositum* yield decreased more through time in 41% and 49% utilisation for 2001-2006. Other palatable dominants at the site, *Dichanthium* spp. showed no response to utilisation level.

Chrysopogon fallax yield increased through time at 20% from 1994-2000, while fluctuating at lower utilisation levels and its trend through time did not vary between utilisation treatments for 2001-06.

From 1994-2000 *Aristida latifolia* yields was significantly higher through time at the 16% utilisation level than at 20%, which varied little through time. From 2001 to 2006, there were no utilisation treatment effects on *Aristida latifolia*. Time utilisation interactions were not indicative of *Aristida* increasing more at higher utilisation levels.

Iseilema spp. yield was highest and varied more inter-annually at 12% utilisation from 1994-2000, and 13% utilisation from 2001-06 (both in the same paddock). *Brachyachne convergens* yield decreased most through time from 1994-2000 at 12% utilisation and was lowest and fluctuated least from 2000-06 in 13% utilisation (the same paddock).

Discussion:

There was no evidence of declining land condition under utilisation levels ranging from 7-20% from 1994 to 2000. In contrast to this, the palatable *Astrebla* spp. yield *increased* through time at 20% utilisation, when they are known to decrease under heavy grazing. Additionally, cover levels at 20% utilisation were within current recommended levels of more than 50% ground cover. This is perhaps not surprising given that 30% utilisation of Mitchell grass vegetation types in Queensland is considered 'moderate' grazing pressure.

From 2001-06, there was some evidence that the highest levels of utilisation may not be sustainable, with negative impacts on the palatable *Panicum decompositum* at 41-49% utilisation. The higher levels of the decreasing *Astrebla* spp. at intermediate utilisation rates of 24-31% suggest these are sustainable levels. However, at 31-49% utilisation cover levels leading into the wet season were less than 50%, which is below that recommended for sustainable land use. The higher incidence of palatable *Iseilema* spp. combined with a lower incidence of increased *Brachyachne convergens* in the lowest utilisation treatment are typical grazing responses found elsewhere.

Conclusions

Fourteen years of grazing across a variety of seasons have demonstrated that land condition can be maintained at levels of utilisation around 24%, and potentially up to 31% utilisation which is considerably higher than the industry average of 20% and is consistent with producer plans to increase production by 25% in the region in the next five years. However, this higher utilisation rate may not be applicable to red soils. It is also contingent upon appropriate infrastructure development and more intensive management systems to manage the increased risk associated with higher utilisation rates.

Project: Developing Sustainable Carrying Capacities in the NT

Project Officers: A. Kain (Alice Springs) R. Allan (Barkly) C. Smith and R. Cowley (Sturt Plateau)

Project Location: Alice Springs, Barkly and Sturt Plateau Regions

Objectives:

To develop methods for objective assessment of carrying capacity, including calibration of pasture growth models, for the Sturt Plateau, Barkly and the Alice Springs regions.
To present the results to pastoralists to enable them to make strategic decisions on seasonal and long-term stocking rates.

Background:

There is potential in the NT cattle industry to increase production through subdivision and intensification of land use. However, land use intensification in other states has sometimes led to unviable small blocks and extensive land degradation, due to an over-optimistic assessment of land capability. To facilitate sustainable development of the NT cattle industry it is therefore imperative that there is an objective and transparent method for estimating carrying capacity, particularly where properties are being subdivided.

This project aims to calibrate the GRASP model to facilitate estimation of sustainable carrying capacities in important grazing pasture types of the NT in the Barkly, Sturt Plateau and Alice Springs regions. The GRASP model is calibrated through the collection of pasture, soil and meteorological data from small exclosures called SWIFTSYND sites. These exclosures have been set up on areas that represent different land systems and vegetation types in order to obtain a broad viewpoint across the region.

Monitoring events (harvests) are conducted four times throughout the year, except for the Alice Springs region where harvests are conducted bimonthly. The timing of harvests is dependent on seasonal conditions. At each harvest, pasture, soil and rainfall data is collected from the sites.

ALICE SPRINGS

Method:

Six sites were constructed on four stations and the Old Man Plains Research Station during 2004-05. They represented the following land systems; Alcoota (Alcoota Station), Ebenezer (Mt Ebenezer Station), Muller (Old Man Plains Research Station), Outounya (Umbeara Station), Renners (Deep Well Station) and Sandover (Alcoota Station).

Results:

Rainfall was patchy across the Alice Springs district in 2004-05 and included short growth events during both summer and winter. Because growth events were so small, it has not been possible to conduct multiple harvests per growth event. Therefore one harvest was undertaken at the completion of each growth event. Table 1 describes how many harvests have been completed at each site.

Table 1. Record of harvests at each site

Land system	Winter growth event	Summer growth event
Alcoota	2	2
Ebenezer	0	1
Muller	2	2
Outounya	1	1
Renners	2	1
Sandover	2	3

Developments

Up to four additional sites will be constructed in 2006-07, depending on availability of staff and cooperation by pastoral stations.

BARKLY

Method:

Twelve monitoring sites have been constructed in the Barkly region. They are located at Alexandria, Beetaloo, Benmara, Brunette Downs, Helen Springs, Newcastle Waters, Rockhampton Downs and Walhallow Stations. They cover Barkly, Creswell, Pollyarra, Pollyarra/Creswell and Wonorah/Barkly1 land systems.

Results:

Monitoring site infrastructure was completed in August 2006.

By August 2006, all sites used prior to July 2006 (excluding Benmara) had been monitored up to the harvest 4 stage. Due to unexpected seasonal inaccessibility, the sites were not harvested over the 2005-06 wet season. A species list is current for all sites monitored prior to July 2006.

Developments

Season 2004-05 data has been collated to the harvest 4 stage.

Harvest 7 will be conducted in September 2006. Four new sites have been constructed in the Barkly region.

The 11 Barkly sites will be reset in October 2006 for the 2006-07 wet season.

STURT PLATEAU

Method:

Ten SWIFTSYND sites are located around the Sturt Plateau on five different land systems. Three sites were erected in October 2005. The selected land systems are Banjo, Larrimah, Sturt, Bulwaddy and Elsey. Together, they represent 71% of the total Sturt Plateau region. Soil moisture cores are taken from every site which will be an important parameter for modelling with GRASP. Complete species lists and herbariums are being compiled for each site.

Results:

This was a challenging year with unusual seasonal rainfall. There was an early break in the wet season in late October which resulted in some delays in resetting some sites. Also, flooding in the Katherine area prevented access to many sites. Other problems included wildfires and cattle breaking into the sites. Currently, the Sturt Plateau SWIFTSYND sites are as follows:

- Two sites to finish this year (seven of eight harvests completed).
- One site to be repeated due to cattle breaking in and destroying standing dry matter.
- Three sites to be resumed after resting for a year after early rains produced too much green growth for burning.
- Four sites to finish first year data collection with five harvests remaining.

At present there is insufficient information to allow modelling with GRASP. However, data on dry matter (kg/ha) of total standing pasture has been collected. It shows patterns developing between the land systems (see Figure 1). Later this year, soil cores will be taken to collect bulk density data from each site.

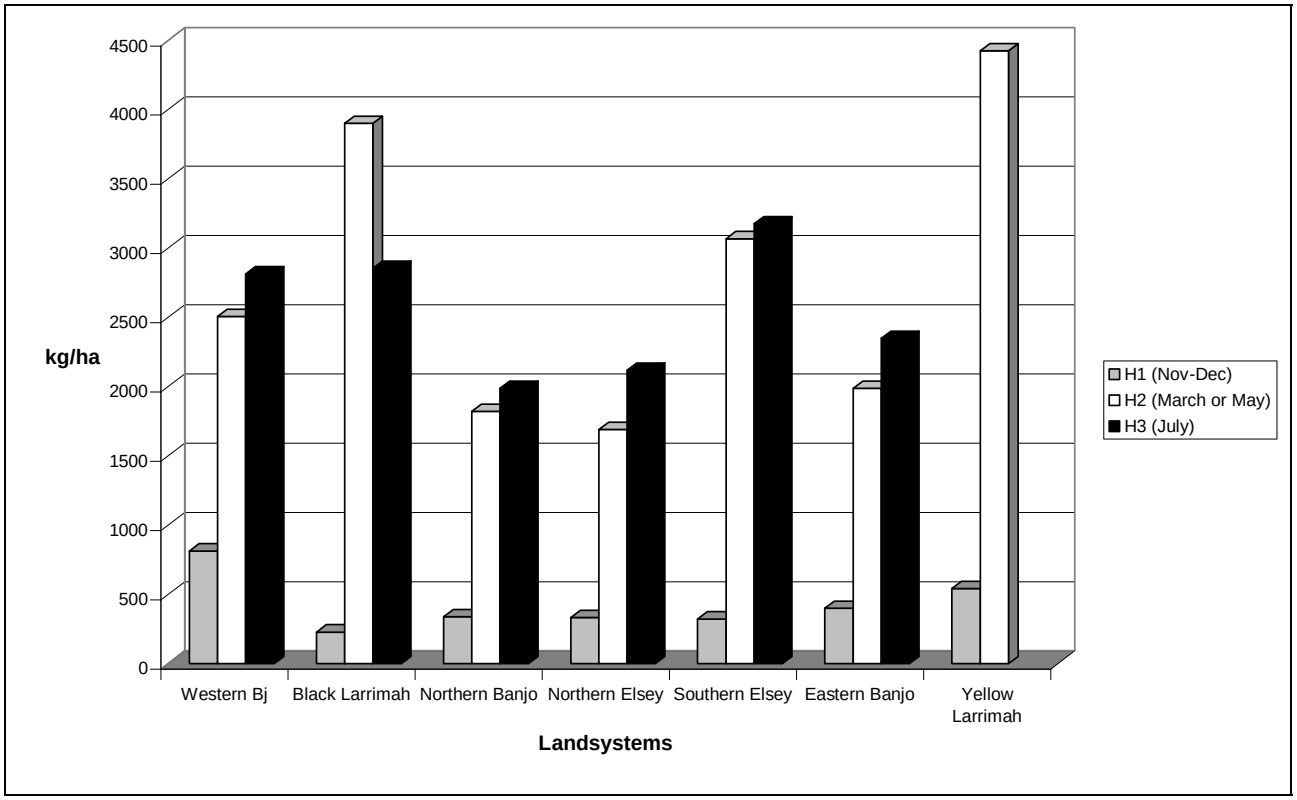

Figure 1. Total standing dry matter from harvests 1 to 3 during 2005-06 - SWIFTSYND sites on the Sturt Plateau

Project: Rangeland Grazing Strategies for Improved Economics and Resource Sustainability

Project Officer: **A. Kain**

Location: Mt Riddock Station, Idracowra Station, Old Man Plains Research Station

Objective:

To develop industry-acknowledged best practice guidelines for grazing strategies in Central Australia that incorporate spelling and which contribute to improved economic viability and resource sustainability.

Background:

Best practice guidelines for Central Australian spell grazing strategies

Over the past decade the ongoing cost-price squeeze has forced pastoralists to seek methods that would allow more efficient use of their land. There has been widespread interest in spelling practices, which potentially could increase sustainable production without damaging natural resources. However, there is little documented evidence of such a potential, particularly at a practical whole-of-property/business scale. Recently, Heytesbury Beef established a major commercial trial of intensified land use at Pigeon Hole Station in the tropical savannah region of the VRD. Also, a project is being set up in the southwest rangelands of Western Australia to monitor the effects of various practices by pastoralists at the property level. In Queensland, a new Meat and Livestock Australia project is exploring the environmental and economic benefits and costs of different grazing systems, particularly cell grazing. Thus current trials cover summer and winter-dominant rainfall regions of the rangelands but leave a hole in the non-seasonal and more variable sector of the rangelands from western NSW and south western Queensland through Central Australia to the Murchison in WA.

The major benefits of spell-grazing practices are likely to be:

- Opportunities to spell country at critical times for pasture regeneration.
- Closer observation of the condition of the country for the benefit of both stock production quality for market and resource condition.
- Resulting better drought preparedness.

Potential risks of spell-grazing include:

- Capital costs of setting up a more intensively-fenced and watered system.
- Errors of judgement in leaving stock on country for too long (though offset by damaging less area in one go), probably made riskier in regions with a more variable climate or fragile soils.
- Lack of access to markets at critical times.

Method:

Three grazing trials will be conducted in Central Australia. Two are on pastoral properties (Mt Riddock and Idracowra Stations) and the third is on Old Man Plains Research Station.

At Mt Riddock, steers are grazed through an eight paddock rotation. Pastures are monitored pre- and post-grazing. Cattle are weighed at the beginning and end of their time in the rotation and will also be weighed periodically throughout the rotation. Animal grazing and behaviour is recorded using a defoliation index and cattle activity index. The defoliation index is a qualitative measurement of yield that has been removed.

Cattle activity is a qualitative assessment of activity within a quadrat. Activity is described by hoof prints or manure. A score of one is given where there are one or two hoof prints. A score of three is given where hoof prints or manure cover all of the non-vegetated area of a quadrat.

At Idracowra, breeders are run in a 500 km^2 paddock that is watered through a moveable trough along a 30-km pipeline. The trough is moved about once a week, depending on seasonal conditions and type of country. Pastures are monitored pre- and post-grazing. Breeders are weighed and pregnancy-tested at the beginning of their time in the paddock (May 2006) and will be monitored annually.

The Old Man Plains trial will consist of four paddocks that allow for annual summer spelling of the calcareous grasslands and bi-annual summer spelling of the mulga sand plains. Pastures are monitored pre- and post-grazing.

Results:

Mt Riddock

Four hundred steers have completed a four paddock rotation at Mt Riddock Station and have been sold. These steers achieved a good price at auction and an average daily weight gain of 0.55 kg/day. There are no results from the control steers at this time. Pasture monitoring results are shown in Figure 1. They are indicative only.

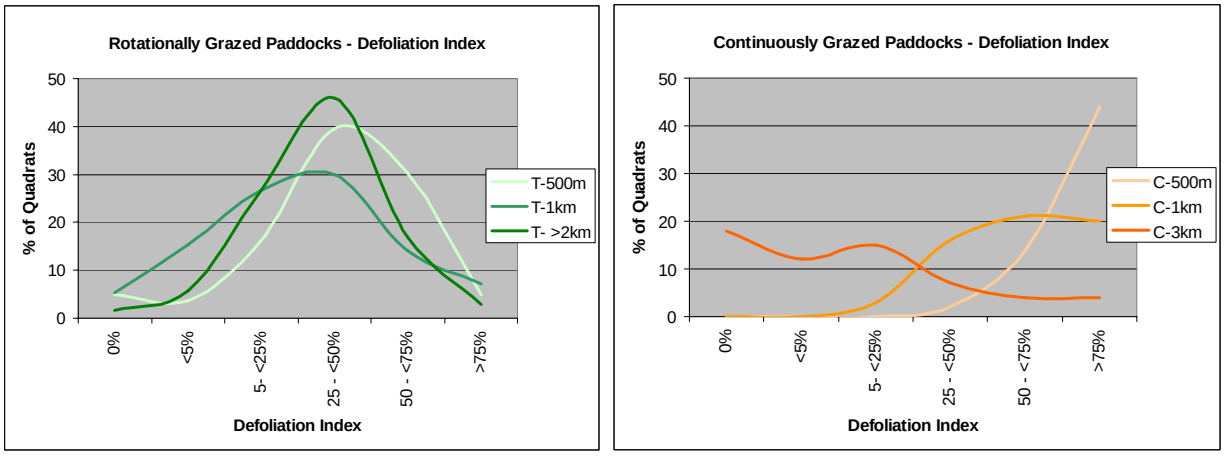

Figure 1. Defoliation index for the rotationally grazed and continuously grazed paddocks

In the rotationally grazed paddocks, the pattern of defoliation rates was similar at all three distances from water whereas in the continuously grazed paddock, the three distances from water had very different defoliation rates. This suggests that rotational grazing achieved more even grazing across the paddock.

The rate of defoliation was also different between the two methods. In the rotationally grazed paddocks, most of the quadrats were defoliated in the range of 25-50% with very few being either ungrazed or grazed in excess of 75%. However, in the continuously grazed paddock, defoliation rates changed with distance from water. At 500 m from water, all of the quadrats had been defoliated by at least 25%, and 44% of the quadrats were defoliated by more than 75% of the total yield. Conversely, at the 3-km distance, defoliation only occurred in 82% of the quadrats and the rates of defoliation were all much lower. This suggests that the rotational grazing strategy might help minimise the effect of the grazing gradient and subsequent pasture degradation close to water.

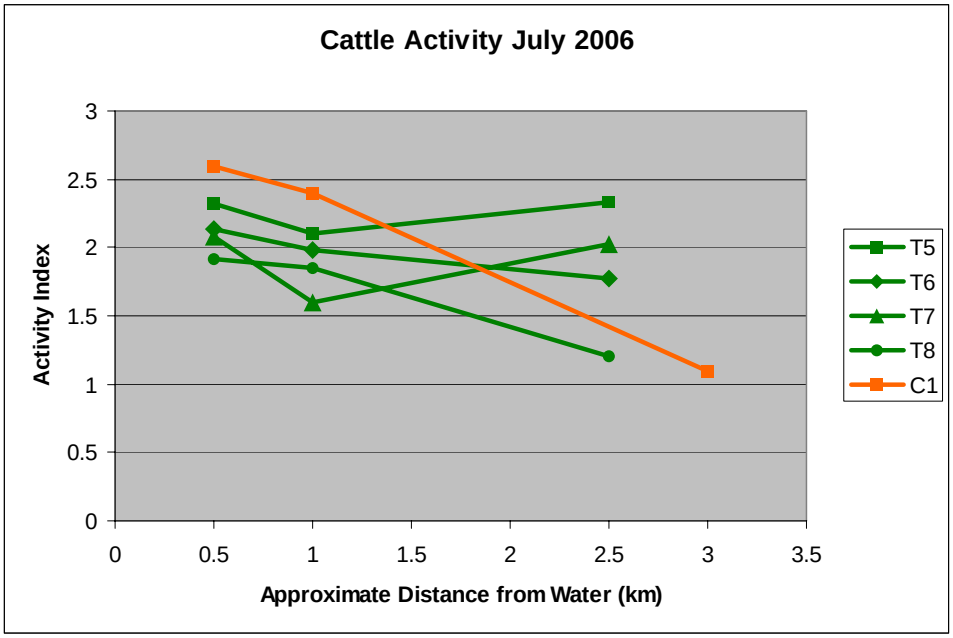

Figure 2. Cattle activity in the rotationally grazed and the continuously grazed paddocks

Figure 2 shows that cattle in the treatment paddocks were almost uniformly active across the whole paddock. The situation in the continuously grazed paddock was quite different and shows that there was heavy activity close to water and much lighter activity at 3 km from water. This type of activity can lead to the formation of grazing gradients and overgrazing of pastures close to water.

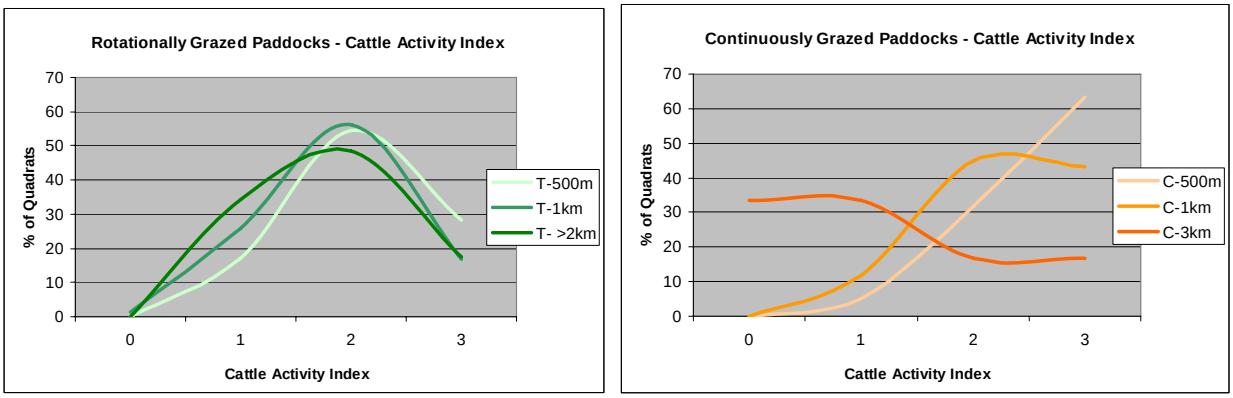

Figure 3. Cattle activity at various distances from water for the rotationally grazed and the continuously grazed paddocks

The pair of graphs in Figure 3 show that cattle in the treatment paddocks were moderately active across the whole paddock with very few quadrats (0.4%) receiving no animal activity and only 20% receiving heavy activity. The situation in the continuously grazed paddock was different. Close to water, all quadrats showed some signs of activity with 63% of quadrats receiving heavy grazing at 500 m and 43% at 1 km. At 3 km from water the situation was is quite different, with 33% of quadrats not receiving any activity and only 34% receiving moderate or heavy activity. When cattle use pastures in such a way, it can lead to overgrazing close to water. It can also lead to overgrazed patches of country at greater distances from water along with other patches that are not utilised.

More even activity across the paddock means that cattle are not camping in favoured areas. This is highly desirable as areas where cattle camp are characterised by large amounts of manure and urine. This means

that nutrients obtained across the pasture are deposited at the camps, potentially leading to a decline in nutrient availability to the rest of the pasture.

Idracowra

At Idracowra, 558 head (516 mixed aged females and associated calves, 20 steers, 22 bulls) were used in the trial paddock from May 2006. In the control paddock, 345 head (317 mixed aged females and associated calves, 18 steers, 10 bulls) were used from May 2006. Pre-grazing pasture monitoring had been completed in April 2006.

Old Man Plains

There are no results for Old Man Plains. The trial is very much behind schedule and infrastructure development is still a long way from completion. The pre-grazing pasture monitoring has been completed for what was expected to be the first paddock of the rotation. However, it now appears that this paddock will not be grazed this year.

The currently funded project continues until 2007. However, there is a commitment within the Pastoral Production Division to continue monitoring the grazing strategies for the foreseeable future (10-15 years) in order to achieve some meaningful results for Central Australia.

Project: Short Duration Grazing Demonstration

Project Officers: P. O'Brien, P. Shotton, S. Reed and DDRF Staff

Location: Systems paddock, Douglas Daly Research Farm

Objective:

To monitor a rotational cattle grazing system under improved pasture to determine the benefits to soil health, plant composition and cattle performance compared with traditional set stocking systems.

Background:

The basic principle behind short duration grazing (SDG) is to divide the grazing pasture into a series of smaller paddocks where the cattle are rotated from paddock to paddock, spending 1-5 days in each. This allows cattle to continuously graze high quality feed, results in even grazing distribution, and allows pasture substantial rest before being grazed again.

It is claimed that through grazing evenly at high stocking rates and promoting even distribution of dung and urine, SDG allows adequate rest, which can bring about dramatic improvements to pasture composition and soil health.

Advocates of SDG (cell grazing) anticipate that an improvement in pasture and paddock condition will promote an ability to increase a property's carrying capacity. As input prices and overheads continue to rise, Douglas Daly producers are keen to find out if SDG can help increase their returns per hectare either by increasing animal weight gain or the property's carrying capacity.

Method:

Eighteen paddocks of 4 or 6 hectares were used to rotationally graze year round while one paddock was used as a control (continuous grazing). In the control grazing paddock heifers were set stocked at the same rate as in the SDG paddocks.

The cattle were Charbray – Brahman yearling heifers, with an average weight of 208 kg. The heifers will remain in the trial until November when they will be replaced with another group of yearling heifers.

In December 2005 all paddocks were assessed for pasture composition and estimated pasture yield.

All paddocks received 50 kg per hectare of Generator® pasture fertiliser in December 2005. The paddocks were also sprayed with herbicides (Amine® 24-D and/or Brush-off®) to control various broad-leaf weeds, particularly Senna (*Senna obtusifolia*), Hyptis (*Hyptis suaveolens*), Sida spp. (*Sida*) and Caltrop (*Tribulus terrestri*).

Each paddock had a different plant composition, pasture yield and size. Therefore carrying capacity for each paddock will differ and hence the time cattle spend in each will vary. Weather conditions will also influence the grazing time and the length of rest periods. In the wet season the pasture resting period was 30 days, allowing five graze periods per paddock. Due to faster pasture growth paddocks 16, 17 and 18 had seven graze periods. In the dry season the rest period was increased to 90 days, allowing only two graze periods before the next expected rain.

The paddocks are stocked at 1.5 head per hectare in the wet season, which was reduced to one head per hectare in the dry season. Supplementary lick blocks were supplied to all cattle (Uramol® ad lib) from 23 June 2006 for the dry season.

Data collection

Pasture yield for each paddock was assessed in December 2005 and again in June 2006 using Botanal®. Changes in desirable and non-desirable plant species were also monitored.

Soil samples were collected in December 2005 to determine soil nutrition and differences between paddocks.

All cattle movements and grazing days are recorded on a grazing chart. Cattle are weighed at the start of the project and then approximately every eight weeks thereafter, to monitor live-weight changes and cattle health.

Results:

At the beginning of the trial SDG heifers averaged 208 kg live-weight. The control heifers averaged 204 kg live-weight.

Weight gains to the end of April were 0.39 kg/head/day for SDG heifers and 0.36 kg/head/day for control heifers. Weight gains for the early dry season (between the May and August) were 0.55 kg/head/day for SDG heifers and 0.47 kg/head/day for control heifers.

All heifers were last weighed on 3 August when SDG heifers averaged 293 kg, with an average weight gain of 90 kg/head over the 225 days (averaging 0.4 kg/head/day). Control heifers averaged 286 kg, gaining 84 kg (0.37 kg/head/day).

The improvement in weight gain during the dry season was probably due to Uramol lick blocks.

Wallabies have influenced grazing pressure in some areas of the trial, particularly in the control paddock and one SDG paddock.

Program: Herd Management

Project: Multibreed Composite Assessment and Brahman Improvement

Project Officers: G. Jayawardhana, DDRF and VRRS Staff

Location: Douglas Daly Research Farm (DDRF) and Victoria River Research Station (VRRS)

Objectives:

To measure the relative growth, reproductive performance and carcass characteristics of the interbred progeny of some tropically adapted multi-breed crossbred bulls mated to Brahman cows, compared with the progeny of Brahman bulls mated to Brahman cows.
To maximise reproductive and growth performance in Brahman cattle while minimising their mature weight.

Background:

Multi-breed composites retain more heterosis (hybrid vigour) in future generations than do the old-style two-breed animals such as Droughtmasters, Brafords and Charbrays. They combine the positive attributes of the more different types of cattle. They are also more suitable for meat quality-based markets than the Brahman and are being explored as a possible alternative to Brahman in case of a downturn in live exports. Most of the large cattle companies such as NAPCO and AACo are shifting to multi-breed composites. This project aims to compare a composite suitable for the Top End with Brahmans that are being improved by selection for growth and reproduction.

Method:

A composite of 56.3% Brahman, 12.5% Africander, 12.5% Tuli, 6.3% Shorthorn, 6.3% Hereford and 6.3% Charolais is being compared with the Brahman. This cross gives a mix that is 81% tropically-adapted and 19% unadapted *Bos taurus* and can be expected to retain about 64% of heterosis from the second generation onwards. It resulted from crossing half Belmont Red, quarter Tuli, and quarter Charbray bulls from Geoff Maynard's Mt Eugene stud in Queensland to Brahman cows. The cows are run at VRRS, while steers and heifers up to three years of age are run at DDRF. The animals are not treated for worms, ticks or flies. Both composite and Brahman bulls are selected on weight, testicle size and percentage normal sperm at yearling, and are used for a maximum of three years. Females are selected on pregnancy and on rearing a calf. Non-pregnant animals are culled except if they yearlings or lactating at two years of age. All are multiple-sire mated. DNA typing is used to identify sires to enable recording in group Breedplan, which is the Australian genetic evaluation system. Breedplan is used to assess genetic progress rather than as a tool for within herd selection. This allows the program to be replicated in more extensive herds.

Results:

The success of the Brahman improvement program is measured by the average days to calving and scrotal circumference – a reproduction trait - estimated breeding values (EBV). DDRF Brahmans are the best of all the herds on the Brahman Group Breedplan. The 400-day weight EBV are slightly lower than the breed average, a consequence of the high level of selection for reproductive traits, while mature cow weight is kept relatively low, as large cows require more feed. The Brahman breed average has significantly improved for weight but mature cow weight has also increased and there has been no improvement in scrotal

circumference and days to calving. This is a worrying trend for the Brahman breed as reproduction has been shown to be economically more important than growth, and large mature cows will not re-breed in harsh environments.

Another indicator is the difference in performance between DDRF Brahmans and industry Brahmans that are mated at DDRF. This year, the pregnancy rate in industry heifers - from a different property to last year - was 34% compared to 67% for DDRF yearling Brahmans, at a similar weight range of 220-300 kg. This clearly shows the benefits of selection for fertility.

The success of this program in a small herd of 250 females over a 12-year period shows that very rapid improvement is possible in the large NT herds if proper breeding methods are followed. Work in Brazil by Eler et al. in 2004 indicates that the heritability of reproduction is much higher than is generally accepted in Australia. There was 69% heritability for yearling pregnancy in Nellore cattle compared to the Australian estimate of between 7 to 15%.

Fertility in composites was better than in the selected Brahmans (see Table 1). In the weight range above, the yearling composite pregnancy was 73%. This is 6% better than DDRF heifers and 39% better than industry heifers.

Table 1. Trait comparisons between Brahmans and composites

	Brahmans (no.)	**Composites (no.)**	**Difference**
Birth weight (kg)	28.4 (259) 26.6 (82)	1st cross 27.9 (233) 2nd cross 27.4 (127)	-0.5 0.8
Weaning weight (kg)	188.1 (316) 174.6 (134)	1st cross 195.8 (329) 2nd cross 179.3 (150)	7.7 4.8
Yearling (400-day) weight (kg)	199.0 (317) 211.1 (153)	1st cross 208.1 (327) 2nd cross 220.4 (109)	9.1 9.3
Yearling (400-day) testicle size (cm)	23.1 (107) 19.7 (28)	1st cross 26.1 (109) 2nd cross 22.6 (15)	3.0 2.9
Normal sperm at yearling (%)	7.7 (107) 5.0 (46)	1st cross 25.2 (109) 2nd cross 22.6 (35)	17.5 (3 x Brahmans) 17.6 (4 x Brahmans)
Yearling pregnancy (%)	29.9 (40/134) 42.7 (38/89)	1st cross 57.0 (86/151) 2nd cross 65.2 (60/92)	27.1(almost 2 x Brahmans) 22.5 (1.5 x Brahmans)
Average joining weight (kg)	223.6 (134) 224.4 (89)	1st cross 231.5 (151) 2nd cross 222.2 (92)	7.9 -2.4
Average joining weight (kg) Average pregnant weight (kg)	240 (163 to 293) 249.1 (191 to 297)	1st cross 240.5 (186-306) 2nd cross 237 (166-285)	0.5 - 12.1
Average joining(empty) weight (kg)	216.7 (153 to 279) 206.1 (151 to 288)	1st cross 219.7 (144-281) 2nd cross 210.6 (164-254)	3.0 4.5
Pregnancy rate in lactating two year-old animals (%)	30.6 (11/36) 70.6 (12/17)	1st cross 61.5 (48/78) 2nd cross 65.7 (23/35)	31.7 (2 x Brahmans) -4.9
Pregnancy rate in lactating three year-old animals (%)	74.5 (76/102) 100 (1/1)	1st cross 77.7 (80/103) 2nd cross 76.9 (10/13)	3.2 Brahman on first calf
Pregnancy rate in lactating adults (%)	70.2 (59/84)	1st cross 88.2 (82/93)	18.0
Two year-old steer weight (kg)	390.0 (54)	415.9 (51)	25.9
Carcase weight (kg)	227.8 (27)	237.2 (25)	9.4
Eye muscle area (cm^2)	73.3 (27)	78.4 (25)	5.1

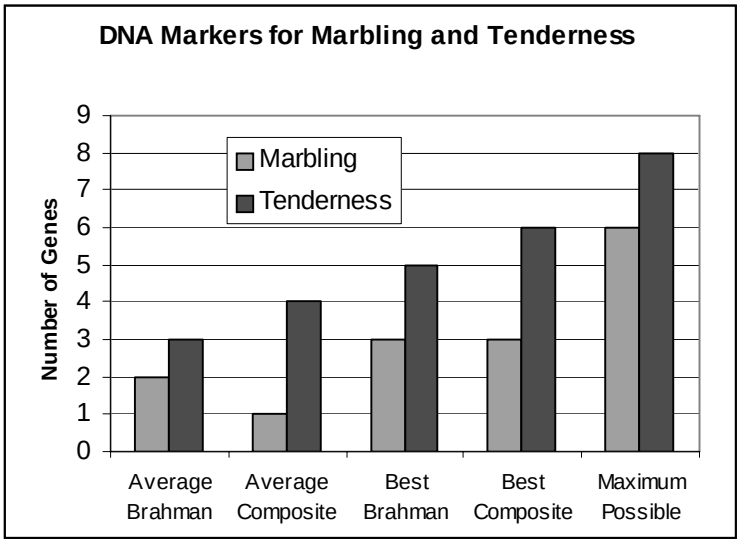

Figure 1. DNA markers for marbling tenderness

The first cross composites were lighter at birth than the Brahmans but gained weight faster. Their weight and reproduction figures have been consistently superior to those of the Brahmans. Initial carcass figures indicate that eye muscle area per kilogram of carcase weight is superior in the composites. The composites also have good resistance to ticks and flies.

The first of the second-generation data is presented here with second cross composites consistently heavier too. They mostly showed superior reproduction, particularly an ability to get in calf at lighter weights. This could be due to gene segregation bringing out some of the characteristics of the light African breeds. Some of the heavier non-pregnant animals probably displayed later maturing European traits. This second-generation performance is more important than that of the first cross as the loss in heterosis in a composite occurs between first and second generations. The higher pregnancy rate in the lactating two-year Brahmans was from one year's data compared to two years' data in the composites. There were some amazing individual animals within this group such as a yearling composite which was mated when it was 188 kg and it weaned a 189 kg calf and became pregnant the following year.

This year, 17 Brahman and 19 composite herd bulls were Genestar® tested for tenderness and marbling.

There are now four pairs of tenderness genes and three pairs of marbling genes available. They account for about 30% of the variation in these traits. In northern supermarkets, tenderness is more important than marbling, though neither is currently important for live export. Selected herd bulls were sampled at yearling and the results were used in the selection at two and three years of age. The average frequency of tenderness genes is higher in the composites but, surprisingly, more marbling genes are in Brahmans.

Composite and Brahman steers was sent to the Austasia feedlot in Lampung, Indonesia. Details of weight gain and feed conversion are shown in Table 2.

Table 2. Data from animals exported to Indonesia

Breed (no.)	Induction weight	Feedlot gain	Average daily gain	Feed conversion	Slaughter weight	Dressing percentage	Carcase weight
Brahman (23)	291 kg	155.6 kg	1.6 kg	6.1 kg DM/kg	446.6 kg	50.4%	225 kg
Composite (27)	316 kg	155. 3kg	1.6 kg	6.5 kg DM/kg	471.3 kg	50.1%	237 kg
Difference	25 kg	-0.3 kg	-	0.4 kg DM/kg	24.7 kg	-0.3%	12 kg

Feedlot performance was relatively similar. The striking difference was that the composites had a poorer feed conversion than the Brahmans. Some of this could be due to the heavier weight. Hence there was a greater demand for maintenance in the composites.

Calf losses from 1987-88 to the present averaged 6.2%, 142 calves from 2382 pregnancies. This is lower than the accepted industry average of 10% from pregnancy testing to weaning in adult cattle

Reference:

Eler, J. P., Silva, J. A., Evans, J. L., Ferraz, J. B. S., Dias, F. and Golden, B. L. (2004). Additive genetic relationships between heifer pregnancy and scrotal circumference in Nellore cattle. *Journal of Animal Science* 82: 2519-2527.

Project: The Relative Breeding Herd Efficiency of Adult Charolais x Brahman and Brahman Cows Grazing Native Pasture in the Victoria River District

Project Officer: **K. McCosker**

Location: Victoria River Research Station (VRRS)

Objectives:

To measure and report on the relative breeding herd efficiency (kg calf weaned per 100 kg of cow mated) of adult cows containing 25% later maturing genes in a two-way criss-cross crossbreeding program compared with purebred Brahman, by 2007.
To practically demonstrate a two-way criss-cross crossbreeding system.

Background:

Reports from SE Asian feedlotters in the early 1990s indicated an increasing problem with over-fattening at the completion of the feeding phase in young Brahman cattle sourced from northern Australia. SE Asian feedlot beef is usually supplied to the local wet market, which has a low value for fat and considers it a less-desirable component of the carcass.

A method to overcome the problem of over-fattening is to introduce later maturing genes in tropical beef cattle. However, it has been historically established that animals with a high proportion of later maturing genes are not productive in northern Australia. This project is investigating the productivity of breeders containing later maturing genes and introducing later maturing genes into a high grade Brahman herd, in a two-way criss-cross crossbreeding system using Charbray and Brahman at VRRS (Figure 1).

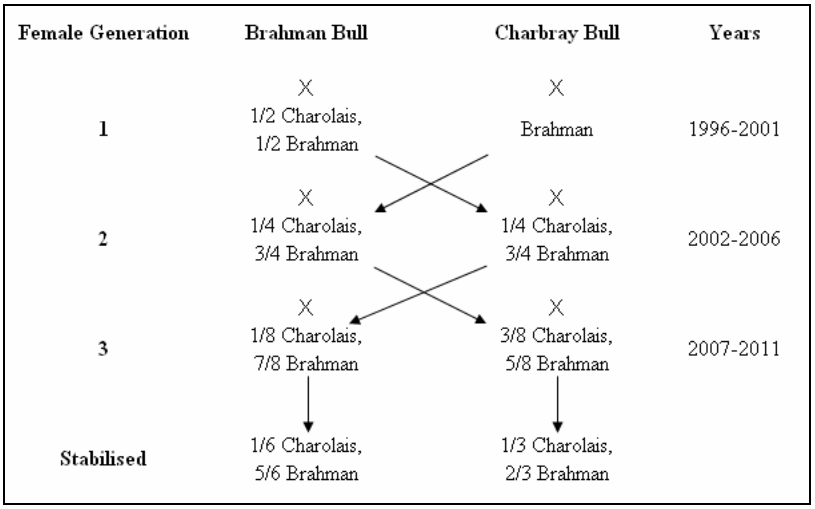

Figure 1. The two-way criss-cross crossbreeding system at VRRS
Note: Arrows indicate female progeny of each generation used as replacements in the other herd.

The first generation of this two-way criss-cross crossbreeding system was previously investigated and the results were reported in *Productivity consequences of incorporating late maturing genes into a tropically adapted breeding herd in the Victoria River District, NT*. In the current project, the productivity of the second generation females (¼ Charolais, ¾ Brahman) will be investigated.

Method:

Location

The breeder herds are in 'Boab', 'Coolibah', 'Nutwood' and 'Supplejack' paddocks at VRRS.

Breeding herd

The breeding herds are managed under a modified Best Bet Management System using a stocking rate calculated from the long-term median pasture growth and estimated safe utilisation rates.

The breeding herds are processed twice a year, usually in May and October. Data is recorded on pregnancy and lactation status and empty live-weight. The condition of the animal is visually assessed at processing and assigned a score against a nine point system. Breeders are culled if they are barren (empty and non-lactating), temperament, injury and age (10 years). The breeders are continuously mated at 4% to annually fertility-tested bulls. All stock was vaccinated against C & D botulism strains during May and a booster vibriosis vaccination is given to bulls in October.

At processing, the progeny are tagged, accorded to genotype and weighed. A weaning weight of 100 kg is used for both weaning rounds across all years.

Supplementation

Animals receive supplements all year round. During the dry season, a loose supplement is provided consisting of 20% urea, 20% Kynophos, 10% sulphate of ammonia and 50% salt. During the wet season, a loose mix is provided consisting of 35% Kynophos, 15% sulphate of ammonia and 50% salt. The supplement mixes are distributed weekly at the rate of about 110 g per head per day.

Paddock differences

In order to highlight any differences between paddocks, 10 indicator steers are included with each breeder herd. Monthly faecal samples are collected from each paddock.

Indicator steers

Ten steers of similar genotype, age and weight are introduced into each paddock in May and are replaced in May the following year. The inter-paddock difference in average live-weight gain is used as an indicator of paddock quality.

Faecal samples

Faecal samples are collected monthly from various locations within each paddock. A bulked sample representing each paddock is then analysed for faecal nitrogen, dietary crude protein and dry matter digestibility using NIRS technology.

Results:

Table 1. Mean breeder live-weights at mustering

Genotype: Brahman				**Genotype:** 1/4 Charolais			
Boab Paddock		**Nutwood Paddock**		**Coolibah Paddock**		**Supplejack Paddock**	
Muster date	**Mean breeder live-weight (kg)**	**Muster date**	**Mean breeder live-weight (kg)**	**Muster date**	**Mean breeder live-weight (kg)**	**Muster date**	**Mean breeder live weight (kg)**
06 May 04	425.6	11 May 04	437.2	11 May 04	476.8	06 May 04	456.4
12 Oct 04	409.5	19 Oct 04	417.1	19 Oct 04	424.7	12 Oct 04	456.0
10 May 05	465.5	17 May 05	470.9	17 May 05	505.9	09 May 05	511.4
27 Sep 05	420.0	05 Oct 05	428.4	05 Oct 05	443.6	27 Sep 05	460.8
23 May 06	467.8	27 May 06	495.0	27 May 06	518.2	23 May 06	549.8
Weaning round 1 mean	453.0		467.7		500.3		505.9
Weaning round 2 mean	414.7		422.8		434.1		458.4

Breeder productivity

Table 2. Pregnancy and lactation status of breeder herds at mustering

	Muster date	Breeders pregnant (%)	Breeders lactating (%)	Breeders pregnant and lactating (%)
Genotype: Bra x Bra (low)	21 May 03	66	57	30
Boab Paddock	30 Sep 03	95	5	2%
	06 May 04	35	83	20
	12 Oct 04	66	36	10
	10 May 05	41	67	16
	27 Sep 05	64	35	2%
	23 May 06	56	67	31
Weaning round 1 mean		50	69	24
Weaning round 2 mean		75	25	5
Genotype: Bra x Bra (high)	30 May 03	64	55	20
Nutwood Paddock	22 Sep 03	75	8%	2
	11 May 04	42	87	24
	19 Oct 04	57	46	11
	17 May 05	53	58	19
	05 Oct 05	56	29	2
	27 May 06	65	60	23
Weaning round 1 mean		56	65	21
Weaning round 2 mean		63	28	5
Genotype: F1 x 1-4Char	27 May 03	38	79	20
Coolibah Paddock	22 Sep 03	64	21	2
	11 May 04	35	87	20
	19 Oct 04	51	55	9
	17 May 05	54	51	16
	05 Oct 05	63	30	1
	27 May 06	56	67	30
Weaning round 1 mean		46	71	21
Weaning round 2 mean		59	35	4
Genotype: Bra x 1-4Char	21 May 03	58	90	48
Supplejack Paddock	30 Sep 03	78	11	5
	06 May 04	36	82	21
	12 Oct 04	73	35	10
	09 May 05	48	71	28
	27 Sep 05	82	22	8
	23 May 06	34	81	21
Weaning round 1 mean		44	81	29
Weaning round 2 mean		77	23	7

Table 3. Weaning rate of breeder herds

Breeding herd	Paddock	Breeders mated		Weaners weaned		Weaning rate (%)
Bra x Bra (Low)	Boab	2003	44	2004	42	95
		2004	59	2005	45	76
					Mean	84
F1 x 1-4Cha	Coolibah	2003	105	2004	87	83
		2004	112	2005	73	65
					Mean	74
Bra x Bra (Hi)	Nutwood	2003	44	2004	42	95
		2004	59	2005	45	76
					Mean	84
Bra x 1-4Char	Supplejack	2003	118	2004	103	87
		2004	113	2005	81	72
					Mean	80

Weaning weight

Table 4. Mean weaner live weights at mustering (a 100 kg weaning weight was used)

Genotype: Brahman				**Genotype:** 3/8 Charolais		**Genotype:** 1/8 Charolais	
Boab Paddock		**Nutwood Paddock**		**Coolibah Paddock**		**Supplejack Paddock**	
Muster date	**Mean weaner weight (kg)**	**Muster date**	**Mean weaner weight (kg)**	**Muster date**	**Mean weaner weight (kg)**	**Muster date**	**Mean weaner weight (kg)**
06 May 04	172.6	11 May 04	168.3	11 May 04	205.1	06 May 04	173.8
12 Oct 04	161.7	19 Oct 04	171.7	19 Oct 04	158.4	12 Oct 04	144.9
10 May 05	155.6	17 May 05	176.4	17 May 05	185.1	09 May 05	175.0
27 Sep 05	148.5	05 Oct 05	155.6	05 Oct 05	125.5	27 Sep 05	151.6
23 May 06	204.0	27 May 06	221.9	27 May 06	220.5	23 May 06	238.0
Weaning round 1 mean	177.4		188.9		203.6		195.6
Weaning round 2 mean	155.1		163.6		142.0		148.2

Paddock differences

Faecal NIRS analysis

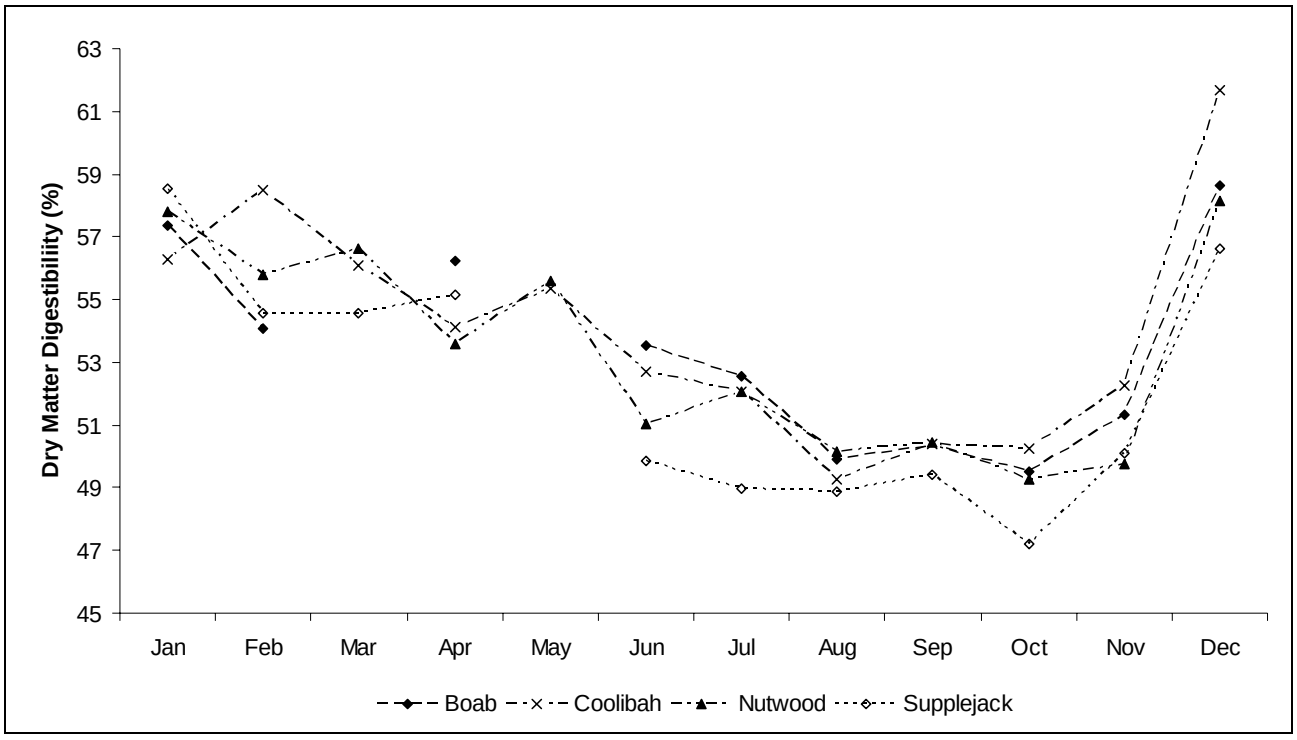

Figure 2. Mean predicted dry matter digestibility (%), using faecal NIRS analysis, of pasture consumed by breeder herds grazing Boab, Coolibah, Nutwood and Supplejack paddocks at VRRS during 2003-06

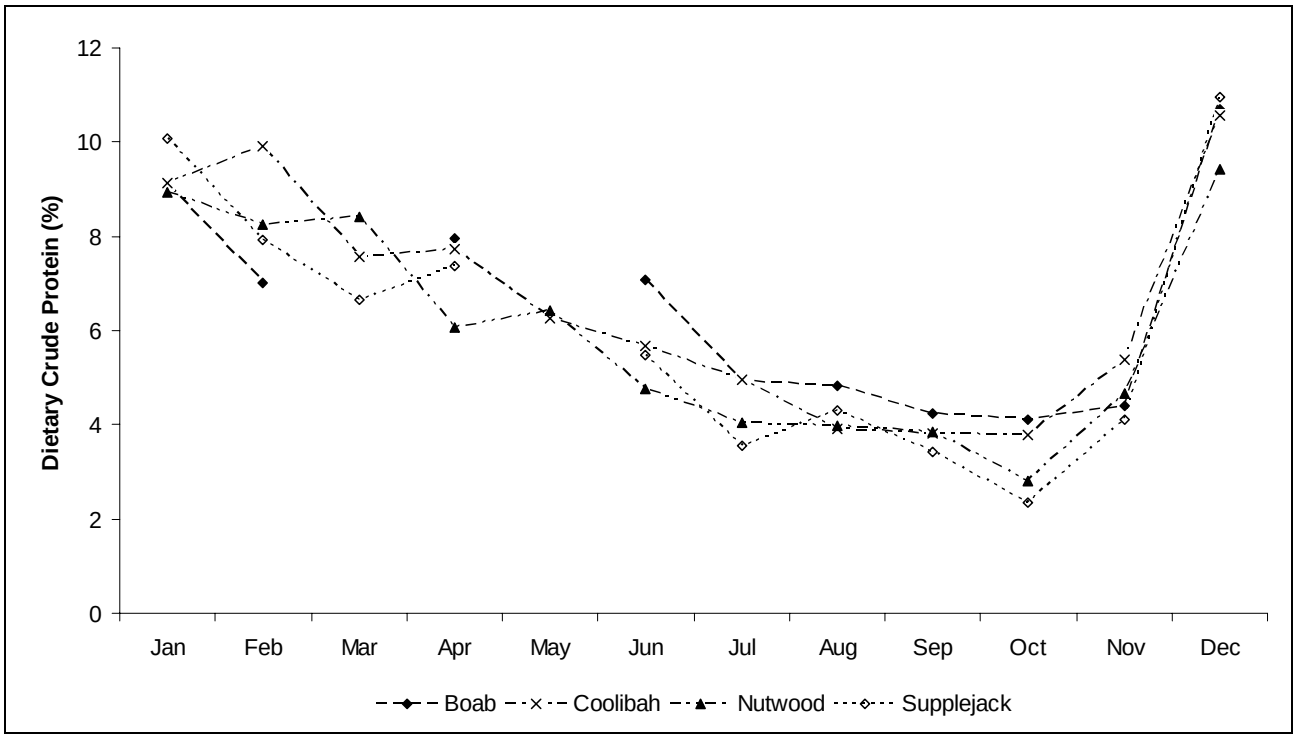

Figure 3. Mean predicted dietary crude protein content (%), using faecal NIRS analysis of pasture consumed by breeder herds grazing Boab, Coolibah, Nutwood and Supplejack paddocks at VRRS during 2003-06

Key points

- ¼ Char breeders consistently achieved higher live-weights than Brahman breeders.
- ¼ Char breeders achieved similar production figures as Brahman breeders.
- Weaning weights of Brahman, 1/8 Char and 3/8 Char weaners were similar.
- NIRS results indicated that feed quality in all paddocks was similar.

Project: Improving Herd Profitability

Project Officer: T. Oxley

Location: Victoria River Downs (VRD) Victoria River Research Station (VRRS)

Objectives:

To measure and report on the costs and returns of each management package in terms of gross margin per animal equivalent (AE) after interest.
To measure the production differences between each management package in terms of kilograms of calf weaned per 100 kg of cow mated.
To measure the differences in labour requirements between management packages in full time equivalents.
To achieve the stated objectives by December 2008.

Background:

The Best Bet Management package was formulated for VRRS in 1990 and has been described in previous Technical Annual Reports.

Subsequently, the performance of the herd at VRRS greatly improved and mortality rates declined from 12% to less than 2%. Weaning rates increased from 50% to over 80%. With the ever-increasing cost/price squeeze, pastoralists are looking for ways to improve or maintain performance with reduced input costs.

Method:

The following paddocks are used:

- Two paddocks at VRRS, one with high nutrition and one with low nutrition, based on the Improved Profit package.
- Two control paddocks at VRRS, one with high nutrition and one with low nutrition, based on the Best Bet package.
- Commercial paddock Riffs Yard on VRD based on the Improved Profit package.

The project commenced in May 2003 and is scheduled for completion by October 2008.

Results:

Table 1. Breeding herd efficiency data for Riffs Yard paddock herd 2003-04 and comparable data from fully supplemented breeders on VRRS

	Breeders		Weaners		Weaning rate	Breeding herd efficiency
	n	mean wt (kg)	n	mean wt (kg)	(%)	(kg weaner/100 kg cow)
Riffs						
2003	506	346	368	158	73%	33.2
2004	505	395	344	166	68%	28.6
VRRS						
2003	100	406	74	169	74%	30.8
2004	119	401	99	167	83%	34.6

Table 1 shows that the performance of the Riffs paddock herd compares favourably with herds under full supplementation at VRRS for the two years of data available. However, results from Riffs paddock are marginally lower in all the key measures of herd productivity.

The largest discrepancy is in weaning rate, with fully supplemented herds producing 6-8% more weaners per year thus far. Weaner production varies from year to year as environmental and management conditions influence conception rates and patterns. Data collected in future years will show whether the Riffs herd is able to match the productivity of VRRS herds run under the Best Bet system.

Project: Understanding and Improving Heifer Fertility in the NT

Project Officer: T. Schatz

Location: Victoria River Research Station (VRRS) Douglas Daly Research Farm (DDRF)

Objectives:

To establish the relationship between body weight (and/or condition) and re-mating conception rates for first calf Brahman heifers in northern Australia.
To produce a simple chart showing the conception rates that would be expected from mating first calf heifers at different weights.

Background:

The low re-mating rates in lactating first calf heifers has long been recognised as the biggest area of inefficiency in northern Australian breeding herds. This project aims to address that by establishing the relationship between body weight (and/or condition) and re-mating conception rates for first calf heifers in northern Australia. From the results it will be possible to produce a simple chart showing the conception rates that would be expected from first calf heifers at different weights which would allow producers to determine the most cost-effective way to manage replacement breeders.

The project will attempt to establish the relationship between joining weight and fertility in heifers first joined as yearlings at DDRF and as two year-old animals at VRRS. The project will take five years to generate

sufficient data to meet its objectives. The project started two years ago and only preliminary data is available at this stage.

Method:

About 100 high grade Brahman first round weaner heifers were used per year at each location. At VRRS, the weaners were selected from the breeding herd, weighed and kept on native pasture with access to mineral supplements to grow away from bulls until their first joining as two years of age. They were vaccinated for vibriosis and leptospirosis. For the DDRF part of the project, weaner heifers were purchased from a commercial property. Only heavy weaners (>200 kg) were selected to ensure they reached sufficient joining weights by late December in the same year that they were weaned. The heifers also received two vaccinations of 7 in 1 and Vibrovax prior to joining. They had access to Uramol blocks during the dry season and Phosrite blocks during the wet season.

Bulls were introduced to the heifers around mid-December and separated on 31 March. An ultrasound machine was used to scan the ovaries at the end of mating to detect non-pregnant heifers that were cycling. This involves scanning the heifers twice, 10 days apart, to look for the presence of a corpus luteum on the ovaries.

Following their maiden joining at both locations, heifers which conceived were allocated to one of two treatment groups:

- High nutrition group (HN) designed to achieve live weight gains of about 50 kg over the dry season prior to parturition, using live export pellets at VRRS or crop stubble and grain at DDRF.
- Control group under normal extensive grazing management. This was designed to produce heifers with a range of weights/body conditions at their second joining. The data from this joining (over several years) will allow the generation of a model that predicts the pregnancy rates likely from mating lactating first calf heifers at a range of pre-calving weights, P8 fat depths and condition scores. From the model, a simple chart can be produced showing the conception rates that would be expected from mating first calf heifers at different weights. Data collected throughout the project will also enable the production of similar charts for maiden heifers.

This work involves three year-groups of heifers, namely number 4, 5 and 6. This will enable three replicate data sets to be produced over the duration of the project.

In addition to the above groups, second round weaner heifers from the previous year at VRRS transported to DDRF were also studied as this class of animals has been identified as a problem group to manage in the Victoria River Downs (VRD) district.

Results and Discussion:

Two-year-old joining at VRRS

Number 4 heifers lost a small amount of weight in the dry season after weaning and then grew well so that the average joining weight in late October 2005 was 280 kg. Bulls were introduced to the heifers in late December 2005. The high average joining weight and the good wet season that followed resulted in 90% pregnancy at the first round muster in June 2006 (see Figure 1).

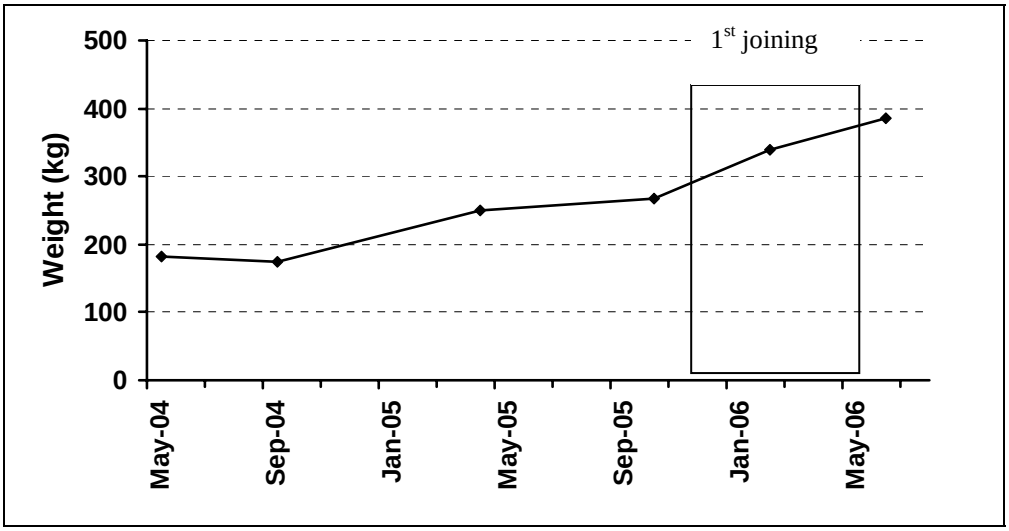

Figure 1. Average growth of number 4 heifers since weaning

The range of weight gain in different heifers was large, averaging 71 kg and 135 kg per year for number 4 in year 1 and 2, respectively, and 88 kg for number 5 in year 1. Number 5 heifers gained more weight than number 4 heifers in the year after weaning due to the exceptional 2005-06 wet season and because their end of year weights were recorded a month and a half later due to the late rain from cyclone Monica.

Figure 2 shows the effect of joining weight on the fertility of number 4 maiden heifers. The fertility of heifers with lighter joining weights was higher than that recorded from performance records on commercial properties so far. Possible explanations for this are:

- An exceptional start to the wet season resulting in high weight gain early in the mating period (January).
- All heifers had been vaccinated with 7-in-1 (lepto) and Vibrovax (vibrio).
- Smaller numbers and a large paddock (100 head in 5.7 km^2) compared with commercial properties

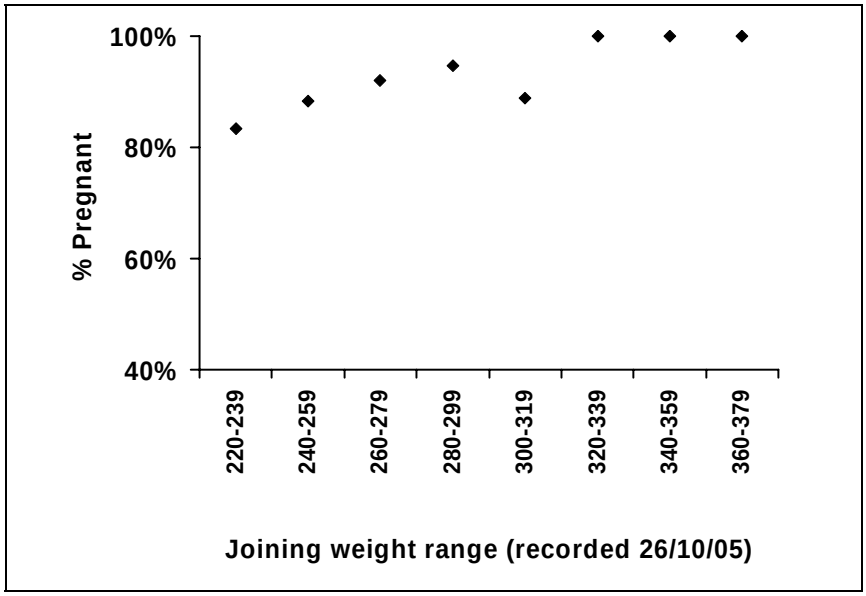

Figure 2. Effect of joining weight on fertility - maiden joining of number 4 heifers

Yearling joining at DDRF

The heifers joined as yearlings had not been able to achieve the target joining weight of 275 kg which resulted in lower fertility. The target weight was not achieved because of a late start to the 2004-05 wet season and the scarcity of heifers to purchase in the following year for transferring to improved pasture until the end of October. Consequently, the 70 kg normally expected growth between weaning and the start of joining did not occur.

Even subsets of heifers that were heavier than 280 kg at the start of joining had lower fertility than other studies have found in Brahman cross heifers, such as 80% at 275 kg. At this stage it appears that commercial high grade Brahman heifers in the NT are later-maturing and hence have lower fertility than crossbred heifers and heifers from some highly selected Brahman herds. The ultrasound scanning of ovaries at the end of joining seemed to confirm this hypothesis as most non-pregnant heifers had small ovaries and had not started cycling as the corpus luteum could not be detected. The preliminary data indicates that transporting such type of heifers to the Douglas Daly region for the purposes of yearling mating is unlikely to be profitable.

However, the heifers that had been weaned at the second round in October in the VRD and then transferred to DDRF and joined at 18 months of age showed very good fertility (see Table 1).

Table 1. Details of heifers joined at DDRF

	Joined 20/12/2004 - 31/3/2005			Joined 20/12/05 – 31/3/06		
Joining age	**n**	**Average weight (kg)**	**Pregnant (%)**	**n**	**Average weight (kg)**	**Pregnant (%)**
Yearling	110	259	27	92	252	36
18 months	15	321	93	51	297	76

The extra six months of age in second round weaners seems to have increased fertility considerably (see Figure 3). It was found that the fertility of the second year group of yearling mated heifers (number 5) was 9% higher than the first year group (number 4) despite their lower average joining weight by 7 kg. This was likely due to the fact that the second year group of heifers were slightly older than the first group. The second year group of heifers were from a continuously mated herd and some had been branded as small calves at the end of 2004 and then weaned in 2005. However, the number 4 heifers were from a control mated herd and none were born before October. Therefore, as a group they were younger at their first joining.

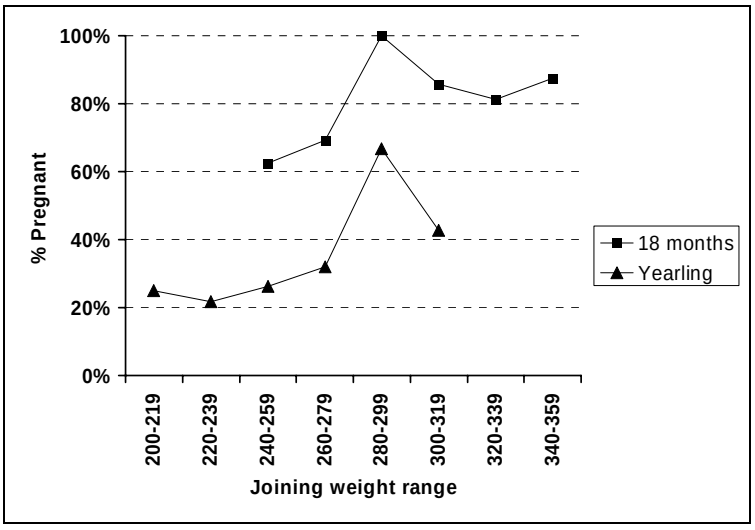

Figure 3. The effect of joining weight on the fertility of heifers joined as yearlings or at 18 months of age (the two-year data was combined)

Second round weaner heifers were used to investigate claims by many managers in the VRD district that heifer calves that are weaned at the second round (WR2) are difficult to manage because few of them reach joining weight that is sufficient for good fertility by the end of the following year.

In a review of data collected at Kidman Springs, VRRS, between 1985 and 1991, Sullivan et al. (1997) reported that only 28% of WR2 heifers were selected to become replacement breeders and of these only 31% conceived at their first joining. In comparison, 74% of heifers weaned at the first round (WR1) became replacement breeders and subsequently 77% of them conceived at their first joining. These figures show that the second round weaner heifer is not a very desirable animal in these areas and is therefore either culled or kept for another year until it reaches puberty weight when it is more likely to become pregnant. This markedly reduces the efficiency of the production system.

In the current project, WR2 heifers that were weaned at VRRS in October were transported to DDRF shortly after weaning where they grazed improved pastures and had access to lick blocks year round. As Table 2 shows, by December in the following year they had reached high joining weights and achieved good fertility during a three-month joining period.

Table 2. Growth and fertility of second round weaner heifers

Weaned	Average weaning weight (kg)	Number	Date joined	Average joining weight (kg)	Joining weight range (kg)	Pregnant (%)
R2 2003	110	15	Dec-04	325	256-360	93
R2 2004	152	53	Dec-05	311	263-360	76

The high fertility reported here is to be expected from heifers with such high average joining weights and shows that transporting WR2 heifers to areas such as the Douglas Daly may be a viable option, especially for companies with properties in different regions.

Re-conception rates of first calf heifers at DDRF

Data is available only from one year-group of first calf heifers at this stage which makes the sample size of 50, small. Therefore the results need to be treated with caution.

The re-conception rate was 70% in heifers that were either joined first as yearlings or at 18 months of age (second round weaners). Their average weight in late September 2005 prior to calving was 403 kg and their average P8 fat depth was 7.7 mm. This was an excellent re-conception rate for lactating first calf heifers and was due to the high average pre-calving weight and fatness. This happened largely due to late rain which resulted in good pasture well into the dry season. In fact, the control group which continued to graze buffel grass throughout the year gained on average 51 kg, which was almost as much as the HN group which grazed sorghum stubble and gained on average 66 kg.

Pre-calving fatness, appropriate weight and date of calving generally result in heifers which are heavier, are in better condition, calve earlier and have higher chances of re-conceiving. All the three parameters had a significant effect on re-conception rates in this trial. However, due to the small sample size, the relationships need to be treated with caution (see Figures 4, 5 and 6). The small sample size probably also explains why the effect of joining weight (corrected for stage of pregnancy) does not seem to have a very consistent effect on re-conception rates.

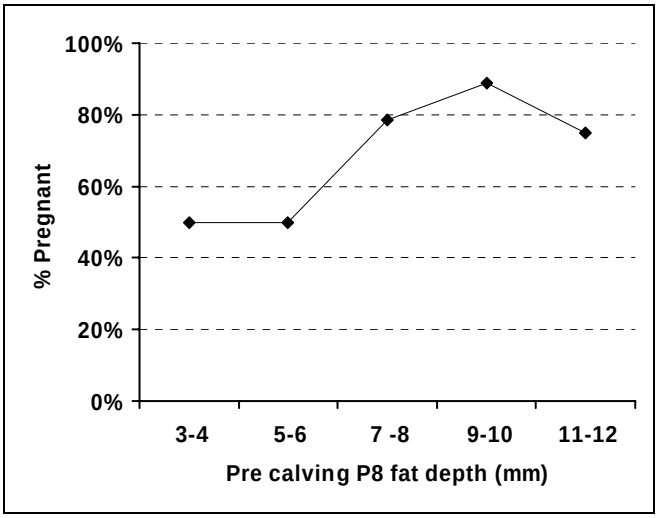

Figure 4. Effect of pre-calving fatness on re-conception rates of first calf heifers

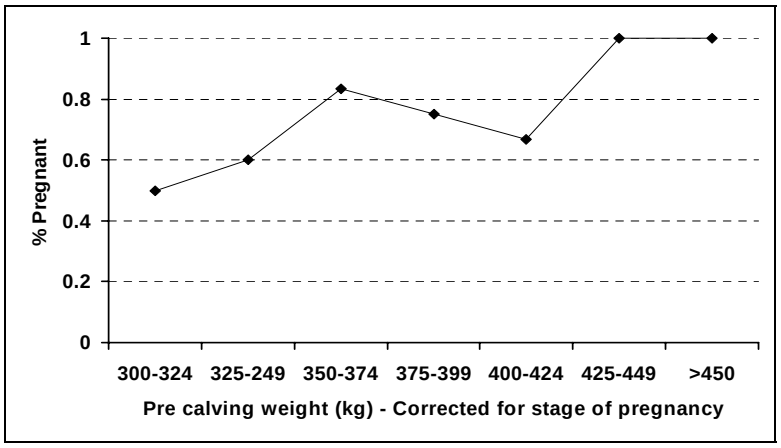

Figure 5. Effect of pre-calving weight on re-conception rates of first calf heifers

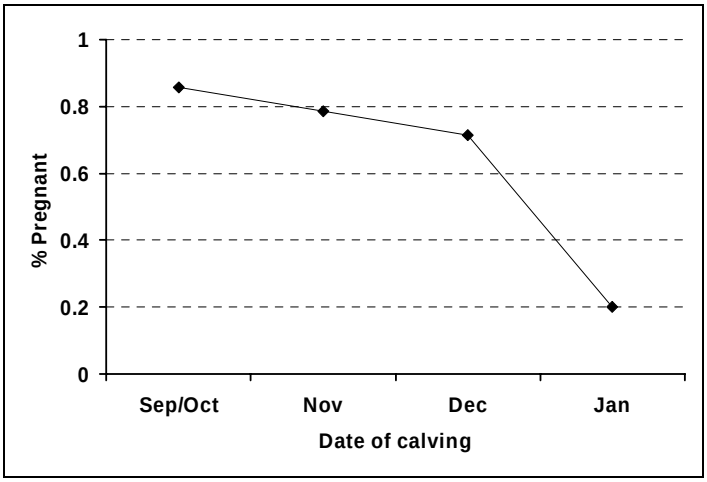

Figure 6. Effect of calving date on re-conception rates of first calf heifers

Reference:

Sullivan, R. M., O'Rourke, P. K. and Neale, J. A. (1997). A comparison of once- and twice-yearly weaning of an extensive herd in northern Australia. *Australian Journal of Experimental Agriculture* 37(3) 287 – 293.

Project: Industry Initiatives to Improve Heifer Performance in the NT

Project Officers: T. Schatz, A. Bubb and S. Leigo

Location: Commercial stations in the Katherine, Barkly and Alice Springs regions

Objectives:

To establish current levels of fertility in heifers in each region.
To investigate current heifer management practices and why some management strategies are not widely adopted.
To demonstrate best practice heifer management in each region and record the production that can be achieved under such systems.
To prepare a best practice heifer management manual.

Background:

The research work in this project is conducted entirely on commercial properties. Decisions about what to investigate are made by producers, through producer groups such as KPIAC, BRAC and ASPIAC, and by the managers of the properties where the research work is conducted.

Part of the project is to establish current levels of fertility in each region and how heifers are commonly managed. This will be done through a confidential survey (face to face) of managers as well as by performance recording on commercial properties. The performance of heifers will be documented for two years on three properties in each of the three regions.

The main research in each region will be conducted at a demonstration site on a commercial property that is selected by the pastoralist management group (PMG). Management practices selected by PMG will be trialled at these sites. This will provide an opportunity for the evaluation of management practices that producers would like tested but do not have the time, resources or research skills to conduct them. The demonstration trials will run for five years.

Progress

Survey

The results of the survey are presented in the *Pastoral Industry Survey 2004* which is available from the Publications Section of DPIFM.

Performance recording

Commercial performance recording is being carried out on properties in the Katherine/VRD, Barkly and Alice Springs regions. Results to date confirm the effect of joining weight on fertility and indicate the extent of the problem of low fertility in lactating first calf heifers.

Demonstration sites

Katherine region – Newry Station

The commercial demonstration site at Newry is going well. A successful field day was held on 5 July 2006 to share the findings to date with producers in the area. While it is still early, the main findings from the research at Newry so far indicate:

- A strong relationship between joining weight and fertility in maiden heifers.
- Re-conception rates in lactating first calf heifers are low but improved by supplementation.
- Wet heifers that re-conceived were on average 40 kg heavier than those that did not.
- Controlled mating is very difficult to implement on most northern properties.
- One injection of Vibrovax prior to joining increased conception rates by 11% at the first round. By the second round (September) the benefit of vibrio vaccination had been reduced to 6% (Table 3) as more heifers conceived later in the control group. However, the higher proportion of late conceptions in the control group is not desirable as such heifers will calve and lactate in the dry season. This will increase the likelihood that they and/or their calves will die before the calves are weaned and reduce the chances for heifers to re-conceive, which will increase inter-calving intervals. Their progeny are also likely to take an extra year to reach turn-off weight.
- Growth can be extremely variable. There was a 140 kg difference in growth between the highest and lowest gaining heifers over the past wet season. When blood samples were taken from some low weight-gaining heifers, it was found that they had elevated liver enzyme activity indicating that they may have consumed some toxic plants. All other results of their blood tests were normal and showed that all three animals had had pesti-virus at some stage but were not currently infected.

The trial has not been going long enough to report on the time taken to re-conceive, or the effect of weaning. This information will be presented in future reports.

Alice Springs region – Tieyon Station

Despite the drought for the last two years, work at Tieyon has been progressing well. A field day was conducted on 22 August 2006 to convey to local producers the results so far to. The research is still at an early stage but the main findings so far indicate that:

- Most heifers calve for the first time at between 2.5 and 3.5 years of age.
- The average weight at first conception was 274 kg (green tags) to 269 kg (yellow tags).
- The range of estimated weights at first conception was large – 165 to 392 kg.
- Not enough information is yet available to calculate average time taken to re-conceive but most heifers are taking more than six months.
- Weaning increased first calf re-conception rates by 25% in orange tagged animals to 28% in green tagged animals.
- The mortality rate is somewhere between 3-12%; but more time is required to see if missing heifers turn up or are actually dead.
- A single vaccination against vibriosis resulted in 19% higher conception rates in young purple tagged heifers but did not improve conception rates in slightly older green tagged heifers, although the number of animals in this study was small.
- Average annual growth of dry (non lactating heifers) was surprisingly high for such a low rainfall area, 0.418 kg/day for purple tagged animals and 0.392 kg/day for green tagged animals.

Barkly region – Helen Springs

Due to exceptional drought conditions, the demonstration site work at Helen Springs has not commenced yet.

Program: Extension and Training

Project: Pasture Development Extension

Project Officer: A. Cameron

Location: Berrimah Farm

Objectives:

To maintain extension services to industry.
To assist industry to increase and manage areas of improved pastures.
To continue producing high quality seed.

During the year there were 336 individual requests for advice from a range of customers, including primary producers, departmental staff and staff from other departments, agribusiness, students, interstate and overseas clients. The largest number of requests was from primary producers (130) and departmental staff (96). The highest numbers of requests were about pasture species (92), identifications (77) and weeds and herbicides (69). Requests were received by telephone (141), face-to-face (132) and email (55).

Specific extension activities included:

- Fifty visits to Top End and Katherine properties.
- Provision of pastures, hay and seed extension services to the Katherine region, following the resignation of the Katherine Agricultural Extension Officer.
- Continued assistance to the Pasture Development Section to control gamba grass on major roads in the Top End. There was limited activity in this demonstration program this year.
- Represented the department on the weed risk assessment (WRA) technical committee which is developing a model to assess the potential for plants grown currently in the NT and those which may be introduced in the future to become weeds. Following consultation with a broad range of interested stakeholders, the questions from the first part of the South Australian WRA model on invasiveness of plants were modified to suit the NT. It was planned to run a number of species through the assessment to test and validate the model.
- Presentation of a seed sampling course in Katherine with Albert Simonato.
- Show judging on properties for the Royal Darwin Show Farm and Pastoral Competition.
- Participation in six interviews conducted by reporters from the ABC Radio *Country Hour* and the *Katherine Times*.
- Compilation of the NT fodder and seed production statistics for 2005 (see below).

NT fodder and seed production

The Primary Industry Group of DPIFM conducted a survey to estimate the production of fodder (hay and silage) and seed the NT in 2005. This includes the significant amount of mulching hay that is produced in the Darwin rural area. The results are presented in Table 1.

Table 1. Hay, silage and seed production in the NT (tonnes)

District	Feed hay	Silage	Mulch hay	Seed
Adelaide River	810			
Alice and Barkly	5200			
Batchelor	160			
Darwin	3770		550	
Darwin River	500		2040	
Douglas Daly	14 800	27 300	200	7
DPIFM	680			9
Katherine and VRD	23 410	7700		62.5
Mary River	350			
Other				1.1
Total	49 680	35 000	2790	79.6

Both hay and silage production increased this year, but seed production declined. The value of the produced hay and silage is estimated to be $13.76m. The value of the produced seed is estimated to be $0.536m.

These figures were compiled with the assistance of departmental staff: Ruth Allan (Tennant Creek), Ben Beumer (Darwin), Chris Materne (Alice Springs) and Phil Hausler (Darwin).

Project: Pastoral Production Extension – Top End

Project Officers: **P. Hausler – Daly**
B. Beumer – Marrakai

Location: Daly/Marrakai

Objectives:

To support an increasing sustainable and profitable production capacity of the pastoral industry in the Top End of the Northern Territory.
To maintain close links with all stakeholders, especially industry, and to extend research and development information.

Daly region

- Results from the 2004-05 survey were published in May 2006 and appear elsewhere in this Technical Annual Report.
- A large scale demonstration was initiated in 2006 to investigate ways to control native regrowth on previously cleared land. Eleven different herbicide treatments were applied to 25 hectare plots on a commercial cattle station. Data is being collected.
- One property produced 56 000 tonnes of sweet sorghum silage in 2006 for the live cattle export trade.
- As part of the National Landcare Program's adaptive management of ecologically sustainable development project, the effects of land development on the natural environment will be monitored.
- Due to the extended wet season and cyclone Monica only one farm walk was held this year. When producers toured the research farm, project officers provided updates on their trials and demonstrations.
- Discussions were held with about 15 people interested in pastoral ventures in the Top End.

- P. Hausler visited Sabah with B. Lemcke for the second annual review of the Sabah Government's cattle and buffalo farms.

Marrakai region

- Manufactured and successfully trialled a small no-till machine that can be pulled along with a quad bike.
- Set up an upland para grass plot to demonstrate the production and quality of para grass seed.
- Participated in the judging at the Farm and Pastoral competition at the Royal Darwin Show.
- Participated in the judging of the senior and junior "Rural Achiever" for the Fred's Pass Show.
- Attended a "capacity building" extension workshop at the Trade Development Zone and the Pastoral Production Group meeting in Alice Springs.
- Participated in the "Blockies' Day" held by the rural blockies extension network of which Marrakai is an active participant.
- Assisted the Lambell's Lagoon Landcare group with the eradication of olive grass from a billabong. Assisted the Churcher Estate Landcare group with chemical control of "curry tree" in the Churcher wetlands.

Project: Pastoral Industry Surveys

Project Officers: T. Oxley, P. Hausler, S. Leigo and A. Bubb

Location: NT

Objectives:

To document the state of the cattle industry in the Northern Territory (NT) to better enable government and industry to monitor the performance of research and development through time.
To collect information to enable DPIFM, Industry Advisory Committees and the NT Cattlemen's Association to better address the needs of the industry.
To determine the most effective ways to provide extension information to producers in each region and to initiate or improve communication between DPIFM staff and cattle producers.
To give the industry the latest information on management practice to better tailor future directions for research.

Background:

The first complete survey of the Northern Territory pastoral industry was conducted in 2004. Earlier, three regions were surveyed more than 20 years ago - Alice Springs in 1979, the Barkly in 1980 and Katherine in 1982 - but the Top End pastoral region was not included. In the current survey, 151 cattle producers were interviewed from across the four regions, accounting for 75% of producers in the NT.

Method:

Face-to-face interviews were conducted with 151 NT producers with cattle enterprises of more than 300 animals. Table 1 shows the breakdown of the number of producers and the area of land surveyed. A cattle enterprise was defined as a property where a person or persons raised cattle and owned, leased or worked on an agisted area within a pastoral lease. In cases where more than one pastoral lease was run as a single business, it was counted as one enterprise. For example, two producers had two properties that were run quite separately, so they were considered as two enterprises, but were counted as one producer.

These surveys were carried out between October 2004 and March 2005. DPIFM staff determined that 202 producers met the criteria for this survey. The response rate was 75%.

Surveys were collected as written hard copies and were then recorded on an Access database. Questions were then analysed using a combination of Access and Excel spreadsheets.

Regional reports were collated and launched in April 2006. An NT-wide report was also collated from the results of the regional surveys.

Results:

Table 1. The number of producers surveyed and the area of land they manage

Region	Producers identified as meeting criteria	Total surveyed	Proportion of producers surveyed (%)	Total area actively managed for pastoral (km^2)	Total area surveyed (km^2)	Proportion of total pastoral land surveyed (%)
Alice Springs	65	40	62	235 856	151 498	64
Top End	32	25	78	23 801	20 680	87
Katherine	85	60	71	183 986	131 330	71
Barkly	28	24	86	203 201	161 893	80
NT Total	**210**	**149**	**71**	**646 844**	**465 401**	**72**

The average size of a cattle station in the NT is 3122 km^2. The surveyed stations had about 1.4 million head of cattle. Brahman is the predominant breed of cattle in the NT; however, British breeds are most prevalent in the Alice Springs region, due to a drier and cooler environment.

The most common structures of station ownership in the NT are owner/manager (32%), privately owned/manager employed (25%) and company/manager (25%). Of the properties surveyed, 6% were indigenous-owned.

The most common property herd sizes in the NT are between 2000 and 5000 animals (20% of properties) and more than 20 000 animals (18%). The most common breeder herd size in the NT is 2000-5000 animals (22%).

The most common production system in the NT is breeding, with a number of properties in the Top End and Alice Springs regions able to fatten cattle. Most animals turned-off from NT properties are 18 to 24-month old feeder steers (63% of producers), followed by cull cows and export heifers. Generally, turn-off occurs between April and September. The two main markets are export (64%) and abattoirs (38%).

Producers in the NT conduct two mustering rounds a year. The timing and length of mustering rounds varies across the NT and is influenced by the environment and markets. The main methods for mustering include the use of helicopters, horses, motorbikes and trap yards.

On average, producers aim to keep 4.3% of their herds as bulls. Bulls are most commonly sourced from Queensland stud breeders. Alice Springs region producers mostly use estimated breeding values when purchasing bulls.

The majority of producers in the NT practise year-round mating of their breeder herds. Weaning calves from their mothers is practised by 98% of producers. The average weaning percentage (number of calves weaned/number of cows joined) for the NT is 72% with a range between 35% and 90%. The average proportion of cows culled in the NT is 12% and there is an average mortality rate of 3%. The average

proportion of heifers kept as replacements is 60%. The mortality rate for first calf heifers is 3.3% and for second calf heifers it is 3%.

Supplements are provided to 93% of cattle throughout the wet and dry seasons. Phosphorus is the most common supplement in the wet season, while urea is the most common supplement in the dry season. However, in the Alice Springs region producers who do provide phosphorus to their animals do so following rainfall. In general, producers supply supplement to all classes of cattle. Production feeding is not a common feature of nutrition management on NT properties.

Of the properties surveyed, 36% stated that they produced their own hay. The average amount of hay produced in the NT is 793 tonnes. In the Top End region, hay is produced from improved pastures, while in the Barkly region, it is produced from native pastures. The Alice Springs and Katherine regions have a mixture of native and improved hay.

The biggest animal health concern for producers in the NT is botulism. Producers in the Alice Springs region are also concerned about lice. Top End producers are also concerned about buffalo flies. The most common disease that producers vaccinate for is botulism, with a smaller number of producers in the Top End, Katherine and Barkly regions vaccinating for vibriosis.

Based on producer estimates, carrying capacities across the NT are expected to increase through increases in station infrastructure. By 2009 carrying capacity is estimated to increase by 29%, and by 2014, by 54%. The largest increases in estimated carrying capacity relative to area are expected in the Top End through planned improved pasture development on cleared land.

Thirty-five per cent of pastoralists in the NT indicated they had areas of fully improved pasture on their stations, while 29% indicated they had areas of improved pasture species, usually legumes, scattered across paddocks,. The level to which pasture had been developed varied greatly across the NT. The most common use of improved pasture in the NT is to improve diet quality in a native pasture system.

Native tree or shrub build-up was reported by 79% of stations across the NT. Forty-eight per cent of these pastoralists believed it to be of major concern to their production system, 33% a minor concern and 19% of no concern. Producers believe it is having a significant effect on pasture growth and mustering. Controlled burning is used by 50% of producers in an attempt to reduce encroachment.

Weeds are of importance to producers because they can severely limit production. Eighty-one per cent of producers made a planned effort to prevent weeds being introduced to their property. The most common preventative action taken was to buy certified clean hay. To control weeds in 2004 pastoralists spent an average of $19 568 for each property.

Pastoralists also cited feral animals as hampering production. Wild dogs were named as having the biggest impact on production across the NT, although feral pigs were an equal problem in the Top End region. Out of all feral animals, wild dogs were named as the most important target for control. The average cost of control of feral animals was $4928 for each property in the NT in 2004.

Sixty-seven per cent of producers surveyed named cattle production as their only source of income. Sixteen per cent cited hay production as an additional source of income. Nine per cent indicated that tourism occurred on their stations.

Producers were asked to identify hurdles in running or managing their enterprises. Recruitment and retention of staff was identified as the biggest hurdle, except in the Alice Springs region where seasons were reported to be the largest hurdle. The increasing costs of production were also identified widely as a hurdle to enterprises.

The most significant threats to economic sustainability were rising costs of production, cattle prices and other market issues, and road conditions. Once again, the Alice Springs region rated seasonal conditions as the biggest threat to economic sustainability.

Producers named exotic weeds as a major threat to environmental sustainability with importance placed on issues such as erosion and the ability to manage climate variability. There was concern over such areas as government policy and ill-informed community pressure.

Producers named lifestyle as the predominant reason for choosing to be members of the pastoral industry.

Project: Reproduction Management Advisory, Training and Maintenance of the Semen Vat

Project Officer: G. Jayawardhana

Location: Berrimah Farm and properties across the NT

Objectives:

To train and advise NT pastoralists on reproductive/management techniques to improve profitability of animal industries.
To maintain a liquid nitrogen vat to store and transport semen to facilitate artificial insemination in cattle and buffalo in the NT.

Activities:

Advice was provided to cattle properties through visits and/or by telephone. Properties that received such advice included Amungee Mungee, Annaburroo, Avago, Ban Ban, Beetaloo, Bob's Gully, Bonalbo, Camp Creek, Cave Creek, Cedar Park, Ceres Downs, Coolibah, Elsey West, Ferguson River, Florina, Heytesbury Pastoral Company, Inverway, Hodgson River, Ironstone, Jindare, Killarney, Lakefield, Maneroo, Middle Creek, Midway, Mt Keppler, Mt McMinn, Mt Ringwood, Charles Darwin University Rural Campus, Old Mt Bundy, The Pines, Singosari AI Centre (Indonesia), Stylo, Taminmin High School, Theyona, Vermelha, VRD Centre Camp, VRD Mt Samford, Willeroo, Wollogarang and Wombungi.

The semen vat contains about 21 000 doses of cattle and buffalo semen. It belongs to DPIFM and 28 producers. Semen was transported to five artificial insemination programs.

Project: Review of Past Barkly Projects

Project Officer: **H. James**

Location: Tennant Creek

Objectives:

To locate, assemble and prepare summaries of all scientific research conducted on the pastoral industry in the Barkly region over the last 20 years.
To make the information available to pastoralists and researchers in the region.

Background:

Continual changes in staff and pastoralists in the region compared to other regions have reduced awareness of scientific research work that has been carried out in the Barkly region over the years. To address this issue, summaries were prepared of all known research work which has occurred over the last 20 years.

Developments

Summaries have been prepared for 65 past research projects carried out in the Barkly region. The projects have been grouped as rangeland, animal and biodiversity. Preparations are being made to create a departmental publication of the summaries to be published by December 2006.

Program: Cattle Production from Mixed Farms

Sub-program: Livestock Management

Project: Pasture Species Evaluation under Grazing at DDRF

Project Officers: **B. Lemcke, P. Shotton, L. Huth and DDRF Staff**

Location: Douglas Daly Research Farm (DDRF)

Objectives:

To evaluate pasture species and mixtures under a continuous grazing regime on Blain soil at DDRF.
To determine their persistence, productivity and contribution to the weight gain performance of cattle.

Background:

Promising pasture species are evaluated under grazing at DDRF to determine their long-term potential in the Douglas Daly environment.

Method:

The pastures are grazed in 4 hectare paddocks by five Brahman weaner steers per paddock (1.25 animals/ha). The exception is Paddock 49, which has an additional five animals. This increases the stocking rate to 2.5 animals/ha. The objective in this paddock is to monitor the long term effects of heavy stocking rates on buffel grass. Steers are allotted to paddocks in June/July (post-weaning) and remain in the grazing trial until the following June.

Paddocks are top-dressed annually with a phosphorus-based fertiliser. This year Pasture Generator® (NPKS 0:15:0:18) was aerially spread on the paddocks at 50 kg/ha. During the wet season various weed control measures were undertaken where required, usually spot-spraying for broad-leaf weed control. Some grass only paddocks are boom-sprayed with Starane®/2, 4-D or 2, 4-D/Brush Off® mixtures if broad-leaf weeds become prominent. Urea was applied at 100 kg/ha to paddock 532 (split applications in December and February) as a substitute for wet season block supplements.

Animals were supplemented with ad-lib Uramol® blocks during the dry season and Phosrite® blocks in the wet season. Intake was recorded monthly.

Cattle were weighed monthly, condition scored and measured for P8 rump fat from January to the end of the grazing season in June 2004.

Pasture composition and yield were assessed twice during the year, the first time in early wet season, in December 2005. A post-wet season assessment was conducted in May 2006.

In early December 2004, Paddock 42 was sown with Jarra grass, while maintaining Wynn cassia. It was then restocked in February 2005. In December the half rows of leucaena were extended to full length in Paddocks 45, 48 and 534.

Paddock 39 has been divided into two and grazing is rotated monthly to allow the leucaena to recover leaf on a regular basis

Table 1. Mean cattle live-weight gains in each paddock (kg/animal)

Paddock No.	Pasture type	July 05-Nov 05 (mid-late dry)	Nov 05-April 06 (wet season)	April 06-June 06 (early dry)	Total July 05-June 06
39	Buffel/leucaena (5 rows)	48. 9	142.0	42.8	233.7
40	Nunbank buffel	32.7	126.6	30.1	189.4
41	Tully (B. humidicola)	29.2	115.5	34.2	178.8
42	Wynn cassia / Jarra	48.9	121.8	35.0	205.7
43	Oolloo	24.2	138.1	49.2	211.5
44	Pangola	42.5	134.9	52.6	230.0
45	Pangola/leucaena	36.7	164.6	45.0	246.3
46	Sabi	26.5	119.8	33.4	179.7
47	Jarra	28.9	143.6	44.4	216.9
48	Sabi/leucaena *	33.4	151.2	44.2	228.8
49	Buffel/tall variety	7.0	133.3	31.2	171. 5
50	Buffel/legumes	26.9	127.1	45.2	199.2
51	Strickland/Wynn	38.2	124.2	40.8	203.2
52	Arnhem/Oolloo	8.6	123.1	35.8	167.5
531	Buffel/sabi/ WS blocks	21.9	139.0	40.4	201.3
532	Buffel/sabi/ + 100 kg urea	26.5	141.5	41.4	209.4
533	Buffel/sabi/Wynn	26.2	141.2	32.8	200.2
534	Leucaena/buffel/sabi **	43.3	144.1	43.6	231.0
535	Buffel / Oolloo	25.9	139.0	43.8	208.7
All paddocks	**Mean live-weight change**	**30.3**	**135.3**	**40.3**	**205.9**

*Cattle de-stocked from Paddock 48 to Paddock 39 from 25 May 2006 to 16 March 2006

** Cattle de-stocked from Paddock 534 to Paddock 39 from 20 February 2006 to 16 March 2006

Table 2. Mean live-weight gains (kg/animal) during the past eight years

Year	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
Live-weight gain	190.4	187.7	176.1	173.0	173.1	176.5	168.0	205.9

There was a huge increase in the live weight-gains (LWG) in the cattle this year in all paddocks due to the better wet season, particularly with heavy late rain. This resulted in 60% of the extra live weight gain occurring after the wet, 20% during the wet and 20% extra over the previous dry, compared with the previous year.

Paddock 49 had the second lowest per animal LWG, but because of the double stocking rate there is still a large gap of 93 kg/ha between it and the highest of the rest in terms of kg/ha LWG. However, only an extra two animals on the pangola/leucaena would be enough to surpass the Paddock 49 figure. It is suggested that the extra stocking rate could be easily achieved with no detriment to the leucaena mixtures and their sustainability. The other consideration in opting for a lower per animal productivity is if an extra dry season is required for turn-off to occur, then this may remove the per hectare advantage. The Arnhem paddock has slipped to the bottom of the list but there has been little Oolloo available in the paddock for a few years while the broad-leaf weed problem was being addressed. Jarra was very impressive this year compared with previous years, which is difficult to explain, particularly compared with the Strickland. This is the first year that the Strickland paddock has performed worse than the Jarra. However, the Strickland paddock appeared to be struggling against the competition from the *Chamaecristas* in the same paddock. This year appears to have favoured legumes in particular, compared with normal years, with much greater dry matter available. The Jarra-only paddock out-performed the much younger Jarra/Wynn pasture. The only explanation would

appear to be animal-related, in that animals in Paddock 47 may have missed bovine ephemeral fever this season.

Table 3. A comparison of performance on mixtures of legumes and grasses (kg/animal/year)

Mean LWG all leucaena/grass paddocks	Mean LWG all legume/grass paddocks (excluding leucaena)	Mean LWG all grass-only paddocks
235.0	204.8	193.8

The benefit of having legumes in the sward was demonstrated this year with only a few exceptions, such as pangola and Jarra.

Block consumption

Uramol was provided in all paddocks from 17 June 2005 to 1 November 20005, and then Phosrite® from 1 November 20005 to 15 June 20006 with the exception of Paddock 532.

Table 4. Supplement consumption

Paddock No.	Variety / species	Dry season: Uramol® consumption (137 days) g/animal/day	Wet season: Phosrite® consumption (226 days) g/animal/day
39	Buffel / leucaena (5 full length rows)	84.7	88.3
40	Nunbank buffel	81.8	103.7
41	Tully (B. humidicola)	108.6	67.3
42	Wynn cassia / Jarra	58.4	121.8
43	Oolloo	47.2	58.1
44	Pangola	73.0	36.4
45	Pangola/leucaena	57.7	38.2
46	Sabi	84.7	54.4
47	Jarra	115.0	102.5
48	Sabi/leucaena	74.5	59.7
49	Buffel (tall variety) double stocking rate	58.4	80.1
50	Buffel/legumes	116.8	94.2
51	Strickland/Wynn	146.0	93.9
52	Arnhem/Oolloo	104.1	52.2
531	Buffel/sabi/blocks	87.6	94.4
532	Buffel/sabi/urea	116.8	Not supplied
533	Buffel/sabi/Wynn	116.8	110.6
534	Leucaena/buffel/sabi	85.8	90.3
535	Buffel/Oolloo	75.9	98.8
All paddocks		**89.1**	**80.3**

Consumption rates compared with last year were higher for both Uramol (up 10 g/animal/day) and Phosrite (up 12 g/animal/day). Over eight years, it was at the lower end of the range for Uramol (range 78-134 g) and also below the average for Phosrite (previous range 72-119 g). Group consumption was more variable than last year with consumption rates up quite a bit higher in some paddocks than the previous year. Phosrite consumption was higher overall, with four paddocks recording more than 100 g/animal/day. Phosrite continues to be consumed at a much lower rate in pangola pastures.

The comparison between N fertilisation of buffel grass and wet season block use will be continued for a few more seasons to see if the effect of N is cumulative. The annual difference in the first year was 23 kg LWG/animal in favour of the block-fed group (Paddock 531 compared with Paddock 532). Last year the difference was only 10 kg LWG/animal. This year the difference was 8.1 kg/animal in favour of the urea-fed group. This trend is expected to continue as the N content of the pasture tends to increase through accumulation and recycling. It is interesting that Uramol consumption in the urea-fertilised paddock during the dry is consistently higher than in the control paddock except in year 1 when they were the same; but were 26% and 33% higher in years 2 and 3, respectively.

Project: Pasture Species Evaluation under Grazing at DDRF - Consumption of Leucaena and Pasture Legumes

Project Officers: P. Shotton, B. Lemcke and DDRF staff

Location: Douglas Daly Research Farm (DDRF)

Objective:

To monitor the consumption of companion pasture legumes with improved grass species using near infrared reflectance spectroscopy (NIRS).

Background:

The pasture species evaluation trial at DDRF was established in the 1970s to evaluate a number of different potential pasture species and mixtures under continuous grazing. See *Pasture Species Evaluation under Grazing at DDRF*.

Currently there are 19 paddocks under evaluation with predominantly grass pastures, one legume-only pasture and mixed grass/legume species. All paddocks are annually maintenance-dressed with phosphate fertiliser.

Pure grass stands of sabi, buffel, Jarra, Stickland, pangola, kazungula, Higane and pure legume stands of Wynn and Oolloo have given varying results over the years with the kazungula and Higane eventually dying out within a five-year period.

Companion legumes such as leucaena, Maldonado, blue pea, Wynn, Oolloo and Verano have been used and in most cases the grass/legume pasture mix has produced higher live-weight gains compared with grass-only pastures.

Pasture composition and yield were assessed twice during the year, in December 2005 and in May 2006. Although the proportions and yields of grass, legume and other plant species are estimated, the actual consumption of grass and non-grass species by cattle is unknown. Dung samples are analysed by the NIRS system for dietary crude protein, faecal nitrogen and digestibility.

Method:

Each paddock is grazed by five Brahman weaner steers at the rate of 1.25 animals per hectare over a 12 month period and are changed over in June each year.

The animals were supplemented with Uramol® blocks during the dry season and with Phosrite® blocks in the wet season. Intake was recorded monthly. Intake ranged between 47 and 146 g/animal/day (average 90 g) for Uramol® and 36 to 122 g/animal/day (average 80 g) for Phosrite®.

Broad-leaf weeds were controlled with either 24-D Amicide®, Starane® or Brushoff® herbicides. Some hand weeding and spot spraying is carried out each year for broad-leaf and grass weeds, mainly spiny head sida *(Sida acuta)* flannel weed *(Sida cordifolia)*, hyptis *(Hyptis suaveolens)* and senna (*Senna obtusifolia)*.

Dung samples were generally collected from each animal at the time of cattle weighing. The dung from each group was combined, mixed, sub-sampled then dried in a dehydrator at 60^{o}C.

A total of 130 dung samples were analysed with a majority of the samples collected from steers from paddocks 39 (buffel grass and leucaena), 45 (pangola and leucaena), 48 (sabi grass, Wynn and leucaena), 534 (buffel grass and leucaena), 535 (buffel grass and Oolloo), 533 (buffel grass and Wynn), 42 (Jarra grass and Wynn) and 51 (Strickland grass and Wynn). Pasture leaf samples were also collected three times throughout the year for assessment by NIRS.

Note: Because NIRS predictions are based on calibration equations and the digestibility of both grass and non-grass proportions are not separated, the percentage of non-grass proportions of the diet may be under estimated.

Progress

The proportion legumes consumed varied throughout the year ranging from zero to 58%.

Paddock 39 has leucaena rows at 12-metre spacing. Leucaena forage was available most of the time. However, the pasture is rotationally grazed by spelling one half of the paddock each month. Dung samples collected from animals a few days after being on fresh leucaena regrowth indicated a much higher consumption than just prior to change over, indicating a preference for new growth.

Paddock 534 had the lowest amount of leucaena forage available; but it had other legumes, such as Verano, stylo and Wynn cassia. The eastern half of the paddock has rows of tall established leucaena trees where some browsing is available. Vast amounts of seeds fall underneath and seedlings are established during the wet season, promoting new growth. These seedlings are generally consumed before the end of the dry season. The western half of the paddock has two-year old rows of leucaena, 8 metres apart. Production appears less than in other paddocks.

Paddock 48 also contains other legume pastures - particularly Wynn. The Leucaena rows in the eastern end of the paddock (10-metre row spacing) were established five years ago. However, these remain short due to slashing in the past, weed competition and constant grazing. The western leucaena rows were established two years ago (also in 10-metre row spacing) and produce large quantities of fodder.

Paddock 45 has five-year and two-year-old established leucaena rows at 12 metre spacing and produces reasonable amounts of fodder.

Leucaena consumption varied greatly throughout the year. The overall non-grass proportion for leucaena from the NIRS dung analysis was 21.5% in Paddock 45, 17.7% in Paddock 39, 15.9% for Paddock 48 and 9.4% in Paddock 534.

Most of the species trial paddocks contain some Wynn cassia plants. Paddock 51 has a mix of Strickland grass and established *Chamaecrista* spp (1/3 each of Wynn, CPI 86172 and CPI 86178). The dominance of legumes could be visually seen throughout the year and in May 2006 it was approximately 70% of the biomass, mostly cassia. Legume consumption varied between 14 and 76%.

Paddock 533 (buffel and Wynn) was sampled from February to June 2006. The non-grass portion of consumption for February, March and April was virtually zero, and only in the last two months (May and June) was there some consumption of legume (10 and 33%). Past trials and observations suggest that Wynn was not sought after by cattle. The May Botanal survey found Wynn produced 47% of total biomass and Verano 2%.

Paddock 42 was planted with Jarra grass two seasons ago following a two-year pasture of near pure Wynn. The May 2006 Botanal survey showed Wynn cover of approximately 9.3% with small amounts of Verano stylo. The Jarra grass grew tall, which shaded the Wynn and probably reduced its growth. Consumption of the non-grass plants ranged between 11% and 25%, averaging 18%.

Paddock 535 was established four seasons ago with buffel grass and Oolloo as a companion legume. Consumption of legume was continuous throughout the year and non-grass consumption ranged between 7% and 58%.

In all the paddocks assessed, the percentage of non-grass in the samples was highest during the last two months of the trial at the start of the dry season (May and June 2006) when pastures were starting to dry off a little. The high rainfall of the 2005-06 wet season apparently had an effect on legume production. Cattle at this stage are at their heaviest, requiring a sufficient quantity of protein and energy to increase live weight gain.

As expected, the dietary crude protein, faecal nitrogen and digestibility dramatically improved at the start of the wet season then declined a little in May and June 2006. At this stage no apparent correlation can be seen between the dietary crude protein and the proportion of legume in the diet. The highest yearly live weight gains were produced from the four grass/leucaena paddocks and Paddock 535 (buffel- Oolloo mix). Although the consumption of *Chamaecrista* spp varied between Paddocks 533, 51 and 42, yearly live-weight gains were very similar.

Psyllids were present in sometimes high proportions throughout the year reducing the yield of leucaena leaf. Future control methods such as insecticide applications may be necessary to control the pest.

Although dietary crude protein and digestibility were found to be good during April, live-weight gain was low possibly due to the wet weather and animal suffering from BEF or three-day-sickness.

Dung samples collected in March 2006 were also assessed for faecal phosphorus. Results showed high levels of faecal phosphorus of between 0.75% and1.33%.in all steers assessed in Paddocks 39, 42, 44, 45, 48, 49, 51, 533, 534 and 535.

Pasture samples plucked from grass and legume species (selecting new growth) in March 2006 were also analysed for crude protein, digestibility and phosphorus. Results showed the phosphorus was high in the pastures (0.24–0.3%.Supplementary feeding of phosphorus was not essential.

Conclusion

Statistical analysis is required to fully understand any relationship between dietary crude protein, the proportion of non-grass consumed, weight gain and digestibility. Further research and on-going calibrations with NIRS technology will assist with more accurate analysis. The management of grass/legume pastures, particularly leucaena, will help to best utilise the pasture mix in different grazing systems, plant varieties and the proportion of grass to leucaena.

Project: Pasture Species Evaluation under Grazing at DDRF - Buffel/Legumes

Project Officers: P. Shotton and B. Lemcke

Location: Paddock 50, Douglas Daly Research Farm (DDRF)

Objective:

To monitor the value of a companion legume with buffel grass in terms of nitrogen availability, pasture quality, quantity and the persistence of the legume species.

Background:

Buffel grass is a commonly used improved pasture in the Top End, south of and including the Douglas-Daly region. As established buffel grass pasture tends to grow in clumps, a favourable legume companion species would be beneficial to help utilise the area between buffel plants and ideally provide nitrogen to the grass, resulting in higher quality and better yielding pastures. A higher protein diet for cattle from the legume would be an additional benefit.

The project follows a non-grazed plot trial between 1996 and 1998 that evaluated the benefits of six tropical pasture legume species as companions to buffel grass (see *Technote 110*).

Method:

On 6 January 2000, seeds of five pasture legume species were planted into a 4 hectare paddock (paddock 50) at DDRF. The legumes were Wynn cassia *(Chamaecrista rotundifolia),* Verano stylo *(Stylosanthes hamata),* Oolloo *(Centrosema brasilianum),* Maldonado *(Macroptilium gracile)* and Milgara blue pea *(Clitoria ternatea).* The legumes and the buffel (*Cenchrus ciliaris)* only control were replicated four times, randomized within blocks with a plot size of 12 m x 130 m.

In December each year approximately 50 kg/ha of Goldphos 20® or equivalent fertiliser was applied to the area.

The area was left un-grazed in the first wet season to allow legumes to set seed. The paddock was stocked with five Brahman weaner steers at 1.25 animals per hectare for a 12 month period. Steers are kept for 12 months and are changed over in late June each year. Animal weights, condition and fat score are recorded monthly.

The animals are supplemented with Uramol® blocks during the dry season and with Phosrite® blocks in the wet season. Intake is recorded monthly.

Broad-leaf weeds were controlled with Starane® as a post planting/pre-emergent herbicide in January 2000. Some hand weeding and spot spraying is carried out each wet season for broad-leaf weeds, mainly spiny head sida *(Sida acuta)* flannel weed *(Sida cordifolia)*, hyptis *(Hyptis suaveolens)* and senna (*Senna obtusifolia)*.

Pasture composition and yield were assessed twice each year in December and May using Botanal®.

Results:

During the first two seasons, all legumes established well. The most prolific were Milgara blue pea, Oolloo and Maldonado. Wynn cassia and Verano stylo were less prolific than the twining legumes. Verano, Wynn and blue pea seeded well while Oolloo and Maldonado seeded poorly. However, in the second year all legumes seeded well. Results from the April 2001 biomass harvest indicated that the greater the legume content, the higher was the overall yield, although grass yields in the Oolloo were lower, indicating that the legume was competing with buffel grass.

During the first three years the proportion of legumes decreased except for Oolloo which sustained a grass/legume mix (see Figure 1). Very few legumes were present during the 2003-04 wet season. However, in the following season Oolloo, Verano and Wynn increased in proportion to grass. This was particularly true for Wynn and Oolloo.

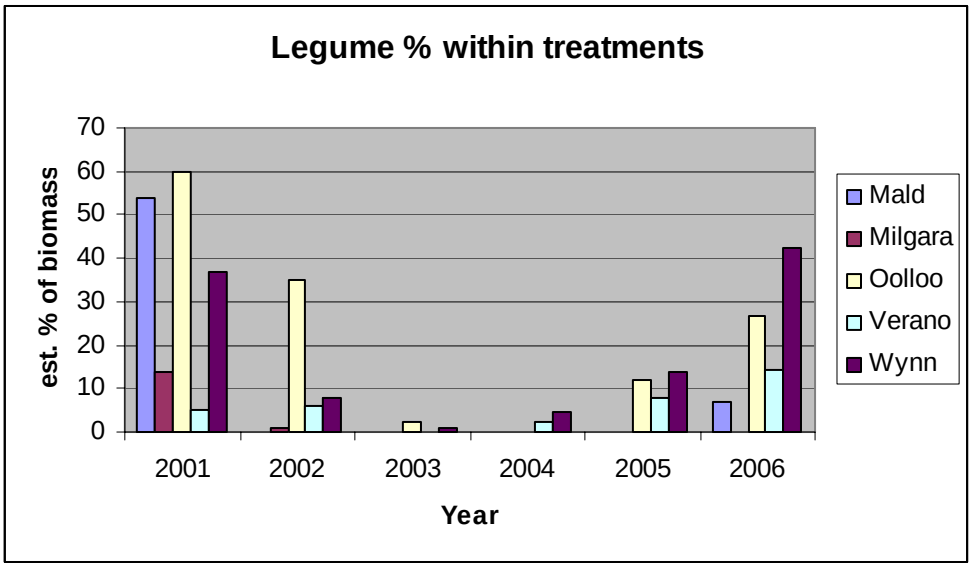

Figure 1. Proportion of species and total yields of Paddock 50 buffel/legume trial

Plant analysis results suggest that the higher the proportion of legume content, the higher was the nitrogen in the companion buffel grass. This could be clearly seen throughout the wet season and in the early dry season, particularly the grass growing with Oolloo was dark green, flowered earlier and had a denser stand.

Average intake of Uramol® was 106 g/animal/day in the dry season and of Phosrite® 68 g/animal/day during the wet season.

The average annual live-weight gain was higher compared with some previous years (see Table 1) and was slightly lower than the average of the other species paddocks. This may have been due to the different mix of steers used, the shorter rainy season in 2004-05 or a decline in available legume in the pasture. In 2005-06 there was improvement in all paddocks. The increase in the proportion of legume in the paddock this year is pleasing to note, reversing the steady downward trend of the first four years.

Table 1. Mean annual live-weight gains (kg)

Year	2002-03	2003-04	2004-05	2005-06
Average weight gain	176	190	160	199

Conclusion

Hard seediness, climatic conditions, insect pests and palatability of legumes have long-term effects on the pasture mix. Different management techniques such as non-grazing to allow seed set every second or third year will improve the sustainability of pasture legumes. A limitation in the trial was the ability of animals to selectively graze more palatable legumes, which may have resulted in over-grazing, and depletion of some legumes, allowing the less palatable species to survive. The promising performance of Oolloo as a companion legume in buffel grass has stimulated further monitoring in Paddock 535, where the legume was introduced in December 2002.

DDRF received 1846 mm of rain over a seven month period in the 2005-06 wet season, which encouraged pasture legume production.

The pasture composition rating carried out in June 2006 (Botanal®) showed that all legume species were present except Milgara.

After four years of dormancy and very little growth, Maldonado was found within and outside the treatment plots showing up in 17 of the 24 plots and contributing an estimated 7% of total biomass within the treatment plots and 4% of the total paddock biomass.

Wynn and Verano were found in all 24 plots throughout the paddock, Verano contributed 14% of the biomass within treatments and 6% over the total area. Wynn contributed 42% of biomass within the treatments and 15% over the total area.

Oolloo was present in all the treatment plots with a biomass of 27%. However, it did not spread throughout the paddock as much as Wynn and Verano. It was recorded in nine of the 24 plots across the paddock. Total biomass over the paddock was 14% indicating that where it was present it was robust and competitive with other grass and plant species.

Apart from the buffel grass and the introduced legumes, *Cassia pilosa, Ocimum basilicum* (Basil), *Centrosema pascuorum* (Cavalcade) and *Sida acuta* were most commonly found plant species in the trial paddock.

Program: Improved Pasture, Hay and Seed Production

Sub-program: Pasture Development

Objective:

To expand the industry base through increasing areas under pasture and improving industry skills and experience in managing pastures.

Outcomes:

An expanded industry through increased pasture production.

Continued support of forage research and demonstration programs aimed at increasing hay supply to the emerging forage cube industry.

Overview:

2005-06 wet season

The wet season was average or better for most of the district. Significant rainfall events began in October for a number of sites in the Darwin and rural, and Darwin-Daly areas.

October and November rainfall was higher than in the previous year in both areas of the district. December and March had normal rainfall, January rainfall was high in most areas of the Darwin-Daly, Rainfall in February was low, while in April it was higher than normal, boosted by the cyclone late in the month. In the Darwin and rural area, February rainfall consisted mostly of coastal showers, while for the Darwin-Daly there were isolated storms. There were no prolonged monsoonal periods during the wet season and only four days had widespread significant falls of rain, one each in November, January, March and April. There was only one day with significant amounts of rainfall in May.

The number of rain days was up 50% of that received in the previous season, which was similar to the number in 2003-04. Most sites received 600 to 1 000 mm more rain in significant falls than in the previous wet season.

Pasture yields were good across the district. The rain in April kept pastures green well into the dry season. The late rain disrupted and delayed the harvesting of fodder crops in the district this year.

The late rain also filled the floodplains to capacity at the end of the season. The late flood followed by cooler than normal dry season conditions delayed drying out of the floodplains. Some of the deeper areas of the floodplains will not dry out at all this dry season and will not be grazed this year.

A survey in the NT showed that total production of hay was approximately 52 470 tonnes, of silage 35 000 tonnes and of seed 79.6 tonnes.

Additional information relating to Pasture Development Extension is reported elsewhere in this Technical Annual Report under the Extension and Training Program.

Project: Seed Increase of Early Generation Seed of Released Pasture Cultivars

Project Officer: A. Cameron

Location: Berrimah Farm, Coastal Plains Research Station (CPRS) and Venn Blocks in Katherine

Objectives:

To evaluate new lines in a confined non-grazed environment.
To bulk-up seed from promising lines for further evaluation.
To bulk up early generation seed of pasture cultivars released in the NT.

Method:

Small areas of cultivars released in the NT are maintained in Paddock 8 and Paddock 9 at Berrimah Farm, C RS, and Katherine Research Station, as well as on commercial properties. Seed harvests are scheduled as required to ensure that fresh early generation seed is available.

Seed crops of annual species are grown and harvested as required.

Results:

A prebasic seed area of Cavalcade was sown at the Venn blocks near Katherine. A prebasic seed crop of Ingrid pearl millet was grown in the netted area at CPRS Horticulture, where off types were removed from the crop. About 50 kg of millet was harvested.

Duration: 2001-2010

Program: Resource Management

Project: 21st Century Pastoralism Project

Project Officers: M. Ashley and A. James

Location: Alice Springs

Objectives:

To provide research, development and extension services to commercial pastoral producers in the Alice Springs region and the broader desert regions of Australia as a component of the Desert Knowledge Cooperative Research Centre.
To increase the economic and livelihood opportunities associated with desert pastoralism by developing unique enterprise models, economic development systems and pastoral management systems that provide tangible benefits to producers.

Highlights for the year:

The 21st Century Pastoralism™ project commenced in early February. Its objective is to create a desert pastoral research collaboration system that will cover desert regions and involve relevant scientific disciplines. In April 2006, pastoral industry members, skilled regionally-based researchers and research funding organisation representatives met and identified four main research areas for the project, namely:

- Engaging Aboriginal pastoralists.
- Utilising technology - pastoral telemetry systems.
- Managing for variability.
- Improving economic sustainability.

Each of these research areas will be developed into individual sub-projects within the broader 21st Century Pastoralism™ project framework. Considerable progress was made in developing the *utilising technology* research area. In April, telemetry industry representatives and researchers participated in a project development workshop and a project coordinator has been appointed who will lead the implementation of the project. The *utilising technology* project will conduct cost-benefit analyses of commercially available telemetry systems and develop innovative “next generation” telemetry prototypes. The research will be guided by an industry analysis of telemetry needs and will lead to the creation of telemetry systems that are appropriate for desert pastoralists and supported by regionally-based service industries.

The 'Engaging Aboriginal Pastoralists' research area has developed into a collaborative project that incorporates:

- A participatory research evaluation of the Indigenous Pastoral Program in the NT.
- A review of indigenous pastoral employment initiatives across northern Australia.
- An evaluation of the Kimberly Indigenous Management Support Service in Western Australia.

The 'Engaging Aboriginal Pastoralists' research area has attracted $194 000 in external funding from the Indigenous Land Corporation and $50 000 external funding from Meat and Livestock Australia to implement the research activities. This research will commence in late 2006 and will deliver improvements in indigenous pastoral development programs through program delivery recommendations, government policy advice and project management guidelines.

The 'Managing for Variability' and 'Improving Economic Sustainability' research areas will be developed in early 2007 following further stakeholder consultations and establishment of multi-agency research teams.

Program: Buffalo Production

Project: TenderBuff Development and Supply

Project Officers: B. Lemcke, E. Cox, L. Huth and BHRS Staff

Location: Beatrice Hill Research Station (BHRS)

Objectives:

To promote and implement the TenderBuff Quality Assurance program for local and interstate markets.
To ensure year-round supply of TenderBuff in the NT.

Background:

The TenderBuff program was initially started to provide higher returns to the producer whose buffalo numbers were small, post-BTEC. It was seen as a serious substitute for the feral fillet market to restaurants using a much larger range of cuts. The Livestock Management Group runs the project in conjunction with the NT Buffalo Industry Council and provides the personnel to do quality assurance and branding of carcasses at the abattoir. The price paid to the producer remains at $3.10 per kg hot standard carcass weight (HSCW). There are five specifications that a carcass must comply with to receive the TenderBuff strip brand.

Supplies are now sourced mainly from commercial properties and raised at BHRS to maintain a steady year-round supply. With its extensive floodplain and ponded pastures, BHRS is able to fatten stock all year round and is only a 45-minute drive from the Litchfield abattoir. It is ideally placed to supply the market. Several producers are now preparing to participate in the developing industry with suitable pastures so that they can turnoff directly into this market.

Since March 2001, BHRS has concentrated on producing TenderBuff, sending only non-conforming stock to the live export destinations.

As TenderBuff has lower cholesterol and fat than beef, the two factors can be used for positive marketing of the product. Some ¾ River crosses are showing increased fatness on the rump and ribs. However, there appears to be no increase in intramuscular fat. As River cross buffalo grow much faster than Swamp progeny, they can be turned off at a much younger age and their meat should therefore be much tenderer.

Method:

The current specifications are:

- 150-300 kg HSCW.
- 3-12 mm fat at P8 site.
- No permanent teeth.
- Electrically stimulated carcass.
- Muscle below a pH of 5.8 after 18 hours.

Livestock Management or Research Station staff monitor TenderBuff animals through the abattoir on slaughter day and conduct chiller assessment the following day.

The discount grid determines the sale price to the wholesaler of animals that do not comply with the five specifications. This usually amounts to a 10% discount for each non-conformance to specifications. Discounts are also multiplicative when there is more than one non-conformance.

All purchased and home-grown bulls that are not suitable for sale as breeders are castrated. This reduces the unwanted pregnancy rate in females destined for TenderBuff. The only other management option would be to use the Willis spay technique on the females. Our policy is to purchase stock that need at least 100 kg of live weight gain prior to turnoff. The preferred weight and fat range at turnoff is in excess of 400 kg LW with more than 5mm of P8 fat.

Results:

The problem of less than 3 mm of fat in bulls in the dry season appears to have been overcome at this stage as the steers carry more fat, but it is less than that in heifers.

Table 1. Carcass parameters for TenderBuff

	July-December 2004	**January-June 2005**	**July-December 2005**	**January-June 2006**
No of animals	51	47	45	46
Mean HSCW (kg)	217.3	231.6	235.6	244.8
Mean eye muscle area (cm²)	58.6	61.4	64.7	65.4
Mean pH	5.53	5.50	5.49	5.51
Mean carcass length (cm)	103.9	105	105.8	105.4
Mean gross ($)	656.67	711.32	720.01	732.85
Total gross value ($)	33 490	33 432	32 400	33 711
Mean grid ($/kg)	3.02	3.07	3.02	2.99
Mean P8 fat (mm)	7.5	9.1	10.5	8.3
Mean rib fat (mm)	8.0	9.2	10.1	9.9
Mean dressing (%)	50.9	51.4	53.3	53.2
Total carcass weight (kg)	11 085	10 886	10 739	11 261
River cross stock (%)	33/51=64.7	32/47=68.1	2/45=95.6	8/46=82.6

TenderBuff meat production remained fairly static this financial year with only a 2.4% increase in carcass output and a small drop in the number processed. The slight increase in the price per animal (increased

carcass weights) was offset by fewer animals slaughtered. The drop in numbers was mainly due to the loss from the NT of the South Australian purchaser of TenderBuff, who moved interstate.

The increase in the proportion of crossbreds used in TenderBuff is a consequence of their superior quality and the lower weights of feral stock available for purchase, due to the Malaysian market buying a greater number of feeder animals from the feral herd. An increase in eye muscle area was also due to the increasing River cross proportion. The drop in mean grid value price per kilogram was due to the necessity of finding enough Swamp stock to supply the RIRDC New Meats project with samples. It was necessary to use some stock with recently emerged permanent incisors (one pair and outside of TenderBuff specification limits).

Dressing percentages are continuing to rise in both Swamp and River cross buffalo so that now it is rare to detect a carcass below 50%. It is difficult to increase TenderBuff consumption because of the nature of the wholesale meat business in Darwin, where margins are small and it is difficult to find qualified butchers because of pressure from supermarket chains. Younger people are not being attracted to the butchery trade. The next looming problem will be the closure of Litchfield abattoir if a buyer cannot be found to continue the operation.

Table 2. Comparison of traits in Swamp and River crossbreds for July 2005 to June 2006

	Swamp	**River crosses**	**River cross advantage (%)**
No of animals	10	81	
Mean HSCW (kg)	224.6	243.9	8.6
Eye muscle area (cm²)	57.3	66.0	15.2
Mean pH	5.49	5.50	0.2
Mean carcass length (cm)	103.6	105.8	2.1
Mean grid $/kg	2.88	3.02	4.9
Mean P8 Fat (mm)	7.1	9.6	35.2
Mean dressing (%)	52.0	53.4	2.7
Mean price ($ per animal)	647.48	736.26	13.7

This year, an even larger proportion of River cross animals were processed for TenderBuff. The main economic differences were:

- The eye muscle area which translates to greater meat recovery.
- The mean carcass dressing percentage which puts more dollars in the producer's pocket when paid based on HSCW.
- The greater weight for age and the increased mean price per head of the River cross carcass.
- The increase in P8 fat in River crosses can be a disadvantage but is partly related to the higher HSCW. This can be reduced by turning off the River cross animal at a lower live-weight and hence at a younger age than the comparable sized Swamp animal. This will relate to increased tenderness.
- The lower grid price for the Swamp animals was due to the shortage of Swamp stock available due to the need to submit meat samples for chemical analysis for the RIRDC Nutritional Status of New Meats Project. A number of animals with the first pair of permanent teeth broken were needed to make up the numbers for comparison.

Project: Riverine Buffalo and Crossbreeding Project

Project Officers: B. Lemcke, E. Cox, G. Jayawardhana and BHRS Staff

Location: Beatrice Hill Research Station (BHRS)

Objectives:

To determine the merits of crossbreeding and upgrading to Riverine buffalo for the NT buffalo industry.
To distribute suitable progeny from the program to industry for breeding or for supply of TenderBuff.
To demonstrate sustainable buffalo production systems.

Background:

It was the long held dream of pioneer buffalo researcher, the late Don Tulloch, and the vision of the NTBIC, to introduce Riverine blood into the Australian Swamp buffalo population. The dream became reality in 1994 with the importation of two bulls, followed over the next three years by a further four heifers and two more bulls. Two of these heifers were purchased by a private producer and left at BHRS for mating. A crossbreeding program was started and progeny performance is monitored. Progeny are also put through the TenderBuff system. The purebred group has increased now to 53 animals at BHRS. Two of the original imported bulls have died; one accidentally whilst on loan to a local producer and the other from TB destocking eight years ago.

The aim is to produce purebred River buffalo from two directions, by using the purebred cows to increase their numbers from within and also by crossbreeding then backcrossing to purebred through 3/4, 7/8 and 15/16 generations.

It is expected that during this process it will be possible to identify those mixtures of the two breeds that will best suit the various meat, export and dairy produce markets in Australia and overseas.

There is a co-operative arrangement with the Australian Dairy Buffalo Company in Millaa Millaa, Queensland to supply data on milk-producing potential of the various crosses compared with the pure Riverine.

A small group of heifers sold in 2004 to a dairy farmer in Maleny, Queensland has started calving. Another four purebred heifers, two calves and a Riverine cross bull were sold in 2005.

Method:

All animals are held at BHRS. Half-bred cows and heifers are mated to the imported bull to produce ¾ calves. Bull 5775 was the sire of all the 7/8 calves, while a half-Italian bull 5796 (by AI) sired all the 15/16 calves. Some semen of Italian milking buffalo was also imported into Australia. Semen from three bulls has been used in AI projects. Some of the purebred cows and 7/8 heifers have been inseminated with Italian semen and semen from one of the imported American bulls. The other imported American bull was mated to the swamp group this wet season to produce this year's F1 calves.

Results:

Table 1. The composition of Riverine and crossbred buffalo groups at BHRS, June 2006

	Imported bulls	Local bulls	Breeder cows	Yearling bulls	Yearling heifers	Male calves alive	Female calves alive	Calf mortality (%)	Total
Purebred Riverine	2	7	26	4	2	7	5	2	53
Swamp			29						29
F1			34		6	9	6	1	55
¾			31		11	7	16	2	65
7/8		5	22	12	9	7	10	2	65
15/16		1	1	2	1	7	6	1	18
TOTAL	2	13	143	18	29	37	43	7	285

There was a slight increase in the herd since last year, mainly in the purebred Riverine and 15/16 groups. As these groups grow the numbers in the lower percentage breeds will be gradually reduced through culling for fertility and temperament. Four purebred heifers with two calves at foot were sold to Thompson's in Maleny. Five ¾ Riverine cross heifers in calf were sold to Humphries in Millaa Millaa for dairying. Some of the purebred cows also changed owners but remained at BHRS for agistment.

Table 2. Calving in 2005-06 and pregnancy status in June 2006

Breeder Group	Calves born/cows mated = calving rate (%) for 2005-06	No. pregnant June 2006/cows mated DEC 2005	Pregnancy (%)	No. pregnant + wet cows/total wet cows =% wet cows pregnant
Swamp cows	15 / 34 = 44	17 / 29	59	9/15 = 60
F1 cows	24 / 35 = 69	21 / 34	62	15/23 = 65
¾ cows	19 / 31 = 61	25 / 30	83	13/16 = 81
7/8 cows	14 / 18 = 64	17 / 22	77	10/12 = 83
15/16 cows		0 / 1 (AI heifer) (2 rounds)		
Riverine cows	14 / 25 = 56	8 / 11 (AI 2 rounds)	73	4/9 = 44
Total	86 /143 = 60	88 / 127	69.3	51/75 = 68

From the first round of pregnancy diagnosis, there appears to be a slight increase of 10% in calves expected next year. The Swamp group was still slow in overall calving performance compared with all the other groups, but did show significant improvement over the previous year. We will continue to increase pressure on culling for poor reproductive performance as numbers increase. There are nine empty and dry culled cows this year from the whole herd. Calf losses were 8% this year, which is above normal.

Project:	**Genetic and Reproductive Improvements in Australian Water Buffalo - RIRDC**
Project Officers:	**B. Lemcke, E Cox, A. Turner G. Jayawardhana and BHRS Staff**
Location:	Beatrice Hill Research Station (BHRS) and co-operating properties

Objectives:

RIRDC is funding, within the Buffalo Program, a project that has three components:

To develop an artificial insemination (AI) synchronisation protocol to deliver good outcomes.
To set up a database for the entire Australian buffalo industry into the future.
To analyse and report on the genetics of the swamp buffalo from DPIFM data.

Background:

This project is funded by the RIRDC Buffalo Program. In November 2005, six purebred cows and 11 crossbred heifers were inseminated. Only two cows and one heifer became pregnant. In February 2006, 20 pure Riverine heifers were inseminated in Yambuk, Victoria. A very experienced local inseminator of dairy cattle achieved a 50% pregnancy rate in this group. This is the first really successful attempt with just a single insemination per animal. In April 2006, another attempt was made at BHRS with 10 cows and 15 heifers in very good condition. Work was completed by Alf Turner, who has had greater AI experience. The results were more pleasing, with five cows and four heifers confirmed pregnant (50% and 27%, respectively). Another five heifers appeared pregnant early at eight weeks but could not be confirmed three weeks later. There may have been early trauma and loss of foetuses, but this has not been confirmed. A fourth attempt with AI was carried out on the remaining seven crossbred heifers, 14 purebred cows and four purebred heifers. This was in early July 2006 but results of pregnancy tests will not be available until September 2006.

Data on the current herd at BHRS has been sent to the Agricultural Business Research Institute (ABRI) for analysis. The historical data will be sent to ABRI later this year after it is verified.

ABRI will use the collated current data from BHRS and Yambuck to establish a register for buffaloes in Australia.

Program: Indigenous Pastoral Development

Project: Indigenous Pastoral Program

Project Officers: S. Blyth, T. Freshwater, C. Delacoeur, P. Blore and J. Norris

Location: Between the Northern and Central Land Council regions

Objectives:

To increase cattle numbers on indigenous land.
To increase indigenous participation in the pastoral industry.

Background:

The indigenous pastoral project is a multi-agency approach to increasing participation by Aboriginal people in the pastoral industry of the NT. It was initiated by a memorandum of understanding (MOU) between the Indigenous Land Corporation (ILC), the Northern and Central Land Councils (NLC and CLC) and the then Department of Business, Industry and Resource Development (DBIRD) in February 2003. The ILC part funded four positions, two within DPIFM (former DBIRD) over a three-year period, and one each within the CLC and NLC, renewable annually over a three-year period to implement the Indigenous Pastoral Project. It was recognised that a multi-agency approach was required in order to address the many issues and factors involved with indigenous enterprise development. This included such areas as native title legislation, pastoral expertise, infrastructure funding, training and capacity building, and provision of land management and land monitoring ability. In this regard, the project has been a landmark case of cross agency cooperation and the establishment of a unified direction.

The main aims of the project are to increase cattle numbers on Aboriginal land and to increase Aboriginal participation in the pastoral workforce. The vision at the inception of the project was to assist Aboriginal landowners to implement sustainable pastoral enterprises and increase pastoral production from Aboriginal land in the NT.

The key principles that underpinned the project are that:

- The project achieves sustainable development outcomes and accommodates multiple land use aspirations, but focus on pastoralism.
- The process of planning, development and implementation of any enterprise require the approval, participation and commitment of the land owners in accordance with the requirements of the *Aboriginal Land Rights (NT) Act 1976* and where relevant the *Native Title Act 1993*.
- The preferred development model for this program fosters direct indigenous participation in the management and operation of pastoral enterprises and maximises indigenous employment and training outcomes.
- The project will focus on maximising the coordination of resources from key agencies, business and industry.
- The project will establish key performance measures and criteria aimed at maximising the delivery of benefits to landowners. Performance may include key measures such as employment, income generation, improved land and infrastructure condition and increased numbers of breeders.

The project is currently guided by a steering committee that oversees the direction of the entire project. The role of the steering committee as defined in the MOU is to:

- Set regional objectives for sustainable pastoral enterprises on Aboriginal land.
- Establish and agree on performance indicators, criteria for assessing proposals, action plans and methods for monitoring and reporting.
- Assess proposals for regional projects and prioritise and allocate resources to them.
- Oversee the implementation and monitoring of regional priority projects.
- Facilitate cooperation and collaboration among contributing agencies to help achieve successful on the ground projects.
- Provide coordinated regional reports to the Project Manager.

The program currently enjoys the support of most of the senior staff of the contributing agencies as it is recognised that the IPP provides a real on the ground solution to indigenous enterprise development.

Results:

The Department of Natural Resources, the Environment and the Arts (NRETA) estimates that indigenous land in the NT is capable of running an extra 200 000 head of cattle. Additionally, there have been estimates of pastoral industry requirements for labour in excess of 300 persons per year. In initiating the IPP, it was realised that in order to achieve long-term success, the program should not focus entirely on numbers of cattle on indigenous land, or people in jobs, as this may divert attention away from the need to establish long-term solutions. However, substantial success has been achieved to date, including:

- Signing of a new MoU by the partner organizations extending the program for another five years, to 2011. The new MoU also formally accepts the NT Cattlemen's Association and the Commonwealth Department of Employment and Workplace Relations as program partners.
- Engaging a full time Program Manager.
- Increasing the number of cattle on indigenous land by 25 000 to date.
- Increasing the number of animals by 10 000 on currently developed country.
- Establishing country to be capable of running a further 10 000 animals by 2006-07.
- Filling 18 seasonal stock camp positions by Aboriginal people at various locations.
- Utilising 25 short-term positions for Aboriginal people in fencing contracts.
- Employed 11 young Aboriginal people in the Indigenous Pastoral Apprentice Scheme.

Other achievements have included:

- Alice Springs Indigenous Pastoral Workshops – two three-day programs designed to introduce Aboriginal people interested or involved in pastoral development to agency and other staff that can assist in that development. A third workshop is planned for October 2006.
- Cooperation and resource allocation from external agencies such as DEET, NRETA, CDU and DEWR in the provision of funding for training as required.
- Provision of additional 50% funding from DBERD for a position to work exclusively on business development; and from the Natural Heritage Trust for two dedicated pastoral extension officers for two years.
- Access to indigenous communities to acquire appropriate land management skills in controlling fires, feral animals and weeds on indigenous land.

Conclusions

The program is in the first year of a new five-year cycle, and as such, the consolidation of lessons learned to date and the streamlining of program activities accordingly will generate further efficiencies in the years

ahead. As part of this progress a 12-month evaluation project will be designed and conducted in partnership with the Desert Knowledge CRC.

Commencement of two new pastoral extension positions within the program over the next 12 months is highlighting the need to undertake succession planning for all positions within the program. Staff development across all partner agencies will receive ongoing priority.

Finally, the expansion of the Indigenous Pastoral Trainee Scheme in 2006-07 will be a major program focus. IPP, NTCA, DEWR and the Land Councils will be closely involved in developing an industry based indigenous employment strategy which will aim to reduce the long-term labour shortages in the pastoral industry and assist to resolve the indigenous community's long term unemployment problems.

Currently in the fourth year, the project has contracted funding until March 2011.

Program: Technical Services

Sub-program: Livestock Exports

Project: Increasing Market Share of NT Livestock Exports

Project Officer: **D. Ffoulkes**

Location: Darwin and SE Asia

Objective:

To support the development of new and existing markets for NT pastoral and livestock export industries by providing technical assistance to importing countries.

Background:

For some years now, the NT Government has provided technical support to governments and industry sectors of importing countries, which has helped to raise the profile of the Territory's pastoral industry as a supplier of good quality cattle. The Technical Services program continues to provide assistance in the form of feasibility studies, technical advice and training in best practice management of imported cattle.

The program is focused on providing technical support to offshore cattle industry development projects seeking to import cattle from northern Australia. There are currently good prospects for establishing a new market for NT cattle in the Philippines, resuming NT livestock exports to Sabah and Malaysia, and fostering closer ties between the NT and the Indonesian government by providing technical assistance and training for livestock development programs in those countries.

Method:

The Negros Cattle Industry Development Project in the Philippines is a two-staged production system for growing out weaners and finishing them in feedlots (Ffoulkes 2002). A trial shipment of feeder cattle from the NT was undertaken to test the feedlot operation and the markets. A second shipment of young cattle will be

distributed to small holder farmers for growing out prior to finishing in small commercial feedlots. Officers from DPIFM will provide technical support and training during the implementation of the project.

In Sabah, a Memorandum of Cooperation (MoC) between DPIFM and the Department of Veterinary Services and Animal Industry (DOVSAI) concerning cattle industry development and trade was signed by respective Ministers in Darwin in February 2005. A working group of representatives from each region will develop action plans and review cooperative activities on an annual basis. Activities are generally aimed at capacity building of DVOSAI staff in tropical beef production, veterinary laboratory techniques and operational management of abattoirs.

Following a training program for staff of the Indonesian Government Directorate General Livestock Services, there were follow-up discussions at the Australian-Indonesian Working Group on Food and Agriculture Cooperation in Melbourne in March 2005 on possible future institutional strengthening programs for Indonesia's livestock program. These discussions led to the commissioning of DPIFM staff by the Commonwealth Government to undertake a study tour of the Indonesian National Artificial Insemination Centre in East Java.

Results and Discussion:

The Philippines

The results of the initial trial shipment of Brahman crossbred cattle from the NT which arrived in Negros Occidental in October 2003 have been reported (Ffoulkes 2005). In July 2005, further technical workshops were held in Bacolod (Negros Occidental) and Dumaguete (Negros Oriental) together with the launching of a handbook on *Receiving and Raising Australian Commercial Cattle* prepared by the Technical Services program. Two weeks of work experience in the NT was also provided for the manager of a provincial dairy in Negros Occidental who was appointed as operations manager of the cattle development project.

To date no further shipments of cattle have occurred related to this project in spite of pledges from proponents of the project and members of the Island Cattlemen's Association of Negros. Major constraints include a shortage of suitable young stock from Australia and high prices for export cattle. As a result, the Australian consortium has revised its financial strategy and engaged the Technical Services program to review the technical component of the plan. The consortium is now confident of procuring a shipment of NT cattle in 2006. For this reason, Technical Services will extend its offer of training in cattle handling and husbandry to Negros livestock managers at the time of the next shipment. This will be reviewed in December 2006.

Sabah

Some of the activities that were identified by the working group in 2005 were completed successfully; others were deferred or changed during the year. The evaluation of the Sabah Government livestock farms was reported in the 2004-05 Technical Annual Report.

In July 2005, three DOVSAI farm managers, together with the operations manager from the Negros cattle project, came to the Territory to take part in a two-week work experience program at Douglas Daly Research Farm and Beatrice Hill Research Farm. Among the topics covered were the TenderBuff program, herd management and management of improved pastures. The group also visited Douglas Daly pastoral properties, the Charles Darwin University Rural Campus and the Royal Darwin Show.

In November 2005, two laboratory staff from the Sabah Government Animal Disease Research Centre (ADRC) and Tawau Veterinary Laboratory spent two weeks at the Berrimah Veterinary Laboratory (BVL) for training in quality systems (QS) and diagnostics of animal diseases. The two staff also attended as observers an avian influenza simulation exercise in Darwin. Following the visit by the laboratory staff, a senior staff member from BVL travelled to Sabah to evaluate progress in the development of QS at ADRC

and to visit the Tawau laboratory. Considerable progress was found to have been made in QS towards accreditation to international standards (ISO/IEC 17025).

The working group met in February 2006 and endorsed the placement of DPIFM's Senior Meat Industry Officer as Development Manager of the Sabah Meat Technology Centre (SMTC) for six months in the current calendar year. Other actions identified for 2006 included (a) assistance with an avian influenza simulation exercise, (b) the development of training programs for SMTC, (c) evaluation the TenderBuff program, (d) a feedlot study and training program, (e) the continuation of capacity-building for managers of government farms and staff of veterinary laboratories, and (f) attendance at the Sabah International Expo and official opening of SMTC.

DOVSAI staff were able to conduct an avian influenza simulation exercise in Sabah without assistance from DPIFM, proving that attendance by staff at a similar exercise in Darwin had provided sufficient information. DPIFM's Senior Meat Industry Officer took up his position at the SMTC in May 2006 with the aim of having the abattoir operational before mid-August. A training officer was contracted by DPIFM to assist with the development of a competency-based training program for SMTC which was delivered in June 2006. The remaining activities are scheduled for the second half of the calendar year.

Sabah imported 1905 breeder cattle and 314 buffalo from the NT in 2005, and 1087 breeder cattle up to June 2006.

Indonesia

Three officers from DPIFM Pastoral Production and the Director of the NT Rural College (Charles Darwin University Rural Campus) undertook a study tour of the Indonesian National AI Centre at Singosari, East Java, the Beef Cattle Research Station at Grati, East Java, and farmer enterprises in the district of Blitar, East Java. The NT team recommended a number of projects on genetic improvement, breeding and nutrition that could have a significant impact on the productivity of the local beef industry and could be implemented as part of the Australian Government's Indonesian assistance program. A project proposal on *Building Institutional Capacity for Delivering Beef Cattle Breeding and Genetic Improvement Programs as Part of an Indonesian Government Strategy for Improving Productivity of the National Beef Herd* was presented to LiveCorp/Meat and Livestock Australia in December 2005 and was initially accepted for funding subject to discussions with the Indonesian Government. No further action has been taken regarding this proposal.

References:

Ffoulkes, D. (2002.) Visit Report: Negros Occidental Development Project. Market Development Program. DPIFM.

Ffoulkes, D (2005). Negros Occidental Cattle Development Project. In: *The 2004-05 Technical Annual Report Technical* Bulletin No.323, pp 143-144. DPIFM.

Sub-program: Higher Education and Training

Project: Joint DPIFM/CDU Beef Production Program

Project Officer: D. Ffoulkes

Location: Charles Darwin University (CDU)

Objective:

To establish CDU's School of Science and Primary Industries, in collaboration with DPIFM's Pastoral Production Division, as a leader in research and education in tropical and arid beef cattle production.

Background:

Under the spirit of the NT Government/CDU partnership agreement signed in 2003, DPIFM and CDU have agreed to work together to establish higher education and research programs at CDU's School of Science and Primary Industries. Arrangements were made for the Technical Services Program Manager to manage this program for a period of two years up to December 2005.

Method:

The joint program will focus on the following outputs:

- Development and delivery of a post-graduate unit in tropical beef production.
- Delivery of international short courses in tropical beef production.
- Development of an externally funded international project.

Results and Discussion:

An application to deliver a post-graduate unit on *An Introduction to Tropical Beef Production* for delivery in Semester 1 of 2006 as part of Tropical Environmental Management tertiary studies was approved by the University Panel in August 2005. The unit, which covered tropical production systems, sustainable rangeland management, beef operations, sustainable management of beef cattle industries in the tropics, socio-economic issues, enterprise management and best practice, attracted one student who successfully completed the course.

The joint program did not deliver any other outputs during 2005 and was not extended beyond December 2005.

RESEARCH AND DEMONSTRATION FARMS

Program: Management of Research and Demonstration Farms

Project: Research Farms

Project Officers: **Research Farm Managers and Staff**

Location: Darwin, Katherine and Alice Springs

Objective:

To facilitate profitable and sustainable primary industries in the Northern Territory through focused research, development and extension programs.

The Research Farms allow departmental staff to conduct research, development and extension (RD&E) programs under secure, managed, conditions. Berrimah Farm (BF), the Katherine Research Station (KRS) and the Arid Zone Research Institute (AZRI) in Alice Springs are regional headquarters for the Department.

The research and demonstration farms in regional areas include Beatrice Hill Farm (BHF) and the Coastal Plains Horticulture Research Farm (CPHRF), both located at Middle Point in the Darwin rural area; the Douglas Daly Research Farm (DDRF), in the Douglas Daly region, Victoria River Research Station (VRRS), in the Victoria River District (VRD), Ti Tree Research Farm (TTRF), at Ti Tree and Old Man Plains Research Station (OMPRS) at Alice Springs.

During the year the nine Primary Industries farms were consolidated under Research and Demonstration Farms.

BF

BF is the headquarters of the Department and accommodates 200 primary industry and fisheries staff. The BF complex consists of:

- The campus area which provides staff with office and laboratory accommodation, and a work base for operational service program delivery.
- Farm land and farm facilities.

Farm facilities are used for a range of RD&E projects, including hay and animal production, fruit and vegetable production and agroforestry.

Highlights for 2005-06

- Production of 190 tonnes of quality pangola hay from 17 ha, at the rate of 11 tonnes/ha. The hay will be used at BF, VRRS and OMPRS.
- A small cattle herd of sentinel animals was kept for the national arbovirus monitoring program.
- Animals were provided to the Virology Section for its maternal antibody project.
- Facilities and assistance were provided to an animal welfare project evaluating the impact of various manipulative and surgical procedures performed on the reproductive tract of female cattle in the northern beef industry.
- Stockyards were set up for the demonstration to industry of the National Livestock Identification Scheme procedures.

BHF

BHF is a 2600-hectare property located 60 km from Darwin on the Arnhem highway. The farm was established in the late 1950s and is used primarily to support buffalo research. Because BHF is adjacent to the Adelaide River, approximately 80% of it is floodplain. Very high pasture production is achieved during the dry season using ponded paddocks.

- The buffalo breeding herd project is monitoring the performance of various Riverine/Swamp buffalo crosses. Performance is evaluated for both meat and dairy production.
- The Tenderbuff project aims to provide a set of quality control measures to guarantee good quality buffalo meat for the domestic market. Animals graze flooded pasture during the dry season to ensure year round turnoff.
- An RIRDC project is in progress to improve pregnancy rates in artificially inseminated buffalo.
- A sentinel herd is run on the farm for the Virology Section. It is part of the national arbovirus program.
- Approximately 230 tonnes of hay was produced. It is mainly used at BHF and OMPRS.
- Gamba grass on two paddocks was replaced with Jarra grass. This is part of a program to eradicate gamba grass from the farm.
- Fencing of the new 100-ha block between CPRS and Middle Point Village was completed.
- The stockyards have been set up for the National Livestock Identification Scheme demonstrations.

CPHRF

CPHRF is the NT's principal horticultural research farm. It covers 140 hectares and is located at Middle Point, near Fogg Dam in the Darwin rural area. It has national significance as a site for tropical horticulture research. It is part of the national mango research program, the cocoa evaluation program and is testing the potential of new tropical horticultural crops, including Kakadu plum. Research, development and extension projects at CPHRF are valuable for the horticulture industry in the Top End.

Highlights for 2005-06

- Commercial cocoa assessment in northern Australia.
- Strategy for, and progress in, the genetic improvement of African mahogany.
- The National mango breeding program and arboretum.
- Banana tropical race 4 panama disease management.
- Improving and maintaining productivity of bamboo for shoots and quality timber.
- Collection of tropical germ-plasm of rambutan, durian, sapodilla and cupuacu in the exotic net.
- Katherine pearl millet seed was planted by Pastures in the exotic net.
- Two hundred round bales of hay were produced on a 6-ha paddock.
- The Australian Mango Industry regional meeting was held in May.
- The farm loaned out equipment to support local growers.
- DCIS conducted an occupational health and safety workplace assessment and trained staff.

DDRF

DDRF is a 3100-hectare farm located in the Douglas Daly region, 220 km southwest of Darwin. It has about 2000 hectares of improved pasture. Beef cattle production is the main focus of research. The farm conducts research on peanut and fodder production on 40 hectares of centre pivot irrigation. It also conducts trials and demonstrations on suitable dry land field crops.

The residential area at DDRF has a primary school, a social club and 35 residents. It is the hub of a growing mixed farming community.

DDRF received 1800 mm of rain in the 2005-06 wet season. The average is 1208 mm. The first substantial rainfall was on 16 October and the last was on 30 April.

Highlights for 2005-06

- Improved pasture species evaluation and the importance of legumes.
- Assessment of multibred composite cattle.
- Improvement of Brahman herd fertility.
- Assessment and improvement of heifer fertility in the NT and the importance of nutrition pre-conception.
- Short-duration grazing demonstration. Assessing the impact of short-duration-high intensity grazing on pasture composition, soil health and cattle performance.
- Irrigated peanut research and demonstration. Irrigated forage trials.
- Cavalcade hay production.
- Sesame seed production on 50 hectares.
- Hosted an industry field day for Top End producers in April.

KRS

Located on1240 hectares of land on the outskirts of Katherine, KRS is the headquarters for the Department in the Katherine region. KRS staff maintain centre pivot, lateral move and trickle irrigation systems; a dedicated horticulture research area; and improved pasture for beef cattle production. Underground water usage is monitored as part of the irrigation program. A 2000-hectare area has been agisted from the adjacent *Old Kumbidgee Station*" for maintaining 300 breeders to produce female crossbred Tuli, Belmont Red and Senepol for breeder genotype comparison projects at VRRS.

Highlights for 2005-06

- This is the last year of the 10 year Cotton CRC funded research program.
- OGTR monitoring was conducted on a monthly basis

Entomology

- The effectiveness of lablab, pigeon pea and sweet potato companion crops was tested in an IPM system.
- A late season sucking pest trial was conducted to establish sucking pest thresholds post squaring in cotton.
- A companion requirements trial was conducted to assess which crops produce enough Helicoverpa moths to aid in resistance management.
- Pheromone trap monitoring was conducted to monitor local populations of Helicoverpa armigera, Helicoverpa punctigera, pink bollworm and Spodoptera litura.

Sesame

- Breeding trials were conducted of new cultivars and seed quality of different varieties was assessing.
- Entomology studies were conducted in sesame.
- Breeder seed multiplication studies were conducted.
- Sweet sesame breeding trials were conducted.
- Staff selected a sweet Giles line for the local and Japanese market. Forty selections were evaluated this year.

Bio-fuels

- Investigations are continuing in dry season irrigated crops that have potential for bio diesel or ethanol production. Crops include sunflower, safflower, soybeans, canola, mustard, cassava and African oil palm.

Biological farming system

- Staff collected baseline soil health and insect populations/dynamics data for sorghum, millet, lablab, sesame, sunflower, sabi pasture, mangoes and melons.

Livestock production

- Studies were conducted on mature weight and productivity of Belmont Red and Tuli crossbred cattle.
- A sentinel cattle herd is run on the farm for virology work with the National Arbovirus Monitoring Program.
- Observations were conducted on the relative mature size of young Charolais x Brahman and Brahman cattle in a feedlot.

Hay production

- The farm produced 125 tonnes of grass hay, 87 tonnes of Cavalcade hay and 10 tonnes of forage super Dan hay.

African mahogany clone test

- A 1 hectare mahogany orchard was established to benchmark clones to identify trees with straight stems and minimum branching. Trees that meet the criteria will be selected for commercial propagation.

The annual Farm and Garden Day was held in April. About 1900 people attended.

TTRF

TTRF is on the Stuart Highway about 190 km north of Alice Springs, in the 200-hectare Ti Tree farms area which consists of eight properties of various sizes. It is 8 hectares in size. It is mainly used for horticulture trials, grower meetings and for training in indigenous economic development.

Highlights for 2005-06

- *Citrus trial*
  Evaluation is continuing on lemon, orange and mandarin scion/rootstock combinations. The trial is in its fifth year and will continue for at least another three years. The plantings will also be used for training purposes. Little data was collected this season due to the presence of Queensland fruit flies (QFF). As part of the eradication program, all the fruit was harvested while immature.

- *Eradication of QFF*
  QFF were first detected in early March. As the Ti Tree farms region has had a QFF-free area status, all effort has been made to eradicate the pest. All host fruits were stripped, buried and cover sprayed. Malathion and protein baits are still applied on a weekly basis around the farms area and extra lures have been put in place to monitor the progress of eradication. No QFF have been detected in the Ti Tree farms area since 18/07/06, which is an indication of successful eradication.

- *Indigenous economic development*
  TTRF is increasingly involved in horticultural training of local indigenous people. We currently have one full-time and one part-time school based horticulture apprentices under training, with another full-time apprentice joining in the near future. Vegetables, mangoes, grapes and bush tucker will be planted by the apprentices as part of their training. We also have up to eight work-for-the-dole indigenous workers three half days a week for training in basic horticulture.

- *Fencing boundary of TTRF*
  We are currently in the midst of fencing off the perimeter of TTRF with kangaroo and cattle-proof ring-lock fencing. This is being done with the assistance of the apprentices and the work-for-the-dole crew to protect plantings at the research farm and to provide training to workers. As a lot of damage was inflicted last season by kangaroos, it was necessary to fence the area to prevent this from occurring again.

Other projects are planned for the 2006-07 season, such as establishing a one-hectare best practice grapes block and extending the current asparagus and bush tucker block.

VRRS (Kidman Springs)

VRRS is located in the VRD and is about 314 km² in area. VRRS is a cattle breeding farm. Most progeny are sent to DDRF following weaning. Currently VRRS has 900 breeders.

Highlights for 2005-06

- Native pasture management
  - The use of fire in the VRD to control woody vegetation
- Grazing management
  - Pasture sustainability
- Herd management
  - Improved breeder herd profitability
  - NIRS sampling
  - Strategic bull removal
  - Understanding and improving heifer fertility
- Future markets
  - Breeding herd efficiency of adult Charolais x Brahman
  - Multi breed crossbreeds
- Virology
  - Sentinel herd monitoring - NAMP sampling

A producer field day was held at the Station in August 2006.

A new computer communication system (WAN) was installed and should be connected in 12 months.

Solar pumps have been installed on Rosewood and Conkerberry dams to improve efficiency.

AZRI and OMPRS, Alice Springs

AZRI is located 10 km south of Alice Springs and OMPRS is another 10 km south on the Stuart Highway. The total area of these research stations is 557.5 km². They are used as demonstration sites and for research and training. The stations help the pastoral industry in the arid areas with sound guidelines for long-term viability and preservation of the rangeland ecosystem. Research, planning and development programs are conducted in consultation with industry.

Highlights for 2005-06

- Grazing systems partnership with the Desert Knowledge CRC in a four-paddock rotation trial.
- Collaboration in the GRASP pasture growth model.
- Fire period analysis.
- Water smart pastoral production trial plan (a combination of best technologies in stock water storage and delivery on pastoral properties.
- Maintenance of sentinel animals for virology and NAMP.
- Developed a breeding program for the drought master herd involving artificial insemination and controlled breeding.
- Improved management of weaners.

Best practice demonstrations

- Monitoring wildlife that affects pastoralism to develop and demonstrate the benefits of strategic management (dingo control).
- Active demonstration of the benefits of forage budgeting and rotational rest grazing.
- Firebreak maintenance using plough technology.
- Infrastructure development (location and construction of roads, fence lines and pipelines).
- Rehabilitation of degraded land (fence line and pipeline location and construction).
- Fencing to land type for better grazing land management.
- Water development for stock distribution purposes.
- Genetic herd improvement by using estimated breeding values.

Maintenance and development

- About 20 km of internal fencing was erected at OMPRS for a grazing trial.

Project: DDRF Weather Recording

Project Officers: P. Shotton, T. McComish, and the Bureau of Meteorology

Location: DDRF

Objective:

To record daily weather information from the DDRF manual and automatic weather stations.

Background:

Weather plays a vital role in farm productivity. Weather records are therefore vital for research trials on research stations.

Method:

Manual meteorological observations include evaporation, wind run, minimum and maximum temperatures and rainfall.

The automatic weather station records wind run; wind speed, gusts and direction; wet and dry bulb temperatures for humidity and dew point; minimum and maximum temperatures; rainfall amount and intensity and barometer pressure.

Results:

All past DDRF weather information is available from the Bureau of Meteorology. Tables 1 and 2 show the historical monthly weather data and data for 2005 for Douglas River, respectively.

Table 1. Douglas River historical weather data

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean daily maximum temp (ºC)	33.9	32.7	33.9	34.9	33.1	31.5	31.7	33.6	36.5	37	36.9	34.9
Highest daily max temp (ºC)	39.2	37.1	37.6	38.5	38.4	36.6	36.6	38.7	40.6	42.6	41.5	40.7
Mean daily minimum temperature (ºC)	23.9	23.9	22.9	20.8	16.9	13.9	13	15.1	19.1	22.4	23.4	23.8
Lowest daily min temp (ºC)	19.5	19.5	11.6	10	5.5	4	2	2.5	4.5	11.5	14.2	16.4
Mean 9 a.m. air temp (ºC)	27.6	26.9	27.2	26.8	24.1	21.4	20.7	23	26.9	28.8	29.2	28.5
Mean 9 a.m. relative humidity (%)	83	87	83	73	61	56	57	59	64	67	71	78
Mean 3 pm relative humidity (%)	62	68	56	41	34	29	29	26	25	34	41	56
Mean monthly rainfall (mm)	275.4	292.8	226.1	41.5	8.4	3	3.4	0.8	4.6	38.7	114.7	198.7
Mean no. of rain days	17.7	18.4	15.1	4.7	1.2	0.2	0.3	0.2	0.9	4.2	9.9	13.7
Highest monthly rainfall (mm)	786.6	572	636.4	229	96.8	86.8	47.7	8.4	37.6	124.8	241.6	515.6
Lowest monthly rainfall (mm)	106.3	77.4	63.4	0	0	0	0	0	0	0	30.4	30
Highest recorded daily rainfall (mm)	194.6	206.4	155	73	52.8	40.1	41.8	8.4	37.2	93.5	98	113
Highest recorded wind gust (km/h)	59.4	59.4	64.8	51.8	53.6	51.8	50	50	50	48.2	66.6	70.2
Mean daily evaporation (mm)	5.6	5.2	5.3	6	6.4	6.2	6.4	7.2	7.7	7.6	6.8	6.1

Table 2. Douglas River weather data for 2005

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean daily max temp (ºC)	33.8	34.3	34.4	35.6	33.8	27.1		33.3	37.2	37.7	35.2	29.6
Highest temperature (ºC)	36.7	37.2	37	36.9	36.5	34.9	32.7	35.5	39.0	40.7	36.9	36.7
Mean daily min temp (ºC)	23.8	23.6	23.6	20.5	15.5	15.5	15.1	15.1	21.0	23.8	23.8	23.8
Lowest temperature (ºC)	19.7	21.4	20.2	167.3	9.7	7.8	5.0	7.6	15.5	19.9	21.2	20.5
Mean daily pan evaporation (mm)	4.0	5.7	4.8	5.7	6.3	5.4	6.9	7.2	6.9	5.6	5.5	6.0
Monthly rainfall (mm)	484	170	153	4.2	0	0	0	0	0.4	115	240.0	230
Rain days	19	14	11	1	0	0	0	0	1	8	18	14

DIAGNOSTIC SERVICES

Program: Agricultural Chemistry

Project: Plant Analysis

Project Officers: G. Patch and S. Willoughby

Location: Darwin (Berrimah Farm)

Objective:

To provide a quality-focused analytical chemistry and information service to meet the needs of primary industry, government agencies and the private sector.

Background:

The Plant Analysis Section conducts analyses of inorganic nutrients and trace elements in plant tissue for primary industry and research programs. In particular, the Section conducts plant tissue and petiole sap testing for Horticulture and pasture sample testing for Agriculture. The laboratory is able to test other miscellaneous samples such as animal feeds, fertiliser, gypsum, animal tissue and soil.

Results:

In 2005-06, 1067 samples were received for testing.

The laboratory provides a petiole (leaf stem) sap testing service to horticulture growers to monitor plant health and maturity and to manage nutrient levels, especially nitrate and potassium. The laboratory analysed 143 samples of cucurbit (primarily melon and cucumber), tomato, eggplant, taro and snake bean sap with a same day turnaround. The analyses on taro and snake beans for DPIFM Horticulture were carried out at the same time with leaf analyses to establish the value of sap testing for these crops and to benchmark interpretation levels.

Horticulture tissue samples, primarily mango leaves, together with other fruit and vegetable samples were tested to ensure optimum growing conditions were maintained for the crops.

Testing was provided for the following DPIFM Horticulture and Agriculture projects:

- Douglas Daly irrigation fodder.
- The Douglas Daly species grazing trial.
- The agro-forestry mahogany research program.
- The Katherine PCA cotton program.
- The Barkly Tableland pasture and burning program.
- Horticulture mango salt tolerant rootstock.
- Citrus leaf testing for nitrogen for comparison with SPAD chlorophyll values.
- Ti Tree vineyard grape petiole testing.

Quality assurance was a high priority with regular proficiency testing by the Australasian Soil and Plant Analysis Council.

Among miscellaneous tests were environmental testing of soil for copper, chrome and arsenic to determine the extent of contamination at a timber treatment site for the Department of Natural Resources, Environment and the Arts, and aqueous extracts for Charles Darwin University for sulphur.

Project: Pesticide Analysis

Project Officers: G. Patch and M. Picton

Location: Darwin (Berrimah Farm)

Objective:

To provide a quality- focused analytical chemistry and information service to meet the needs of primary industry, government agencies and the private sector.

Background:

The Pesticide Analysis Section conducts analyses of pesticide residues in produce, soil, water, plant and animal tissue, cattle dips, post-harvest insecticidal dips and concentrates for quarantine certification. The laboratory is able to test for other miscellaneous organic residues such as herbicides and hydrocarbons.

Results:

In 2005-06, 578 samples were received for testing.

Residue testing of produce was important for the horticulture industry to ensure clean produce and market access. Tests were conducted on 50 mango samples and 23 samples of other fruit and vegetables to meet MRL standards. Most of this work was for grower quality assurance, in particular the Freshcare program for supplying supermarkets.

The recent purchase of a gas chromatograph/mass spectrometer has increased our residue testing capabilities for multiple classes of chemicals and confirmation of chemical identity. Attempts will continue to increase the range of residue tests we can offer.

Testing of acaricide cattle dips continued to ensure correct strength is maintained to control ticks and to allow cattle movement. In 2005-06, 106 samples were tested together with a number of fee-for-service samples from Western Australia.

Testing of post-harvest insecticide dip concentrations was again primarily focused on the quarantine ICA certification program for mangoes. To ensure compliance, 96 dip or spray analyses were conducted for the insecticides dimethoate and fenthion. Some tests were for the fungicide prochloraz. In addition, 54 product dimethoate or fenthion concentrations were tested for the ICA program.

The laboratory provided analyses for the herbicide 2,4-D to the NRETA to control the weed Cabomba in Darwin River. Tests were conducted on 91 samples with same or next day turnaround to monitor herbicide levels at the point of application and residual environmental levels.

Testing for DPIFM Agriculture included soil samples for the cotton deep drainage program and residual herbicide testing in soil. Other miscellaneous tests included diagnostic contamination tests in water and soil for levels of pesticides and hydrocarbons.

Program: Berrimah Veterinary Laboratories (BVL)

Objective:

To provide a quality-assured veterinary laboratory service.

BVL provides an ongoing diagnostic service in the broad fields of veterinary pathology and veterinary virology. BVL also conducts research projects and participates in quality assurance programs to ensure the quality of tests it conducts meets national and international standards.

BVL is accredited by the national association of testing authorities for testing in veterinary anatomical pathology (necropsy, histopathology and cytology), microbiology (bacteriology, mycology and virology), parasitology and serology of infection.

In 2005-06, 1676 submissions were received and processed at BVL. Each submission may consist of one or more specimens and each specimen may undergo one or more tests in one or more of the 12 Sections of BVL.

The 1676 submissions consisted of 21 906 specimens and generated 41 244 individual tests in gross and microscopic pathology, bacteriology, clinical pathology, parasitology, serology and virology. The number of tests and investigation reasons are provided below:

Number of tests	Investigation reason
6063	Diagnosis of disease in production animals, including aquaculture species
29	Monitoring for bovine tuberculosis
3327	Export and movement certification
2758	Diagnosis of disease on a fee-for-service basis for companion and performance animals, aviary birds and native fauna
19 933	Monitoring of sentinel herds and flocks for exotic and endemic diseases
3081	Research programs
5652	Surveillance programs
2	Regulatory
399	Quality assurance

BVL participates in 22 laboratory tests in the Australian national quality assurance program for inter-laboratory veterinary proficiency testing. BVL also participates in quality assurance programs in bacteriology, haematology, parasitology and anatomical pathology.

Table 1. Laboratory submissions by region and by species

Species	Darwin	Katherine	Tennant Creek	Alice Springs	Interstate/ Overseas	Total
Amphibian	11					11
Banteng						
Bat	23	1			0/1	25
Bee	2	1				3
Bird (cage & wild)	50	9				59
Buffalo	16	1				17
Camel				1		1
Cat	32	4				36
Cattle	152	113	17	17	7/0	306
Crab	39				2/0	41
Crocodile	55					55
Deer						
Dog	301	19			2/0	322
Dolphin						
Donkey						
Echinoderm						
Fish	81		1	1		83
Goat	9	17				26
Horse	61	18	5	1	1/0	86
Human	2				12/0	14
Insect	80	22	9	9		120
Mouse	1					1
Native fauna	38	1				39
Pearl oyster	36				4/0	40
Pig	49				2/0	51
Poultry	73	21	11	25	2/0	132
Prawn	20			2	78/0	100
Rabbit	1					1
Rat	11					11
Sheep	4				4/0	8
Turtle	28	1				29
Other/not applicable	35	1	2		15/0	53
Total	1210	229	45	56	130/0	*1670

* This figure is based on date collected

Table 2. Type and number of laboratory submissions

Diagnostic	353
TFAP**	20
Export	7
Movement	7
Regulatory	3
Sentinel	270
Research	201
Survey	225
Fee-for-service***	548
Quality Assurance	42
Total	****1676

** TFAP: tuberculosis freedom assurance program
*** Companion and performance animals, aviary birds and native fauna
**** This figure is based on date received at BVL

Sub-program: Diagnostic Pathology

Project: Diagnostic Pathology

Project Officers: **A. Janmaat, J. Humphrey, C. Shilton, L. Melville, S. Benedict, L. Small, R. Wilson, L. Chambers, S. Aumann, C. Burnup, N. Cox, C. Day, and M. Gayoso.**

Location: BVL

Objective:

To provide a quality-assured veterinary pathology service to support diagnostic, regulatory and research programs in livestock health and production.

The Sub-program is divided into the Sections of gross pathology, histopathology, cytology, bacteriology, parasitology, serology, clinical chemistry, haematology and urinalysis. The last three sections fall under clinical pathology.

Gross pathology

Submissions 245

The Section conducts post-mortem examinations of cadavers and gross examination of pieces of organs and tissues from a large range of species. The majority of submissions were from terrestrial production animals and aquaculture species. The others were from aviary birds, native fauna and companion animals.

- Histopathological examination of barramundi *Lates calcarifer* was conducted to reach a provisional diagnosis of streptococcosis, which causes high mortalities. The diagnosis was confirmed by bacteriological isolation of the causative organism, *Streptococcus iniae*. A program of preventative vaccination was implemented.
- Histopathological examination of barramundi identified a blood parasite, *Trypanosoma* sp. as a major cause of mortalities. The parasite was further characterised by parasitological examination.
- Histopathological examination of barramundi suffering high mortalities showed severe multi-organ necrosis associated with a virulent strain of the bacterium *Vibrio harveyi.* The identity of the organism was confirmed by bacterial isolation and examination.
- The marine bacterium *Tenacibaculum* sp. was confirmed histologically as the cause of skin lesions and low-grade ongoing mortalities in juvenile barramundi. This disease is commonly associated with low water temperatures. The identity of the organism was confirmed by bacterial isolation.
- Necrotising fasciitis in farmed crocodiles was found to be caused by *Streptococcus agalactiae.*
- Piglets born with microphthalmia had possible intrauterine vitamin A deficiency.
- Urea poisoning was diagnosed in a calf at Berrimah.
- Upper respiratory tract infections in eight-week-old turkeys were shown to be caused by *Bordetella avium.* Avian influenza was excluded.

Histopathology

Submissions 601

The number of submissions under the tuberculosis freedom assurance program as lesions from field reactors or as lesions collected at abattoirs under the national granuloma submission program remains very low at four. The brains of 22 cattle were examined as an ongoing NT contribution to the national

transmissible spongiform encephalopathy surveillance freedom assurance program. This program is designed to demonstrate freedom from BSE and scrapie, and to provide early detection should these diseases occur.

- All submissions for tuberculosis and TSE were free from histological evidence of the respective diseases.
- Histopathological examination of pearl oysters *Pinctada maxima* continued to be of value to the industry as it excluded major infectious causes of disease and assisted in identifying likely causes of losses. Pre-translocation histopathological examination of pearl oysters continues to be a major aspect of maintaining the health of translocated stocks.
- Histopathological examination of barramundi fingerlings, in combination with PCR assays, is used routinely to certify the fish free of nodavirus, a notifiable disease which caused high losses in juvenile barramundi.

The Histology Section participates in the histology proficiency testing program of the Australian Animal Pathology Standards Program.

Cytology

Submissions 76

Bacteriology

Submissions 478

- *Streptococcus iniae* was isolated from diseased fish which were previously vaccinated with a streptococcus vaccine. In collaboration with the Centre for Marine Studies at the University of Queensland it was identified that the organism used for vaccine production and the isolate recovered from vaccinated fish belonged to different serotypes.
- A group B streptococcus (*Streptococcus agalactiae*) was isolated from the skin, muscle, liver and spleen of captive juvenile crocodiles. A further investigation on genotypic characterisation and possible origin of this bacterium was carried out in association with the Menzies School of Health Research.
- The Bacteriology Section is currently involved in an investigation with the Centre for Disease Control on a possible environmental source of salmonella infection in children under five. The isolation and identification of salmonella is done at BVL.

For QA purposes, the Section participates in the IFM proficiency testing program for veterinary microbiology. The three Leptospira MATs and culture of *Mycobacterium bovis* (the cause of bovine tuberculosis) are part of ANQAP proficiency testing.

Parasitology

Submissions 179

- Mortalities in farmed barramundi in 2005 were attributed to the presence of a protozoan parasite identified as *Trypanosoma* sp. This parasite had not been previously detected in fish from the NT waters and little was known about its life cycle. Preliminary trials were conducted on transmission routes for this pathogen and the possible involvement of the gill copepod, *Lernanthropus* sp.
- Among the more unusual parasites to be reported was *Demodex bovis* from cows with lumpy skin conditions. This type of mange is more commonly seen in southern States. Investigations continued into the problem of anthelmintic resistance in goats.
- *Toxocara pteropodis*, a round worm, was found in the intestine of juvenile bats.
- Coccidiosis in weaner cattle was caused by *Eimeria zuernii*

The Section participates in a faecal egg count proficiency testing program run by Agriculture WA.

Serology

Submissions 160

Eight tests conducted in the Section were part of ANQAP proficiency testing.

Clinical pathology

Clinical chemistry

Submissions 95

Haematology

Submissions 108

- 'Runts' were investigated in juvenile crocodiles.
- Blood parameters in farmed turtles were examined.

The Section participates in the Royal College of Pathologists of Australia haematology quality assurance program.

Urinalysis

Submissions 38

Sub-program: Virology

Project: Diagnostic Virology

Project Officers: L. Melville, N. Hunt, R. Weir, M. Harmsen, S. Walsh, S. Davis and D. Flanagan

Location: A.L. Rose Virology Laboratory, Berrimah Farm

Objective:

To provide an accurate, efficient and reliable veterinary virology service to support diagnostic, regulatory and research programs in livestock health and production.

Background:

The diagnostic virology service comprises virus isolation and identification and serology. An increasing number of virus detection tests based on polymerase chain reaction (PCR) have been introduced to supplement conventional isolation techniques.

Results:

During the year 69 submissions were received for diagnostic virus isolation, electron microscopy or PCR. A further 110 submissions were received for survey purposes and 14 from research projects. Bovine

ephemeral fever (BEF) virus was detected by PCR and isolated from cattle. A bunyavirus was isolated from three sick horses in the Tennant Creek region. This virus was previously isolated from sentinel cattle at Beatrice Hill Farm.

During the year, 130 submissions were received for diagnostic serology, including five for export testing. A further 44 submissions were received from NAQS and other surveys, and 37 from research projects.

A significant number of samples associated with aquatic animals were received during the year including 171 fish samples for nodavirus PCR, 68 prawns and nine crabs for GAV PCR, 2497 prawns and 28 crabs for white spot PCR.

Export testing consisted of 1072 cattle sera for enzootic bovine leucosis (EBL), 16 horse sera for equine infectious anaemia (EIA) and 12 horse sera for Hendra virus.

The Australian National Quality Assurance Program provided quality assurance tests for agar gel imunodiffusion tests for EBL, BVD, EIA, BEF, epizootic haemorrhagic disease, bluetongue and Aino. Virus neutralisation tests were performed for IBR, bluetongue, BEF, Akabane and Aino. Haemagglutation inhibition tests were performed for Newcastle disease virus.

During the year, 18 736 serological tests were performed.

Project: The National Arbovirus Monitoring Program (NAMP)

Project Officers: **L. Melville, N. Hunt, M. Harmsen, R. Weir, S. Walsh, D. Flanagan, G. Bellis and S. Davis**

Location: BHF, BARC, DDRF, KRS, VRRS, AZRI, Mt Sanford, Alexandria Downs, Killarney, Inverway

Objectives:

To support trade by providing information to meet Australian Quarantine and Inspection Service (AQIS) requirements for export protocol negotiations and certification.
To provide bluetongue early warning by the dynamic surveillance of the northern bluetongue endemic area to detect new viruses or vectors entering Australia and monitoring their southern spread.
To control important insect-borne endemic disease by monitoring for endemic virus activity and the insect vectors which transmit these viruses.

Background:

NAMP is an integrated national program jointly funded by industry and governments to monitor the spread of economically important insect borne viruses of livestock and their insect vectors.

Method:

Monitoring is achieved by using sentinel herds at various sites around the NT, which are bled at regular intervals and tested for antibodies against a number of viruses. At BHF, blood is collected weekly and viruses are isolated. Insects are also collected monthly from light traps at each site.

Results:

1. Sentinel herd serology and virus isolation

Beatrice Hill Farm

A total of 270 viruses were isolated from the following groups:

Bluetongue	type 1	July - April	34
Bluetongue	type 20	April - May	5
Bluetongue group		April - June	31
Palyam	CSIRO Village	Sept - Dec	5
Palyam group		Oct - Feb	8
Simbu group		August, Mar	2
BEF		August - Dec	13
EHD	type 5	Oct - Dec	26
EHD group		August - Feb	6
Ungrouped			140

Berrimah

Monthly serology indicated the following activity:

Bluetongue	January - February, May - June
Akabane	May
BEF	May
Palyam	April
EHD	May - June

Six bluetongue type 1, 2 EHD and 1 CSIRO village isolates were made.

DDRF

Monthly serology indicated the following activity:

Bluetongue	January - May
Akabane	August – September, January - May
BEF	October - March
EHD	March - May
Palyam	November – January

Five bluetongue type 1, 4 EHD and 1 unidentified isolates were made.

KRS

Monthly serology indicated the following activity:

Akabane	January - April
BEF	November - May
Bluetongue	November - May
EHD	April - May
Palyam	January - May

Five bluetongue type1, 3 EHD and one unidentified isolate were made.

VRRS
Monthly serology indicated the following activity:

Akabane	January
Bluetongue	June
BEF	January - February
Palyam	May

Killarney
Akabane, bluetongue, BEF and Palyam positive serology was identified in May.

Mt Sanford
Akabane, BEF and Palyam positive serology was identified in May.

Inverway
No arbovirus activity was detected.

Alexandria Downs
Bluetongue, BEF and Palyam positive serology was identified in May.

AZRI
Serology indicated BEF activity in April.

2. Entomology

Trapping with the green LED light traps showed the distribution, seasonality and numbers of *C. brevitarsis, C. actoni*, *C. fulvus* and *C. wadai* were all elevated compared with the 2004-05 season. As usual, *C. brevitarsis* was by far the most widespread species being detected as far south as the Barkley Tableland. *C. actoni* was the next most widespread reaching the Victoria River District and Katherine while *C. fulvus* was only found as far south as Katherine. *C. wadai* was only detected in the three most northerly sites and only in very low numbers.

Both *C. brevitarsis* and *C. actoni* were found in low numbers at Hudson Creek, the Darwin Port monitoring site.

Project: Monitoring for Murray Valley Encephalitis (MVE) and Kunjin Viruses for Medical Entomology

Project Officers: L. Melville, N. Hunt, S. Davis, S. Aumann and N. Cox

Location: Darwin, Katherine, Tennant Creek, Alice Springs, Gove, Jabiru, Alyangula, Nathan River

Objective:

To detect flavivirus (MVE and Kunjin) activity through poultry sentinel flocks which are bled monthly and tested for antibodies to these viruses.

Background:

Sentinel chickens are used to monitor flavivirus activity in Australia. Currently 31 flocks are maintained in the north of Western Australia, 11 in the Northern Territory, seven in New South Wales and 10 in Victoria. The

aim is to provide early warning for the potentially fatal disease in humans caused by the viruses MVE and Kunjin.

Results:

Sentinel flocks were located at Leanyer, Howard Springs, Beatrice Hill Farm, Katherine, Tennant Creek, Alice Springs, Ilparpa swamp, Gove, Jabiru, Alyangula and Nathan River. Seroconversions to MVE were widespread, occurring at Howard Springs in June, Leanyer in May, Katherine in May and June, Jabiru in May, Tennant Creek in March, Nathan River in June and Beatrice Hill in March and June.

Seroconversions to Kunjin were also widespread, occurring at Leanyer in April, Howard Springs in May and June, Beatrice Hill in May and June, Tennant Creek in April and May and Gove in December.

Project: Improving Bluetongue Virus Surveillance in Remote Areas

Project Officers: L. Melville, N. Hunt, G. Bellis, S. Walsh and M. Harmsen

Location: Beatrice Hill Farm, A. L. Rose Virology Laboratory, Berrimah Farm

Objectives:

To develop the bluetongue virus (BTV) polymerase chain reaction (PCR) on Culicoides spp. fixed in ethanol and other collecting fluids.
To standardise and optimise pool sizes and extraction methods.
To investigate the effects of long term storage in ethanol on detection rates of BTV and the probability of false positives from retention of viral RNA in refractory insects following ingestion of a viraemic blood meal.
To assess possible use of the technique for surveillance in remote areas by testing alcohol fixed insects collected at sentinel sites where bluetongue activity was confirmed by virus isolation or serology.

Background:

The national arbovirus monitoring program (NAMP) carries out national surveillance of economically important insect-borne viruses of livestock and their vectors. The surveillance is carried out by serological testing of sentinel herds of cattle. Vector trapping and identification occurs at similar locations and time periods.

In remote locations it can be very difficult to monitor sentinel cattle and alternative methods of surveillance are required for such areas. The development of molecular techniques, in particular PCR, has provided a possible method by which surveillance for incursion of new serotypes/genotypes into the zone of possible BTV transmission may be carried out.

Method:

The development of BTV PCR in insects

Insects were caught by aspiration from cattle at Beatrice Hill Farm (BHF) and transported to Berrimah where they were sorted. Nulliparous non-blood-fed *C. peregrinus* and *C. marksi* were held in an incubator for 24 hours at 26^{o}C and 85% relative humidity (RH), with access to 10% sucrose as a food source. Insects surviving after 24 hours were inoculated with BLU1 of known titre. Following inoculation insects were held for

3 – 11 days at 26^{o}C and 85% RH to allow viral replication. Inoculated insects were stored at 4^{o} C or in 70% ethanol.

Alcohol fixed infected insects were added to fixed nulliparous unfed and uninoculated *C. peregrinus* and *C. marksi*, at ratios of 1:5, 1:10, 1:20 and 1:50. Five replicates were made of each pool. Pools were tested by PCR to determine the sensitivity of the procedure.

To investigate retention of viral RNA *C. actoni* and *C. marksi* were collected by aspiration from cattle at BHF and allowed to feed on a viraemic calf. The midges were then held for varying time periods before testing by PCR.

Assessment of BTV PCR as a monitoring tool in endemic areas

Parous and gravid *C. actoni* and *C. brevitarsis* collected from BHF from 2003 – 2005 were tested by PCR. The results were compared with BTV activity obtained at the same time from NAMP sentinel herd data at the same site.

Results:

The very dry seasonal conditions in January – March 2005 reduced insect numbers, resulting in a delay of three months in achieving sufficient inoculated insects to commence PCR testing. Testing of single alcohol-fixed and fresh insects in varying pool sizes showed the technique was very sensitive with 19/20 pools positive for BTV. Storage of alcohol fixed insects for up to six months did not affect the detection of the virus. Testing of insects fixed in chlorhexidine was less sensitive with 5/12 pools positive. No false positives were found when 605 male and nulliparous midges were tested including the following species: *C. brevitarsis, C. austropalpalis, C. actoni, C. fulvus, C. peregrinus, C. orientalis, C. nudipalpis, C. oxystoma, C. marksi, C. wadai, and C. ornatis*.

The virus was not detected in residual blood meals from viraemic cattle.

Testing pools of field-collected *C. actoni* and *C. brevitarsis* stored in alcohol found nine positive. These were all collected around the time BTV activity was seen in the sentinel cattle. The technique was found to be suitable for BTV surveillance in remote and offshore locations where sentinel cattle cannot be maintained. It is also useful for screening potential vectors and assessing their relative importance.

Project: Evaluation of Rapid Molecular Detection and Characterisation Systems for Surveillance of Arboviruses Circulating in Northern Australia

Project Officers: L. Melville, R. Weir and S. Walsh

Location: A. L. Rose Virology Laboratory, Berrimah Farm

Objectives:

To develop and evaluate mircroarrays for the rapid identification – serotyping and topotyping – of arboviruses isolated by Berrimah Veterinary Laboratories (BVL) as part of NAMP.
To use global virus characterisation arrays and polymerase chain reaction (PCR)-select suppressive subtractive hybridization for the rapid and full characterisation of a selection of existing and new isolates that remain uncharacterised by conventional approaches.

Background:

BVL is the main laboratory in the NT that monitors arbovirus activity. Surveillance is undertaken by virus isolation and serological testing. The viruses isolated in the program, which can be several hundreds per year, are characterized by classical virological techniques of cell culture, electron microscopy and sero-typing. There is a critical need to increase the speed with which viruses isolated by NAMP and from clinical disease in livestock and wildlife are characterized. It is equally important to fully characterize viruses which remain unidentified by currently available classical virology techniques.

Method:

1. Design and print serotyping/topotyping array for characterisation of viruses circulating in northern Australia (2005).

2. Evaluate arrays with known viruses and evaluate arrays for use in the rapid characterisation of isolates made in ongoing NAMP surveillance at BVL (2006).

3. Add newly characterised viruses to the array, and evaluate for ongoing application to surveillance programs (2007).

4. Test ~ 20 unknown isolates on the global virus characterisation array and preliminary PCR-select suppressive subtractive hybridization on ~ 20 unknown viruses (2005).

5. Select a sample of unknowns for full genome sequencing. Retrospectively screen previous years' isolates by PCR to identify further unknown viruses (2006).

6. Complete sequencing of unknown viruses and use for threat assessment and inclusion on modified arrays for routing use. PCR-select of any isolates identified in year 2 by retrospective PCR as being unique (2007).

Results:

The design and printing of serotyping/topotyping array for characterisation of viruses circulating in northern Australia

The first iteration of arrays for use in this project has been completed in collaboration with Columbia University. The oligonucleotides for the arrays have been purchased and the first batch of arrays has been

printed. Dr. Philippa Jack from AAHL visited Columbia University in July 2005 when the arrays were tested for hybridisation with one agent. The results were very encouraging.

Testing of ~ 20 unknown isolates on the global virus characterisation array

BVL has prepared RNA and cDNA from 15 novel agents. This material was shipped to Columbia University where 10 unknowns were tested on the global array. One has provided unequivocal identification – a Sinbis related virus isolated in Western Australia which had remained unidentified by BVL. Several other isolates have been tested without success on the global viral array. Recent retesting on a new array encompassing all viruses, bacteria, fungi and parasites has identified the presence of mycoplasma species in the tissue culture samples. So far the testing has not proven as fruitful as we had hoped. This can be attributed to the genetic distance that exists between novel Australian virus isolates and the genetic sequences available in the databases suitable for the design of oligonucleotides for inclusion on the array. As new genome sequences become available, additional viruses can be added to the array.

Suppressive subtraction hybridization on ~20 unknowns

The PCR Select technology has been successfully transferred to BVL. Approximately 60% of final genome sequence of a novel bunyavirus was completed by March 2006. The objective is to complete the genome sequence in the coming months so that this virus can be compared with related viruses described elsewhere. In addition, substantial nucleotide sequences from two novel orbiviruses and a novel Rhabdovirus have been obtained.

Program: Entomology

Project: Entomology Extension and Identification Services

Project Officers: **D. Chin, H. Brown, B. M. Thistleton, M. Neal, H. Wallace, G. R. Brown and L. Zhang**

Location: Territory wide

Objective:

To provide accurate advice on the identification and control of agricultural, horticultural and domestic arthropods to primary producers, government personnel, pest control operators and the general public.

Background:

The Entomology Section provides an advisory service on entomological matters pertaining to agricultural, horticultural or domestic situations. Extension enquiries/activities include phone calls from clients for identification and advice on the control of insects, visits to growers, examination of specimens delivered to DPIFM, presentations at industry organisations, schools, the university, departmental field days, rural, horticultural and agricultural shows. Details of the enquiries and the recommendations provided are recorded on a database. Such information may be used to plan future research and to allocate resources.

Results:

During the year, the Section received 749 enquiries. The proportion of enquiries received from each client category and the proportional difference compared with 2004-05 are shown in Table 1.

Table 1. Enquiries received from each client category

Enquiry source	2005-2006 Number	2005-2006 %	2004-2005 %
Government	155	21	22
Household	292	39	24
Growers	216	29	41
Other	69	9	10
PCO	17	2	3
Total	**749**	**100**	**100**

The number of household enquiries increased compared to 2004-2005 due to the introduction of the spiralling white fly to the Darwin area.

Grower enquiries

- Eggplant flowers submitted by a grower were infested with broad mites, *Polyphagotarsonemus latus* (Banks) (Acarina: Tarsonemidae), *Thrips palmi* (Karny (Thysanoptera: Thripidae) and *Frankliniella* sp. (Thysanoptera: Thripidae) (August 2005).
- Swarms of *Dicranolaius bellulus* (Guérin-Méneville) (Coleoptera: Melyridae) in a mango orchard in Katherine caused blockage in sprinklers (August 2005).
- *Ferrisia virgata* (Cockerell) (Hemiptera: Pseudococcidae) were found on mature namdokmai mangoes in a commercial property (August 2005).
- Advice was provided on the control of aphids (Hemiptera: Apididae) and mites (Acarina) on bok choy, kang kong and hydroponically-grown lettuce (August 2005).
- Growers noticed a chemical burn on citrus trees which was caused by spraying a product containing fish emulsion (October 2005).
- A pawpaw grower was advised on the management of oriental scale, *Aonidiella orientalis* (Newstead) (Hemiptera: Diaspididae) (October 2005).
- A cucurbit grower was advised on how to control *Thrips palmi* Karny (Thysanoptera: Thripidae). Trials were carried out and the crops were monitored before and after spraying to test the effect of dimethoate and potassium soap (November 2005).
- A series of insect specimens that were collected from Acacia trees were identified for Great Southern Plantation on Melville Island (November 2005).
- A grower was advised on how to control red scale *Aonidiella auranti*, (Maskell) (Hemiptera: Diaspididae), white louse scale *Unaspis citri* (Comstock) (Hemiptera: Diaspididae) and mussel scale *Lepidosaphes beckii* (Newman) (Hemiptera: Diaspididae) on etrog fruit, *Citrus medica* (November 2005).
- Natural biological control of oriental scale was observed in large numbers of *Chilocorus* sp. (Coleoptera: Coccinellidae) in a crop of pawpaws in Berrimah (December 2005-January 2006).
- Advice was provided on how to control cucumber moth *Diaphania indica* (Saunders) (Lepidoptera: Pyralidae) on cucumbers and aphids on eggplants (December 2005-January 2006).
- Advice was provided on how to treat *Solenopsis geminata* (Fabricius) (Hymenoptera: Formicidae) in a mango orchard (December 2005-January 2006).
- *Rhyparida* sp. (Coleoptera: Chrysomelidae) swarms were noticed in a jackfruit orchard in Howard Springs attacking the young leaves and also the developing fruit (February 2006).

- Advice was provided on how to control *Monomorium* sp. (Hymenoptera: Formicidae) in water pump equipment at a barramundi farm (February 2006).
- A hydroponic snake bean grower was visited. Bean pods had a heavy infestation of *Aphis craccivora* Koch (Hemiptera: Aphididae). Large numbers of syrphid larvae were also seen as a predator of the aphids (March 2006).
- Red-banded thrips, *Selenothrips rubrocinctus* (Giard) (Thysanoptera: Thripidae) were noticed as pests on guava fruit and leaves on a commercial property in Howard Springs (March 2006).
- A melon grower in Berrimah was visited. Although there was some minor damage by pumpkin beetles, *Aulacophora hilaris* (Boisduval) (Coleoptera: Chrysomelidae), the main damage to mature fruit was caused by dingoes (April 2006).
- At a commercial property in Darwin River Pyralid caterpillars, *Leucinodes orbonalis* Guenée (Lepidoptera: Pyralidae) were noticed as the main pest on the shoot tips of eggplants (April 2006).
- A grower in Katherine was advised on how to monitor and treat damage by the mango leaf hopper, *Idioscopus nitidulus* (Walker) (Hemiptera: Cicadellidae) (April 2006).
- Suspect exotic aphids from a commercial lettuce producer in Alice Springs were sent to the Section for identification. The aphids were *Aphis gossypii* Glover (Hemiptera: Aphididae) (May 2006).
- A grower at Howard Springs was advised on how to control ants (Hymenoptera: Formicidae) in potted rambutan plants for export (May 2006).

Government enquiries

- Information on yellow sticky board traps was provided to staff at the Berrimah Farm quarantine screen house to assist in monitoring (August 2005).
- QDPI was advised on how to control the mango leaf hopper, *Idioscopus clypealis* (Lethierry) (Hemiptera: Cicadellidae) after a recent outbreak in Mareeba (September 2005).
- The Botanic Gardens staff suspected a nest in a tree cavity contained European wasps. On inspection by DPIFM, it was confirmed the nest contained European honeybees (October 2005).
- Fruit fly larvae were detected in Queensland pears collected from Nakara Pre-School. The dead immature larvae could only be identified as family Tephritidae (February 2006).
- Pest management advice was given to control *Amblypelta lutescens lutescens* (Distant) in frangipanis at the Botanic Gardens (February 2006).
- Advice was provided to staff at the Quarantine screen house at Berrimah Farm on the control of the mango leaf coating eriophyid mite *Cisaberoptus kenyae* Keifer (Acarina: Eriophyidae) (February 2006).
- Loopers (Lepidoptera: Noctuidae) were reported to attack numerous rosewoods maintained as street trees by the Darwin City Council (March 2006).

Household and home garden enquiries

- A photograph of a spider submitted to the Section was identified as *Eriophora* and confirmed as the garden orb-weaving spider, *Eriophora biapicata* (L. Koch) (Araneida: Araneidae) which is a new species recorded from the NT (November 2005).
- A home gardener was advised to bag guava fruit to prevent damage by *Amblypelta lutescens lutescens* (Distant) (Hemiptera: Coreidae) (December 2005-January 2006).
- Large numbers of ground beetles (Coleoptera: Carabidae) invaded homes in Alice Springs (December 2005-January 2006).
- Ants collected by NT Quarantine from a rural block were identified as *Solenopsis geminata* (Fabricius) (Hymenoptera: Formicidae) (December 2005-January 2006).
- A larva collected from a Casuarina tree in Malak was submitted by a pest control operator as a suspect European house borer. The specimen was identified as a cerambycid larva (December 2005-January 2006).
- A barking spider, *Selenocosmia* sp. (Araneida: Theraphosidae) was submitted for identification (December 2005-January 2006).

- *Protaetia fusca* (Herbst) (Coleoptera: Scarabaeidae) was recorded feeding on over-ripe figs in a home garden in Alice Springs (February 2006).
- Advice was given on how to control vinegar flies (Diptera: Drosophilidae) breeding in a compost toilet of a house in the rural area (March 2006).
- Advice was given on how to control paper nest wasps (Hymenoptera: Vespidae) (March 2006).
- Households were advised on how to control millipedes (April 2006).
- Advice was provided on how to control leeches in the backyard of a rural block (April 2006).
- A sand groper, *Cylindracheta* sp. (Orthoptera: Cylindrachetidae) was found in a backyard at Humpty Doo (May 2006).
- Caterpillars submitted for identification from a backyard in Anula were "woolly bears", *Lyclene quadrilineata* (Pagenstecher) (Lepidoptera: Arctiidae) (May 2006).
- A home gardener was advised on how to control cockchafers (Coleoptera: Scarabaeidae) in grass (May 2006).

Other public enquiries

- An aquarium fish supplier started to breed green tree frogs and wanted to know how to build a light trap to catch live insects as a food source (August 2005).
- A northern mouse spider *Missulena pruinosa* Levitt-Gregg (Araneida: Actinopodidae) was found in a carton of chocolates at a local petrol station (September 2005).
- Due to complaints from a neighbour about barking dogs, the owner of dog kennels in Bees Creek requested information on cicadas (Hemiptera: Cicadidae) as they were causing noise. Apparently, cicadas make a higher level of noise than barking dogs. Cicadas are likely to be around until April or longer (November 2005).
- A local supplier submitted for identification ants collected from a pallet of dried dog food. The ants were identified as *Monomorium destructor* (Jerdon) (Hymenoptera: Formicidae) which is a common species in the NT (December 2005-January 2006).
- Caterpillars collected from the East Point War Museum lawn were identified as *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae) (December 2005-january 2006).
- Ants in a wooden crate originally from Singapore were identified as *Monomorium* sp. (rothsteini group) (Hymenoptera: Formicidae) (December 2005-January 2006).
- Hairy powder post beetle, *Minthea rugicollis* (Walker) (Coleoptera: Bostrichae) was detected in newly installed kitchens in Rapid Creek and Palmerston. Specimens were submitted by the cabinet maker. The infestation in the kitchens was extensive and required control. The source of infestation was traced back to the supplier of the plywood which imported timber from Malaysia. AQIS has investigated the incident and discovered that the company that treated the timber in Malaysia breached quarantine (April 2006).
- There were a number of looper (Lepidoptera: Noctuidae) problems in street trees and on commercial properties (April 2006).

Ant specimens submitted as "suspect exotics" or for advice on control

- *Solenopsis geminata* (Fabricius) (Hymenoptera: Formicidae) (August 2005, February 2006, March 2006).
- *Pheidole megacephala* (Fabricius) (Hymenoptera: Formicidae) (September 2005, March 2006).
- *Iridomyrmex* sp. (Hymenoptera: Formicidae) (September 2005).
- *Iridomyrmex pallidus* (Hymenoptera: Formicidae) (October 2005).

Project: Integrated Pest Management (IPM) in Mangoes

Project Officers: D. Chin and H. Brown

Location: Top End properties

Objective:

To provide an extension and pest identification service to mango growers.

Background:

Mangoes are the most important horticultural crop in the NT and receive a proportionate amount of resources from the Entomology Section. The Section offers growers an extension and identification service as well as information resources through Fact Sheets, Agnotes and an online database. During the 2004-05, the Section provided two workshops, one on general IPM and the identification of pests and natural enemies, and the other on pests that affect mango fruit quality. Three mango orchards were monitored during the season to determine the main pests that affect developing flowers and fruit.

Method and results:

Study sites

The monitored properties were within 60 km south of Darwin and included three orchards in Darwin River (DR) with 5000 trees, Lambells Lagoon (LL) with 4000 trees and Batchelor (B) with 240 trees. The blocks in DR and LL are conventional orchards that incorporate the use of insecticides in IPM programs whereas the property in B produces “organic” fruit without the use of insecticides.

The properties were monitored between July and October 2005 at two to three weekly intervals. For each property, 20 trees were selected at random and monitored for pests or natural enemies. The monitoring technique included selecting four points of each tree and sampling either a flower panicle or fruit sample at random. Another 20 flower panicles or fruit were bagged (tapping method of collection) for sorting in the laboratory. A species list for each property is shown in Table 1.

Thrips and dimpling bug damage

Thrips collected from flower panicle samples were sorted and identified to species where possible. A comparison of the mean number of thrips per panicle for each orchard is shown in Figure 1. There has been concern from growers in the Darwin and Katherine regions that thrips and dimpling bug, *Campylomma austrina* Malipatil (Hemiptera: Miridae) are causing considerable damage to flowers and developing fruit. Therefore, sampling has concentrated on these species. The majority of thrips species in mangoes are either pollinators or predators. Only one species, *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae) has been noticed to feed on developing fruit when the fruit is around 10-15 mm in diameter. These observations are based on data collected from this trial and previous trials conducted by DPIFM in Darwin and Katherine. The mean number of thrips and dimpling bugs per flower panicle are shown in Table 2. The number of *Scirtothrips* and *Campylomma* was very low, ranging from 0.15 to 0.55 for *Scirtothrips* and 0.05 to 0.70 for *Campylomma*. No *Scirtothrips* were recorded in DR. The mean number of thrips (all species) per flower panicle was 27.2 for LL, 29.5 for DR and 35.3 for B.

A comparison of the damage caused by *Campylomma* to developing fruit as observed in the field and on mature fruit post-harvest is shown in Table 3. DR and LL had fewer damaged developing fruit: 18.6% and 21.3%, respectively. B, which had no pesticides applied pre-harvest, had more damaged fruit. The mean damage to each fruit varied from 0.39% for DR, 0.41% for LL to 5.7% for B. Although both DR and LL orchards had applied pesticides to treat *Campylomma* in the field, the benefits of the sprays were not

reflected in the post-harvest fruit. DR had damage in 73.8% of post-harvest fruit, while LL had damage in 16.3% of post-harvest fruit and B had damage in 12.5% of post-harvest fruit. The mean damage per fruit was 8.68% for DR, 0.85% for LL and 1.4% for B. Although there was occasional fruit showing thrips damage, it was not enough to warrant recording. Post-harvest inspections were made at the packing shed to observe damage on fruit from each property. All growers packed their fruit at the WEPack shed in Berry Springs.

Insect damage on post-harvested fruit

The level of insect damage noticed on the fruit in the packaging shed was minimal. All fruit were inspected prior to processing on the packing line where possible. The main insect damage noticed was *Campylomma* and mango scale, *Pseudaulacaspis cockerelli* (Cooley) (Hemiptera: Diaspididae). Although a larger range of insects were seen in the field, many of them fall off the fruit or are removed by pickers at harvest. *Campylomma* damage which is seen as pits, dimples or white patches is more obvious on fruit during early development when it is between 5-65 mm in length as this is when the fruit is most likely attacked. As the fruit increases in size, *Campylomma* damage generally stretches or becomes faded and less obvious. Mango scale was seen on the occasional fruit. Other blemishes or damage not caused by insects which may affect fruit quality included cleavage scars, sap-burn, lenticel blow-out and wind abrasion.

Details of the quantity and quality of fruit from each orchard that was processed at the packing shed are shown in Table 4. The two conventional orchards DR and LL had 63.2% and 61.7% of first class fruit, respectively compared with 81% for B which did not have any pre-harvest insecticide treatment. Although B had a higher amount of *Campylomma* damage on fruit during early development, such damage “grows out” and by the time the fruit matures, the symptoms are reduced and often not detected post-harvest.

Table 1. A species list of insects and spiders collected on flower panicles or developing fruit

Darwin River		
Thysanoptera	Thripidae	*Thrips* sp.
		Scirtothrips dorsalis
		Frankliniella schultzei
		Pancheatothripinae
	Phlaeothripdae	
Araneida		Various species
Hemiptera	Anthocoridae	*Orius* sp.
	Flatidae	*Colgaroides acuminata*
	Miridae	*Campylomma* sp.
Diptera		Various species
Hymenoptera	Formicidae	*Iridomyrmex sanguineus*
		Iridomyrmex sp. (brown)
		Iridomyrmex sp. (black)
		Monomorium sp.
		Opisthopsis sp.
Mantodea		Various species
Lepidoptera		Various species
Coleoptera	Curculionidae	Unidentified
	Lathridiidae	*Cortinicara* sp.
	Silvanidae	*Silvanolomus* sp.

Lambells Lagoon		
Thysanoptera	Thripidae	*Thrips* sp.
		Scirtothrips sp.
		Frankliniella sp.
	Phlaeothripdae	
Araneida	Various	
Hemiptera	Anthocoridae	*Orius* sp.
	Geocoridae	*Geocoris* sp.
	Flatidae	*Siphanta* sp.
	Lygaeidae	*Graptostethus* sp.
	Miridae	*Campylomma* sp.
Diptera	Culicidae	
Hymenoptera	Formicidae	*Iridomyrmex sanguineus*
		Iridomyrmex sp. (brown)
		Opisthopsis sp.
	Apidae	*Trigona* sp.
Lepidoptera	Noctuidae	*Penicillaria jocosatrix*
		Various species
Coleoptera	Anthicidae	*Anthicus* sp.
	Coccinellidae	*Stethorus* sp.
	Lathridiidae	*Cortinicara* sp.
	Scirtidae	*Scirtes* sp.
	Silvanidae	*Silvanolomus* sp.

Batchelor		
Thysanoptera	Thripidae	*Thrips* sp.
		Scirtothrips sp.
		Frankliniella sp.
	Phlaeothripdae	
Araneida		Various species
	Miridae	*Campylomma* sp.
Diptera	Culicidae	Unident.
Hemiptera	Flatidae	?*Siphanta* sp.
	Lygaeidae	*Gralliclava* sp.
Hymenoptera	Formicidae	*Crematogaster* sp.
		Iridomyrmex sanguineus
		Iridomyrmex sp. (brown)
		Iridomyrmex sp. (black)
		Tapinoma sp.
		Tetraponera sp.
Coleoptera	Anthicidae	*Anthicius* sp.
	Curculionidae	Bruchinae
		Unident.
	Lathridiidae	*Cortinicara* sp.
	Nitidulidae	Unident.
	Silvanidae	*Silvanolomus* sp.
Lepidoptera	Noctuidae	*Penicillaria jocosatrix*
	Various families	
Psocoptera		Unidentified
Blattodea		Unidentified

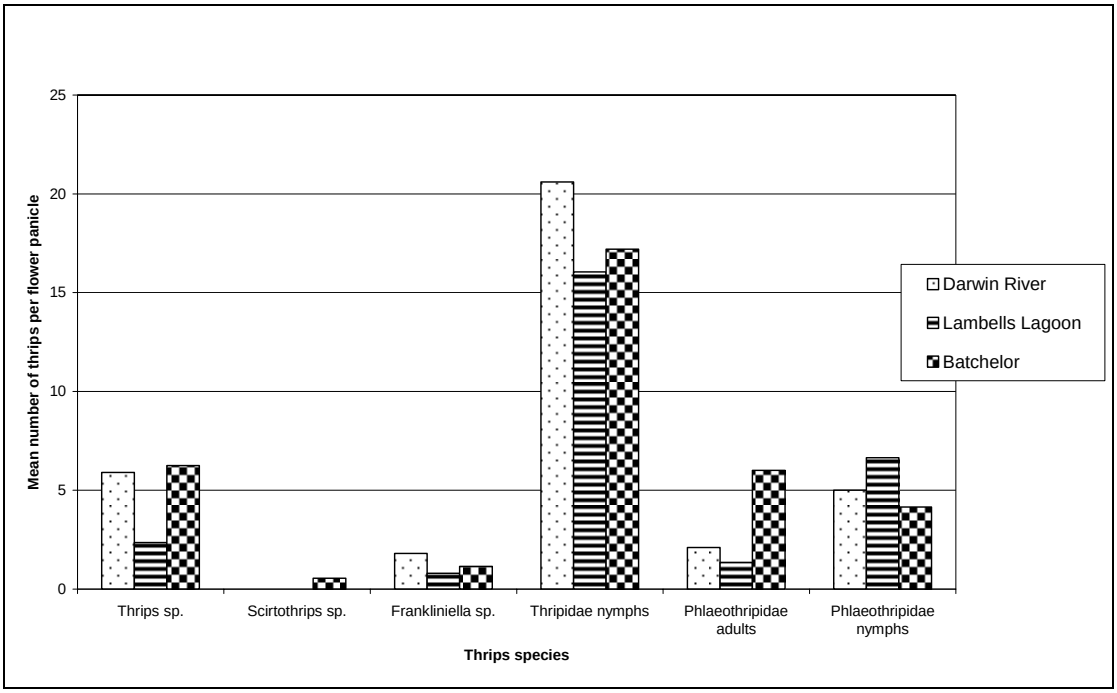

Figure 1. A comparison of the mean number of thrips per flower panicle collected from the three orchards

Table 2. Mean number of thrips and dimpling bugs sampled from each orchard

Orchard	**Mean per flower panicle**		
	Thysanoptera	*Scirtothrips*	*Campylomma*
Darwin River	29.5	0	0.05
Lambells Lagoon	27.2	0.15	0.7
Batchelor	35.3	0.55	0.35

Table 3. Damage rating to fruit contributed by *Campylomma*

Orchard	**Proportion of developing fruit damaged (fruit size 10-65 mm) (%)**	**Mean damage per fruit (fruit size 10-65 mm) (%)**	**Proportion of fruit damaged (post harvest) (%)**	**Mean damage per fruit (post harvest) (%)**
Darwin River	18.60	0.39	73.8	8.68
Lambells Lagoon	21.30	0.41	16.3	0.85
Batchelor	78.80	5.70	12.5	1.40

Table 4. Details of the quantity and quality of fruit from each orchard that was processed at the packing shed

Orchard	Number of trees harvested	Class	Trays	Trays (%)
Darwin River	3000	First	2869	63.2
		Second	1172	25.8
		Third	502	11.0
Lambells Lagoon	2450	First	9339	61.7
		Second	4184	27.6
		Third	1620	10.7
Batchelor	220	First	583	81.0
		Second	106	14.7
		Third	31	4.3

Project: Pest Management in Ornamentals – Alpinia Borer

Project Officers: H. Wallace and B. M. Thistleton

Location: Darwin Region

Objectives:

To advise on the management of pests of ornamentals.
To conduct research on key pests.

Background:

A stem boring moth, *Conogethes pluto* Butler (Lepidoptera: Pyralidae), which causes damage to Alpinia (ornamental ginger) plants, has developed into a significant pest over the last few years. In 2004 a research program commenced to find methods to control this insect. The species *C. pluto* is closely related to the yellow peach moth, *Conogethes punctiferalis,* which has also now been found in Alpinia in the NT.

Trials conducted in the past to determine a suitable and effective method to control this pest were reported in last year's report. Briefly, it was found that light trapping for moths was unsuitable, the use of a systemic chemical appeared to be unsuccessful and the use of synthetic pheromone lures for *C. punctiferalis* was unsuccessful. A spray regime using permethrin coupled with regular monitoring was found to provide the best form of control.

Method:

Monitoring of damage caused by *C. pluto* was started on three properties in January 2004 and continued to October 2005.

Two synthetic pheromones which attract *Conogethes punctiferalis* were supplied by Andy Gibb of *HortResearch*, Canterbury, New Zealand were tested.

Specimens were sent to Dr Karen Armstrong of Lincoln University, Canterbury, New Zealand for DNA analysis to confirm if *C. pluto* and *C. puntiferalis* are indeed distinct species.

Trichogramma pretisoum has been recorded as a parasite of the eggs of the closely related *Conogethes punctiferalis.* This parasite was released at two properties between June and August 2005. The owner of the

first property continued to release the parasite several times more and the Department supplied the parasite for three more releases at the second property.

Results:

Monitoring stopped in October 2005 when enough data had been collected for assessment and growers were familiar with monitoring methods and spraying regimes.

Details of the larval and pupal stages of the moth are now available. From the data collected, it appears that it takes more than 20 days (three weeks) for the larval stage (less than 5 mm in length) to reach the pupal stage. As no eggs were found, it is difficult to define the full life cycle, which takes around five to six weeks (Figure 1).

Neither of the two pheromones attracted the moths, which indicates that *C. pluto* and *C. puntiferalis* are distinct species. Through DNA analysis, Dr Karen Armstrong confirmed that there are indeed two distinct species of moth, *C. pluto* and *C.punctiferalis*. Andy Gibb is working on *C. pluto* to determine if it is possible to extract and later synthesise a pheromone specific to this species. A DPIFM project officer visited New Zealand for a week in June this year to learn how to remove glands and extract pheromone from female moths. The process will be carried out at Berrimah Farm and the extracts will be sent to Andy Gibb for analysis to determine the compounds in them. It is hoped that a synthetic pheromone attractant can be eventually produced.

The parasite *Trichogramma pretisomum* was released several times at two properties. Although there is no experimental evidence, the owners of the properties are convinced that the parasite effectively controlled the pest, which resulted in an increase in the number of marketable flowers.

The results of this project were presented at a meeting of the Heliconia Society International which was held in Darwin on 26 June this year. The presentation was well received, stimulating interest in further research on this economically important pest of cut-flowers.

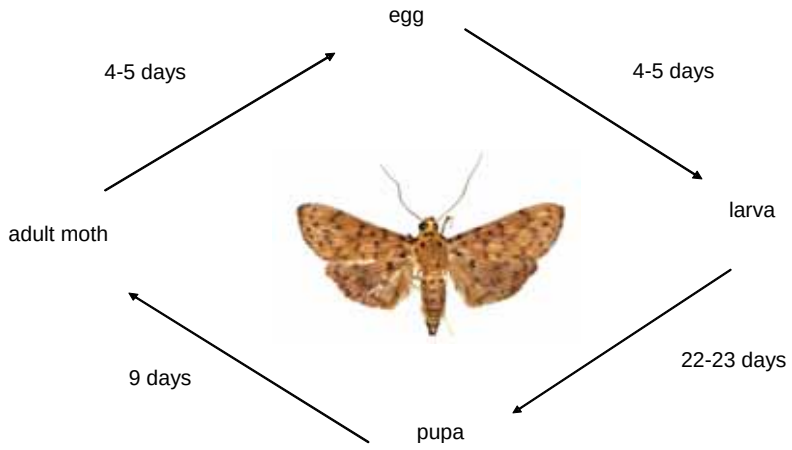

Figure1. Life cycle of *Conogethes pluto*

Project: Developing IPM in Citrus – the Biological Control of Citrus Leaf Miners

Project Officers: H. Wallace and B. M. Thistleton

Location: Darwin and Katherine Regions

Objective:

To introduce and monitor Ageniaspis citricola (Hymenoptera: Encyrtidae), a parasite of citrus leaf miners.

Background:

Larvae of citrus leaf miners, *Phyllocnistis citrella* Stainton, (Lepidoptera: Gracillariidae) feed beneath the epidermal layer of young leaves of various species and varieties of citrus. When young plants are continuously attacked their growth can be retarded.

Light infestation - less than two miners per leaf - causes leaves to become slightly distorted or curled. Old larval miners will persist as scarring on the leaf surface. Heavy infestations - more than six miners per leaf - often result in localised necrosis of leaf tissue, severely reducing the plant's capacity for photosynthesis.

The citrus industry identified a need for a biological control of citrus leaf miners to reduce their effect on citrus plants and reduce the use of chemicals.

Method:

In April 2005, about 408 *A. citricola* were released in a citrus orchard of 500 trees at Bees Creek. Also, about 510 wasps were released among young lemon trees in an orchard in Katherine.

Initial monitoring for evidence of leaf miner parasitism was carried out fortnightly. Monitoring was later reduced to monthly. Fifty young leaves showing signs of leaf miner activity were collected at random and inspected in the laboratory. The number of pupation sites on each leaf and their contents were recorded. The presence of parasite pupa cases was taken as an indication of parasite activity. This included empty sites, sites with non-parasitised leaf miner larva or pupa, sites in which leaf miner larva were parasitised by the native wasp *Semielacher petiolatus* and sites in which the released parasite *Ageniaspis citricola* was evident.

Dr G. Brown is currently studying the parasite specimens for identification.

Results:

Several species have been found among the collected parasite samples including *A. citricola*.

Leaf samples were collected from Katherine whenever possible. There is no evidence that the parasite has established there.

It appears that the parasite has established at the Darwin property. Since the release of the parasite in April 2005, a gradual increase in the number of parasitised leaf miner pupae has been observed together with a decline in leaf damage. This includes parasitism by the native *S. petiolatus* as well as the released *A. citricola.*

Project: The Detection of Spiralling Whiteflies in Darwin

Project Officers: D. Chin, H. Brown, B. M. Thistleton, L. Zhang and M. Neal

Location: Darwin and Darwin Rural area

Background:

The spiralling whitefly, *Aleurodicus dispersus* Russell (Hemiptera: Aleyrodidae) is native to the Caribbean region and Central America. The pest is also found in the southern Florida, the West Indies, South America, Africa, the Canary Islands, Hawaii, Samoa, the Maldives, Cook Islands, Fiji, Guam, Micronesia, Nauru, Taiwan, India, Sri Lanka, Papua New Guinea, South East Asia and the Torres Strait. In Australia, the pest is established in coastal Queensland from Mackay to Cape York. In March 2006 it was detected in the northern suburbs of Darwin, Palmerston and in the Darwin rural area.

Appearance

The spiralling whitefly is a small sap sucking insect which is related to mealy bugs and aphids. To the naked eye, the adults appear like very small moths and are about 2 mm long. Adults have plain white wings, occasionally with pale or dark spots on the forewings. Eggs are elliptical and yellow to tan in colour, 0.3 mm long and are laid one at a time at right angles to leaf veins and are associated with irregularly spiralling deposits of white flocculent wax. This spiralling effect is usually on the underside of leaves but in heavy infestations the spirals may also be seen on the upper surface of leaves as well as on fruit and non-plant material. The first stage of the larva is mobile but the later immature stages are sedentary and have an oval disc-shaped soft body that is light green in colour. The final immature stage is the pupa which is about 1 mm long. The sedentary larvae have characteristic waxy tufts and the final larval stage (pupa) has glass like rods of wax along the sides of the body.

The coconut whitefly, *Aleurodicus destructor* Mackie (Hemiptera: Aleyrodidae) is a local species that resembles the spiralling whitefly. Differences between the two species cannot be seen with the naked eye and require identification by a specialist.

Figure 1. Spiralling whitefly adult

Figure 2. Spiral pattern formed during egg laying

Life cycle

In the temperature range of 20°C to 39°C development from egg to adult takes 34 to 38 days (eggs 9-11 days, 1st instar (stage) larvae 6-7 days, 2nd instar 4-5 days, 3rd instar 5-7 days and 4th instar larva (pupa) 10-11 days). Under laboratory conditions the adult can live for up to 39 days.

Symptoms and damage

The spiralling whitefly attacks a large range of plants including vegetables, fruit trees, ornamentals, native plants and weeds. Some common hosts are acalypha, a local weed called *Euphorbia heterophylla* (sometimes referred to as “milkweed”), chillies, capsicum, cassava, sweet potato, guava, pawpaw, poinsettia, citrus, mango, banana and coconut. The spiralling whitefly will also deposit eggs on non-hosts.

The whiteflies produce honeydew, which may provide a substrate for the growth of sooty mould which interferes with photosynthesis. In heavy infestations, feeding damage may cause leaf drop or reduced yield in crops. The wet season weather is less favourable to whiteflies and they will generally be in low numbers. Higher populations are more common during the favourable weather conditions of the dry season.

Figure 3. Spiralling whitefly larvae

Figure 4. Spiralling whitefly on an acalypha leaf

Surveys to determine distribution in the NT

Media articles and a Fact Sheet have been produced to inform growers and the public to report infestations of the spiralling whitefly. The Biosecurity and Product Integrity Division has assisted in collecting samples for processing by Entomology. The spiralling whitefly has been detected in Anula, Berrimah, Driver, Humpty Doo, Leanyer, Malak, Marlow’s Lagoon, McMinn’s Lagoon, Moulden, Nightcliff, North Lakes, Wulagi, Virginia and Woodleigh Gardens.

Host list

Between March 2006 and August 2006, 172 samples were processed from 62 properties. The spiralling whitefly has been confirmed on acacia, acalypha, aglaomena, banana, bauhinia, bougainvillea, caladium, canna lily, capsicum, chilli, cordyline, crotalaria, custard apple, delineata, desert rose, eggplant, euphorbia weed, frangipani, ginger, golden cane, golden potato vine, ground orchid, grapevine, guava, heliconia, hibiscus, hippeastrum, Indian almond, Indian mast tree, lychee, Malaysian bap plant, mulberry, *Murraya paniculata,* pawpaw, petraea, poinsettia, pseudo-eranthemum, rose, rosewood, scindapsas, sweet potato, tapioca, taro and tomato.

Pest management

Potassium soap spray

Many chemical insecticides are ineffective on the spiralling whitefly and regular spraying generally destroys natural enemies or biological control agents that have been released. Potassium soaps such as “Natrasoap” or “Neemtech potassium soap” may also assist in managing populations on host plants.

Suggested spray rates are listed below. Please note that this spray solution may cause leaf burn to sensitive plants. The best time to apply sprays is in the early morning or late afternoon.

Natrasoap 20 ml/L + Spraytech oil 2 ml/L or
Neemtech 30 ml/L + Spraytech oil 2 ml/L

Biological control

In March a small consignment from DPI Cairns of the wasp parasite *Encarsia* spp. (Hymenoptera: Aphelinidae) was released at one property in Malak and three properties in Humpty Doo. There were two species of *Encarsia* in the consignment, a yellow species and a black species. Both species are 0.1 mm long. Surveys carried out in August 2006 indicated that *Encarsia* have established at one site in Darwent Street, Malak and at one site in Beard Road, Humpty Doo. Only the black species of *Encarsia* has been collected from both sites. *Encarsia* has been collected from the established sites and released at Palmerston, Humpty Doo and two nurseries at Berrimah and Humpty Doo. By late August 2006 *Encarsia* had been released in Darwin, Palmerston, Humpty Doo and all commercial properties where the spiralling whitefly has been detected. *Encarsia* populations are continuing to be monitored by Entomology. More releases will be made to ensure *Encarsia* becomes established in localities where the spiralling whitefly has been detected. The population of *Encarsia* is increasing in the release sites and the incidence of spiralling whiteflies on host plants is decreasing.

References:

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www.cabicompendium.org

Project: Quarantine Entomology

Project Officers: L. Zhang and G. R. Brown

Location: Darwin

Objectives:

To identify insects and other organisms intercepted in quarantine.
To provide advice on the quarantine significance of these organisms and to establish a database for them.

Background:

AQIS continued to provide partial funding to the end of 2005 for the Quarantine Entomologist to identify insects intercepted in the NT by quarantine.

Method:

Insect and animal samples collected by quarantine inspectors were submitted with insect interception record sheets to Quarantine Entomology for identification and advice. The advice and identifications were recorded and the completed sheets were returned to AQIS.

Interceptions that were considered of quarantine significance were further investigated.

Results:

From July to November 2005, 102 samples from 55 insect interceptions were received and recorded. The samples included 38 from around Darwin Harbour, 14 from East Arm Wharf eight from Perkins Wharf, 14 from other unspecified various Darwin Harbour wharves and marinas, 24 from Gove Harbour, 13 from Darwin Airport and eight from air cargo (Patrick's and Australian Air Express).

Species found

The following is a list of taxa and the number of samples examined:

Acarina	3
Aranaea	5
Blattodea	2
Coleoptera	32
Collembola	2
Diptera	5
Eupulmonata	2
Hemiptera	5
Hymenoptera	22
Isopoda	2
Isoptera	4
Lepidoptera	8
Manodea	1
Odonata	2
Psocoptera	6
Trichoptea	1

Countries of origin

The following samples were examined from each region:

Australia	3
Campuchia	2
China	16
Christmas Island	1
East Timor	9
Fiji	1
Hong Kong	2
Indonesia	17
Japan	1
Kuwait	1
Malaysia	6
Solomon Islands	2
Singapore	7
South Africa	3
Taiwan	1
Thailand	7
USA	1
Vietnam	4
Unknown	18

Interesting records

- The giant African snail, *Achatina fulica* (Bowdich) (Eupulmonata: Achatinidae), was collected on a container from Singapore.
- A bush snail, *Bradybaena* sp. (Eupulmonata: Bradybaenidae), suspected of being exotic, was collected on a vessel from Hong Kong.
- An ant, *Paratrechina obscura* group (Hymeoptera: Formicidae), possibly exotic, was collected on a container from Singapore.
- An exotic ant, *Iridomyrmex anceps* group (Hymeoptera: Formicidae), was collected on air cargo from Japan.
- A giant exotic honeybee, *Apis dorsata* Fabricius (Hymenoptera: Apidae), was collected on personal effects from Indonesia.
- An exotic dead and crushed gypsy moth, *Lymantria dispar* (Linnaeus) (Lepidoptera: Lymantriidae), was collected on a cement bag from China.

Project: The Northern Territory Economic Insect Reference Collection

Project Officers: **H. Brown, H. Wallace, B. M. Thistleton, L. Zhang and G. R. Brown**

Location: Berrimah Farm and the Katherine Research Station

Objectives:

To develop, curate and maintain a reference collection of economically important arthropods relevant to various NT agricultural and horticultural industries.
To develop and maintain a suitable, retrievable database of all specimens held in the collection.

Background:

The insect reference collection was initiated in 1970 to become the main insect reference collection in the NT. Over the years, the collection expanded to include economically important arthropods from agricultural, horticultural and domestic sources as well as from general collection. In 1992, the majority of the non-economic specimens were donated and transferred to the NT Museum.

Method:

During the year, 1131 specimens were added to the database. The database now consists of 41 546 specimens.

During 2004-05 the Section forwarded 37 specimens to specialist taxonomists for species identification or confirmation. Most specimens were of economic significance. Another 641 specimens were lent to specialists for study.

The following were newly recorded in 2005-06. They are indicated by locality (new NT, new Aust. or new host records for the NT (New host)).

ACARINA

Acaridae

- *Suidasia* sp.
  - ex. fish food (New NT)

Erythaeidae

- *Callidosoma* sp.
  - ex. body of *Bactrocera tenuifascia* (New NT)

Saproglyphidae

- *Congovidiella* sp.
  - ex. body of ladybird larva (New NT)

Tarsonemidae

- *Polyphagotarsonemus latus* (Banks)
  - ex. leaves of *Capsicum frutescens* (New Host)

Tenuipalpidae

- *Brevipalpus californicus* (Banks)
  - ex. leaves of *Cucurbita maxima* (New Host)

Tetranychidae

- *Eutetranychus orientalis* (Klien)
  - ex. *Citrus sinensis* (New Host)
- *Oligonychus* sp.
  - ex. leaves of *Planchonia careya* (New Host)
- *Tetranychus* sp.
  - ex. leaves of *Lantana* sp. (New Host)

Tuckerellidae

- *Tuckerella* sp.
  - ex. fruit of *Citrus* sp.(New Host)

ARANEIDA

Araneidae

- *Eriophora biapicata* (L. Koch)
  - ex. eaves of house roof (New NT)

COLEOPTERA

Anthicidae

- *Anthicus* sp.
  - ex. flower panicle of *Mangifera indica* (New Host)

Curculionidae

- *Leptopius* sp.
  - chewing leaves of *Acacia mangium* (New host)

Lathrididae

- *Cortinicara* sp.
  - ex. flower panicle of *Mangifera indica* (New NT)

Silvanidae

- *Silvanolomus* sp.
  - ex. flower panicle of *Mangifera indica* (New NT)

DIPTERA

Syrphidae

- *Baccha* sp.
  - feeding on *Aleurodicus dispersus* (New host)

HEMIPTERA

Aleyrodidae

- *Aleurodicus dispersus* Russell
  - ex. leaf of *Capsicum frutescens* (New NT)
  - ex. leaves of *Acalypha hispida* (New host)
  - ex. leaves of *Psidium guajava* (New host)
  - ex. leaves of *Poinsettia pulcherrima* (New host)
  - ex. leaves of *Capsicus annuum* (New host)
  - ex. leaves of *Colocasia esculenta* (New host)
  - ex. leaves of *Ipomoea batatus* (New host)
  - ex. leaves of *Acalypha wilkesiana* cv. harlequin
  - ex. leaves of *Acalypha wilkesiana* (red/curly variety) (New host)
  - ex. leaves of *Bouganvillea* sp. (New host)
  - ex. leaves of ornamental *Ipomoea* sp. (new host)
  - ex. leaves of *Carica papaya* (New host)
  - ex. leaves of *Hibiscus* sp. (New host)
  - ex. leaves of *Caladium* sp. (new host)
  - ex. leaves of *Terminalia cattapa* (New host)
  - ex. leaves of *Annona reticulata* (New host)
  - ex. leaves of *Euphorbia heterophylla* (New host)
  - ex. leaves of *Solenostemon* (*Coleus*) sp. (New host)
  - ex. leaves of *Heliconia* sp. (New host)
  - ex. leaves of ?*Pseuderanthemum* sp. (New host)
  - ex. leaves of *Plumeria* sp. (New host)
  - ex. leaves of *Morus* sp. (New host)
  - ex. leaves of ?*Odontonema* sp. (New host)
  - ex. leaves of *Musa* sp. (New host)
  - ex. leaves of *Cordyline* sp. (New host)
  - ex. leaves of *Canna* sp. (New host)
  - ex. leaves of *Spathoglottis plicata* (New host)
  - ex. leaves of *Solanum melongena* (New host)
  - ex. leaves of *Vitis vinifera* (New host)
  - ex. leaves of *Acacia* sp. (New host)
  - ex. leaves of *Chrysalidocarpus lutescens* (New host)
  - ex. leaves of *Petraea* sp. (New host)
  - ex. leaves of *Acalypha wilkesiana* cv. *moorei* (New host)
  - ex. leaves of *Rosa* sp. (New host)
  - ex. leaves of *Manihot esculenta* (New host)
  - ex. leaves of *Adenium obesum* (New host)
  - ex. leaves of *Euphorbia leucocephala* (New host)
  - ex. leaves of *Citrus* sp. (New host)
  - ex. leaves of *Vigna unguiculata* (New host)
  - ex. leaves of *Crotolaria* sp. (New host)
  - ex. leaves of *Delineata* sp. (New host)
  - ex. leaves of *Bauhinia* sp. (New host)
  - ex. leaves of *Pterocarpus indicus* (New host)
  - ex. leaves of *Lycopersicon esculentum* (New host)
  - ex. leaves of *Barleria* sp. (New host)
  - ex. leaves of *Polyalthia longifolia* cv. *pendula* (New host)
  - ex. leaves of *Zingiber* sp. (New host)
  - ex. leaf of Malaysian bap plant (New host)
  - ex. leaves of *Pseuderanthemum reticultatum* (New host)

Aphididae

- *Aphis craccivora* Koch
  - damaging flowers of *Averrhoa carambola* (New NT)

Cicadellidae

- *Empoasca* sp.
  - ex. *Gossypium hirsutum* (New host)

Conchaspididae

- *Conchaspis* sp.
  - ex. stem of *Croton* sp. (New NT)

Margarodidae

- *Icerya aegyptiaca* (Douglas)
  - ex. leaves of *Acalypha hispida* (New host)
- *Icerya* sp.
  - ex. grass (New host)
- *Icerya ?seychellarum* (Westwood)
  - ex. stems of *Acalypha wilkesiana* cv. *moorei* (New host)

Pentatomidae

- *Oncocoris favillaceus* (Walker)
  - ex. leaf of *Sesamum indicum* (New NT)

Pseudococcidae

- *Ferrisia virgata* (Cockerell)
  - ex. fruit of *Mangifera indica* var. Nam dok mai (New Host)

HYMENOPTERA

Leucospidae

- *Smicromorpha* sp.
  - (New NT)

Vespidae

- *Vespula germanica* (Fabricius)
  - ex. nest in house (eradicated) (New NT)

ISOPTERA

Kalotermitidae

- *Neotermes insularis* (Walker)
  - ex. *Ficus virens* (New host)
  - ex. oregon in house (New host)

Rhinotermitidae

- *Coptotermes acinaciformis* (Froggatt)
  - ex. *Acacia* sp. (New host)
  - ex. *Callitris* sp. (New host)

Termitidae

- *Microcerotermes boreus* (Hill)
  - ex. mound on *Mangifera indica* (New host)

THYSANOPTERA

Thripidae

- *Selenothrips rubrocinctus* (Giard)
  - ex. leaf of *Rosa* sp. (New host)

Project: Management and Control of Termite Pests of Horticultural Crops in the Northern Territory

Project Officers: B. M. Thistleton and M. Neal

Location: NT

Objective:

To develop effective environmentally sustainable control methods against Mastotermes darwiniensis and other termites in horticultural crops in the Northern Territory.

Background:

Mastotermes darwiniensis Froggatt (Isoptera: Mastotermitidae) is the most destructive species of termite in tropical Australia. In the NT this species accounts for substantial annual production losses in horticultural tree crops and is also responsible for losses in vegetable and agricultural crops*. M. darwiniensis* can cause major damage to buildings, wooden structures, electrical cables and a variety of other materials. The main product registered for use in horticulture against this pest is Mirant® containing the organochlorine mirex. With organochlorines being phased out it is necessary that alternative pesticides be tested against *M. darwiniensis. Microcerotermes distinctus* Sylvestri and *M. implacidus* Hill (Isoptera: Termitidae) are also a problem in young citrus and young and bearing grapevines, respectively.

Method and Results:

During the year a number of trials were carried out to continue to test the effect of Termidor Residual Termiticide® (Termidor) containing 100 g/L fipronil applied by soil injection, through the irrigation line or directly into the trunks of trees, on *M. darwiniensis* and *Microcerotermes* spp. Details of the methods can be found in the 2002-03 Technical Annual Report

Mastotermes in cashew trees

Trials were continued on *Mastotermes* control at Wildman River where extensive new plantings of cashews have been established. The aim is to demonstrate that methods of control developed for other horticultural tree crops using Termidor® will also work with cashews. The trials involved drilling the trees and assessing for activity, trunk injection of the Termidor® mixture, and post treatment assessments of treated and non-treated trees to establish how far the product was carried by the termites. Results were consistent with results previously obtained in mangoes.

After the issue of a minor use permit for aggregation drums and sacrificial trees (see below) the plantation was able to control the large infestation in the blocks of old cashews by drilling the many dead (sacrificial) trees and trunk injecting. This will have reduced the risk of termites moving into the new planted areas.

The newly planted blocks are being monitored for damage by *M. darwiniensis.* No damage has been detected yet. Since termite populations in the young trees will be low, a more efficient dissemination of the chemical would be achieved by aggregating populations into drums before treatment. This has been recommended to the plantation management and the use of drums has been demonstrated.

Soil injection for Mastotermes on mature mango trees

A trial was conducted in May 2003 by injecting every second mango tree in a block at Coastal Plains Horticulture Research Farm (see the 2002-03 Technical Annual Report). In this trial pest activity ceased in all trees but monitoring was continued to establish the time before re-invasion occurred and if this period was different for treated and untreated trees. This would indicate if there was any long-term residual effect of the chemical. To date, only a few trees have become reinfested and monitoring is continuing.

Mastotermes on Acacia mangium

The great southern plantation on Melville Island requested assistance to control *Mastotermes darwiniensis* on *Acacia mangium.* Only one small infestation was found. Training was provided on setting up and treating aggregation drums. Other areas were examined for *Mastotermes* populations. Since *Acacia* is a preferred host of *Mastotermes* it is expected that further infestations will be found.

Microcerotermes on grapevines

Trials to test Termidor® for control of *M. implacidus* on grapevines were continued at Ti Tree. A trial to test Termidor® on mature grapevines was set up in September 2004 and subsequent assessments were conducted. Control had not been as good as in young vines, as much of the termite activity was in the trunk and upper branches of mature vines. However, over time there was a 60% reduction in the number of infested vines treated with the higher rate.

A new trial was set up in September 2005 to test two higher rates applied through the irrigation line, compared with an untreated control. The treatments were replicated four times in a randomised complete blocks design. As in the first trial, control was slow and a second assessment was planned for October 2006. Samples of grapes from this trial were taken for residue testing in November 2005.

Minor use permits for Termidor

APVMA issued the Department a minor use permit for Termidor under aggregation drums and in sacrificial trees in September. Since this was the only method approved for the use of Mirant®, the permit allowed for the product to be phased out. No new permits for the purchase of Mirant® were issued after January 2006, and all existing permits will expire by the end of 2006.

Termite identification

A workshop to train pest control operators to identify termites was conducted in February.

Extension

Advice was given by phone, mail or, more usually, by visits to growers in Darwin, Katherine and Mataranka on how to control termites. In particular, the aggregation drum technique was demonstrated to citrus and mango growers on large properties in Katherine and Mataranka. Methods to detect and destroy colonies before and immediately after land clearing were also discussed.

Project: Mastotermes Survey in Papua New Guinea

Project Officers: B. M. Thistleton and M. Neal

Location: Lae, Papua New Guinea

Objectives:

To define the extent of the existing and potential problem posed by the Mastotermes darwiniensis in Papua New Guinea.
To recommend solutions.

Background:

The giant termite (*Mastotermes darwiniensis*) was first discovered in Lae, Papua New Guinea, in 1959. However, it was believed that the initial introduction had occurred during World War II in timber shipped to Lae from either Darwin or Townsville. From 1961 to 1973 eradication attempts were made by the PNG Department of Agriculture, Stock and Fisheries, using arsenic and persistent organochlorine insecticides. The last small infested area at the nursing quarters at Lae hospital was treated in 1973 with the removal of all sources of food from staff houses, the treatment of colonies with arsenic dust, ripping of the soil and incorporating heptachlor granules.

Since 2001 the termite has been present in the Lae Botanical Gardens and the Forest Research Institute (FRI) building. PNG requested the Australian Centre for International Agricultural Research (ACIAR) for assistance. ACIAR contracted the Termite Group at DPIFM to carry out a survey in the area.

Method:

Literature was available that detailed the history of the infestation and the attempts at control. Much of this was used during the survey. Of particular importance were a series of files containing reports from entomologists who dealt with the infestation in the 1960s and 1970s. They provided maps of the areas that were infested and locations of trap posts and trenches and also included details of the control measures used. Also of importance was a report of a survey carried out by FRI staff in 2002 which was used as a baseline for the survey in that area.

The termites bore up through the centre of the trees and into the limbs. Since this species does not produce mounds, its damage often goes undetected until the tree is ring-barked or the weakened limbs start to fall in storms. Thus damage in the Botanic Gardens, and possibly elsewhere in PNG, may not be immediately obvious.

The survey techniques involved examination of buildings and trees for signs of *Mastotermes* activity. Trees were inspected for dead, hollow branches which often fold or break, *Mastotermes* ring-barking and mudding on trunks and limbs, and dead trees.

Local knowledge was also used to obtain information on the termites. At each site local residents were shown photographs of the termites and asked if they had seen them. When damage is severe the termites are very evident and their size immediately distinguishes them from local forms. Residents were also asked if they had seen flights of termites, especially alates attracted to light. The response to this was negative in all cases. The media (radio and newspapers) were used to request information and a poster in English and Pidgin English, was prepared to show the different stages of *Mastotermes.*

Results:

The current infestation appears to have started in the early 1990s in the nursing quarters close to the 1973 eradication attempt. It has since spread to adjoining areas including the main hospital area at the base of the escarpment and the adjoining Lae Botanical Gardens and the FRI building, where it was discovered in late 2001. Since 2000 it has been present in the Okari Campus about 2 km north of FRI. It was discovered in the adjoining Police Barracks in 2004.

Dispersal flights appear to be uncommon despite winged reproductives (alates) forming in the colonies. Dispersal is through budding off at the edges of colonies through the workers (pseudergates) forming secondary reproductives (neotenics). This appears to be limited by the high water table and the existence of large drains which often have standing water or waterlogged soil.

Dispersal also occurs through movement of infested firewood and constructional timber. This is probably how it jumped from the hospital/FRI area to the Okari Campus/Police Barracks area. The ability of workers to moult to become secondary reproductives facilitates this process.

The boundaries of both the infested areas were mapped during the survey. The current infested area is estimated to be about 0.6 km^2 at the hospital/FRI area and 0.8 km^2 at the Okari Campus/Police Barracks area, a total of 1.4 km^2. This is much larger than the area at which the previous (1960-70s) eradication attempts were carried out. An eradication attempt on the current infestation is therefore likely to be a long-term and expensive operation. However, if the termite establishes in drier areas of PNG, the potential damage to crops and infrastructure will be very large.

Fipronil, the current control chemical in use in tree crops in northern Australia, which was not available in the earlier campaign, is a very effective termiticide which is carried by termites through the colonies to a distance of 50 m. This will control undetected infestations close to existing ones, which would have been missed with the chemicals in use during the 1960-70 campaign.

The national agricultural quarantine authority is keen to attempt to eradicate the insect and intends to declare it a notifiable pest. This proposal is supported by FRI, DPI and the Department of Health. FRI has agreed to host an eradication attempt supervised by a steering committee from the above agencies and with possible involvement of DPIFM. All the agencies supported an official application for funding, probably from AusAID to set up an eradication program to operate for a number of years.

Project: The Development of Specimen-based Pest Lists in ASEAN Countries

Project Officer: **B. M. Thistleton**

Location: South-east Asia

Objective:

To facilitate and support the establishment and updating of national and regional specimen-based pest lists in ASEAN countries in accordance with international standards for phyto-sanitary measures (ISPM).

Background:

The Association of Southeast Asian Nations (ASEAN) - Australia Development Cooperation Program commenced in 1999 with an agreement between the Australian Agency for International Development and

the ASEAN Secretariat. The aim of the program is to promote sustainable development within ASEAN by assisting it to tackle priority regional development challenges through regional cooperation.

One of the projects in this program is “Strengthening ASEAN Plant Health Capacity”, technically managed by the Australian implementing partner RMIT International Pty Ltd, in association with the office of the chief plant protection officer (OCPPO) and the Department of Agriculture, Fisheries and Forestry.

The pest list development component of this project aims to train participants from all ten ASEAN countries in the development of specimen-based pest lists for specific crops in order to facilitate international trade in accordance with ISPM. Based on his successful involvement in a related workshop conducted by OCCPO in Pak Chong, Thailand in June 2005, the author was asked to be one of the trainers for this project.

Mangoes were chosen for the pest list development exercise. Our participation in this project will be useful as it will increase our knowledge of pests of mangoes in all the ten ASEAN countries.

Method and Results:

Twenty experienced plant health scientists, an entomologist and a plant pathologist from each ASEAN country participated in a five-day workshop which was held at the Southern Fruit Research Institute, Vietnam in April 2006. The workshop produced a strategy to survey and develop national specimen-based pest lists for mangoes in member countries.

The workshop included:

- Presentations and interactive exercises to build knowledge/understanding of the principles for undertaking surveys.
- Instructions on how pests should be handled and preserved for lodging in a biological collection.
- Discussion of minimum data sets needed if the collected specimens are to be recognised as ‘pest records’.
- Implementation plans for each country to develop a pest list for the priority crop (mangoes) in the region.

The workshop was based on the new “*Guidelines for Plant Pest Surveillance in Asia and the Pacific”* produced by OCPPO and published in 2005 by the Australian Centre for International Agricultural Research. The guidelines elaborate on and further develop those of the *International Standards for Phyto-sanitary Methods, No. 6 – Guidelines for Surveillance.* While these guidelines were developed for Asia and the Pacific they could also be applicable for use in surveillance in the NT and elsewhere in Australia.

The author was a facilitator in the workshop and provided advice to entomology participants, including four talks based on the material in the guidelines.

Program: Plant Pathology

Project: Plant Disease Diagnostic Service

Project Officers: **R. Pitkethley, B. Condé, A. Daly, S. Bhuiyan, L. Ulyatt and I. Arao-Arao**

Location: Darwin and Katherine

Objective:

To provide a plant disease diagnostic service to primary producers and the public.

Background:

With a change in the internal structure of the Department, the Plant Pathology branch has become part of the new Diagnostic Services Division, which groups together the various diagnostic and analytical laboratories.

Method:

The Darwin Plant Pathology laboratory continued to participate in the national grapevine leaf rust eradication program. In addition, the laboratory performs a diagnostic function. Plant pathologists screen all grape leaf samples collected in the course of surveys to determine if rust is present.

In 2005-06, 1230 cases were processed at Berrimah Farm. The figure includes a significant number of grapevine leaf samples that were tested for rust for the National Grapevine Leaf Rust Eradication Program. The Katherine laboratory processed 345 cases of which 200 were mango fruit samples for the 'sea freight' trial.

Some cases of special interest

Olivea tectonae, rust of teak (*Tectona grandis*) – new record for Australia.
Quambalaria eucalypti, gall on *Eucalyptus polycarpa*.
Fusarium oxysporum f. sp. *basilici* wilt in basil.
Phyllosticta musarum, freckle on lady finger bananas.
Elsinoë mangiferae, scab on mango fruit.
Mycosphaerella citri, lesions on pummelo leaves.
Golovinomyces cichoracearum, powdery mildew of *Zinnia elegans*.
Fusarium coccidicola, parasite of scale insects on *Cycas* sp.
Phomopsis psidii, fruit and leaf lesions in guava.
Botryosphaeria ribis, stylar end rot in guava fruit.
Atelocauda digitata (formerly *Uromyces digitatus*), rust in *Acacia mangium*.
Fusarium wilt in sweet basil.
Diplodia theobromae associated with base and collar rot of *Basella alba*.
Phytoplasma on sesame.
Cercosporidium henningsii, leaf spot on cassava.
Cercosporidium personatum, late spot on peanuts.
Ralstonia solanacearum (bacterial wilt) in eggplant.
Meloidogyne sp. (Root knot nematode) in pumpkin and okra.

Some detailed investigations

Jackfruit

Jackfruit tree and fruit problems were investigated at several sites. Fewer fruit were produced by trees grown on poor shallow gravely soil. Many of the fruit dropped off prematurely and of those that survived, a high proportion had dry brown coloured fruit stalks, without the flow of latex associated with healthy jackfruit tissue. A proportion of such under-developed “dry stalk” fruit at each location became infected with the fungus, *Botryodiplodia theobromae* (also recently called *Diplodia theobromae*). Pink disease (*Erythricium salmonicolor*) occurred in the humid wet season weather on medium aged trees. It was not common on young trees, and was absent on very old trees. Treatment in susceptible trees was to open up the canopy and remove infected material where possible and apply protective copper fungicides. The growers were applying agricultural lime to the base of jackfruit trees and at injuries in branches to reduce losses due to trunk and branch rot, with apparent success. They were also advised to apply lime at the drip zone for root absorption to raise the pH where soils were considered too acid. There was a large amount of leaf drop in the dry season, possibly due to the dry cold weather and infestation by mites. Some trees on the shallow gravely soil had rots on the main root (associated with a basidiomycete). Appropriate advice was given to growers to overcome these problems and increase crop yield.

Papaya fruit

A post harvest deterioration of organic papaw (papaya) fruit was investigated. An unusual anthracnose symptom called “chocolate spot” caused by the fungus *Colletotrichum gloeosporioides* developed on each of nine fruit examined. The usual anthracnose lesion has pink sporulation, whereas the “chocolate spot” has a chocolate colour on the spots. This is the first time that this symptom has been recorded in the NT. Like normal anthracnose, this has a latent or dormant phase of infection, infecting fruit when green but not causing disease (and post-harvest decay) until the fruit ripens. The disease is managed by removing dead and senescing plant material, post-harvest sprays and selection of more resistant strains of the fruit.

Wilt of Lebanese eggplants

A severe wilt problem of hydroponic Lebanese eggplants was shown to be associated with bacterial wilt (*Ralstonia solanacearum*). This diagnosis was confirmed by fatty acid analysis. It was unusual to have such a severe problem in a hydroponic system which was off the ground, suggesting the cause may have been contaminated sand.

Cowpea virus

A cowpea mosaic virus was found infecting two cowpea plants (var. PI 162925) at Berrimah Farm. These plants failed to produce seed. The virus was very easily transmitted by mechanical inoculation. In experimental inoculation and indexing tests it was found to infect five cowpea lines, PI 162925, Arafura, Iron, Borroloola, and CB5, whilst Eden cowpea and green pod Kaohsiung (GPK) snake bean were found to be resistant (immune) to systemic infection by the virus. The virus had long flexuous rods and reacted positively to a poty-virus ELISA kit. Initially the virus was thought to be cowpea aphid borne mosaic virus (CABMV). However, a literature review indicated there has been confusion with poty-viruses infecting cowpeas over the last 20-30 years. Many of the virus isolates previously known as CABMV were shown to be actually the black-eye cowpea strain of bean common mosaic virus (BCMV-BlCMV). Further investigations including work on the host range, transmission, seed transmission tests and identification are reported here. Tests on seed transmission (based on visual symptoms) indicated no seed transmission from 1354 plants grown from seedlings or grown from seed produced by infected plants of PI 162925, Arafura and California black-eye 5 cowpeas.

Table 1. Inoculation of snake beans and indexing onto “PI 162925” potyvirus reaction

		Test virus	PI 162925	1st trifolate leaf	Top leaves
Snake bean variety	**Date inoc**	**Visual sympt.**	**Date index**	**PI 162925**	**PI 162925**
Bat Kong	19/08/2005	nil	12/09/2005	positive	positive
Noonamah Dwarf	19/08/2005	nil	28/09/2005	positive	positive
Red eye	19/08/2005	mosaic	12/09/2005	N/A	N/A
Local Purple	19/08/2005	mosaic	12/09/2005	N/A	N/A
Theo beans	19/08/2005	lethal reaction	12/09/2005	N/A	N/A
Kybrook farm	19/08/2005	nil	12/09/2005	positive	positive
Taiwan white skin	19/08/2005	nil	12/09/2005	positive	positive
GPK	10/10/2005	nil	06/11/2005	negative	negative

Note: Theo has lethal reaction when inoculated as seedling but has mosaic reaction when infected in older plants.

Of the eight snake beans tested in Table 1, only snake bean variety GPK was shown to be resistant to infection with the “PI 162925” virus (shown by indexing). Plants exhibiting obvious visual symptoms were not indexed.

Table 2. Inoculation of other legumes indexing onto PI 162925 for “PI 162925” potyvirus reaction

Legume variety	**Date inoc.**	**Visual sympt.**	**Date index**	**Index PI 162925**
Desmodium tortuosum	09/09/2005	nil	27/09/2005	positive
Spearfelt - navy bean	31/08/2005	nil	27/09/2005	positive
Centrosema pubescens	31/08/2005	nil	27/09/2005	positive
Ph. vulgaris cv. Bountiful	31/08/2005	nil	27/09/2005	positive

All four legumes inoculated with the virus failed to exhibit any visual symptoms, but were shown to be susceptible to systemic infection by the “PI 162925” virus as demonstrated by indexing on to PI 162925 (Table 2). These four legumes in family Fabaceae are *Desmodium tortuosum*, *Phaseoulus vulgaris* cv. Spearfelt, *Ph. vulgaris* cv. (USA) Bountiful, and *Centrosema pubescens* may have the potential to be symptom-less carriers of the virus.

Table 3. Reaction on TVu cowpea virus indicators and indexing onto PI 162925

		Neg control	Tests	PI 162925	Final Check
Cowpea variety	**Date inoc**	**Visual sympt.**	**Visual sympt.**	**Date index**	**06/12/2005**
Tvu 2657	31/08/2005	nil	nil	10/10/2005	positive
Tvu 2740	31/08/2005	nil	nil	10/10/2005	negative
Tvu 2845	31/08/2005	nil	mosaic	10/10/2005	N/A
Tvu 3433	31/08/2005	nil	nil	10/10/2005	negative
Tvu 3273	31/08/2005	nil	nil	18/10/2005	positive
Tvu 401	31/08/2005	nil	mosaic	18/10/2005	N/A
Tvu 401-89664	31/08/2005	nil	nil	18/10/2005	positive
PI 162925	31/08/2005	nil	mosaic	N/A	N/A

A set of TVu virus indicators which should enable us to differentiate between CABMV and BCMV-BlCMV was drawn up from papers by Bashir and Hampton (1996) and Taiwo et al. (1982). The “PI 162925” virus was mechanically inoculated onto these TVu indicators, and the new growth was indexed back on to PI 162925 to confirm the presence or absence of the virus. Negative controls for each of the TVu differentials was included, as were negative and positive inoculations for the standard PI 162925 cowpea. The results (Table 3) were compared with those expected for the two viruses. Neither of the two viruses, CABMV nor BCMV-BlCMV was indicated by the reactions of these TVu lines.

References:

Bashir, M. and Hampton, R. O., (1996). Serological and biological comparisons of blackeye cowpea mosaic and cowpea aphid-borne mosaic potyviruses seed-borne in *Vigna unguiculata* (L.) Walp. germ plasm. *Journal of Phytopathology*, **144**:257-263.

Taiwo, M. A., Gonsalves, D., Provvidenti, R., Thurston, H. D. (1982). Partial characterization and grouping of isolates of blackeye cowpea mosaic and cowpea aphidborne mosaic viruses. *Phytopathology*, **72** (6):590-596.

Project: Plant Disease Reference Collection and Database

Project Officers: R. Pitkethley and L. Ulyatt

Location: Darwin

Objective:

To build and maintain the plant disease reference collection and associated database as a diagnostic tool and as a reference source.

Background:

The plant disease collection is an essential reference tool for diagnosis. Specimens of new diseases, or specimens representing new localities, are added to the collection. The specimens form the evidential basis of the plant disease database, which is used as a diagnostic tool and as an information source for market access and pest risk analyses.

Liaison has been maintained with the Plant Pathology herbarium at Indooroopilly, Queensland. The aim is to transmit the data from the NT plant disease database to a new dedicated server at Indooroopilly, which would allow it to become part of the Australian plant disease database (APDD) and, through it, the Australian plant pest database (APPD).

Results:

There were 40 new accessions added to the plant disease reference collection in 2005-06.

The dedicated server at the Plant Pathology herbarium at Indooroopilly was commissioned by Queensland DPI&F and became operational during the year. Discussions are in progress to determine the most effective way to make NT data available to APDD and APPD.

Project: Assessment and Pathogen Testing for the Nursery Industry Accreditation Scheme, Australia

Project Officers: **A. Daly, M. Connelly and J. McDonald (Nursery and Garden Industry Queensland)**

Location: Darwin/Katherine

Objective:

To assess the pathogen status of nurseries for accreditation under the nursery industry accreditation scheme (NIASA).

Background:

Nurseries in the Darwin and Katherine areas are visited twice annually to assess them for potential accreditation or for continuation of their accredited status under the NIASA scheme. Samples of soil, potting media and plant material are collected for pathogen assessment at the Berrimah Agricultural Laboratory.

Method:

- Seventeen visits were made to nine nurseries. One nursery is in the process of meeting requirements to become accredited, whilst the other eight are already accredited.
- In general, the assessed nurseries were in good condition. Drainage was adequate with no obvious "soaked" areas or free standing water and plant health overall was of a high standard. It was unnecessary to collect soil and potting media samples for assessment for the target soil-borne pathogens of *Phytophthora* and *Pythium* species.
- During these surveys, three plant samples were collected for identification of foliage disorders. *Rhizoctonia* sp. (pathogen) and mealy bug (insect) were affecting one plant, while scale insect and a nutritional disorder were affecting the other two plants.

Project: Grapevine Leaf Rust Disease Research

Project Officers: **A. Daly, C. Hennessy, R. Pitkethley, S. West, G. Schultz, G. Hore and M. Hearnden**

Location: Darwin

Objectives:

To develop a PCR-RFLP assay for identification of the grapevine leaf rust pathogen, P. euvitis.
To monitor sentinel vine canopy climate characteristics.
To assess disease control with fungicides in potted vines in East Timor.

Background:

Grapevines are primarily grown in Darwin for their leaves, which are used in Greek style cooking. A disease known as grapevine leaf rust (GLR) affected these household vines. It is caused by the fungal pathogen *Phakopsora euvitis,* which was detected in 2001. The Primary Industries Ministerial Council agreed to participate in an eradication program provided there was industry support for research (including replacement grapevines) and assistance with communication and public relations. Since the detection of the

disease, research funded by the Grape and Wine Research and Development Corporation, has included many *in vitro* assessments such as *Vitis* and native grape species for resistance, fungicidal control, temperature and leaf wetness influences on pathogen growth and disease development and PCR-RFLP identification of the pathogen. During 2005-06 research was directed to a small potted vine trial in East Timor. The aim was to confirm that fungicides with proven disease control in the laboratory could be applied effectively and control the disease on actively growing vines in the field. The research activities also included the continuation of two other activities - PCR-RFLP identification and temperature and leaf wetness monitoring within the canopies of sentinel vines. The scientific advisory panel formed to supervise the eradication and research programs has guided the direction of the research to ensure the appropriate knowledge for the protection of the wine and grape industries is generated.

Results:

PCR-RFLP assay

There are two other *Phakopsora* species closely related to *P. euvitis* which are very similar morphologically. They infect two other species in the grapevine family (Vitaceae): *Parthenocissus tricuspidata* and *Ampelopsis brevipendunculata*. Furthermore, there is a second species, *P. uva* which causes GLR and it affects *Vitis* spp. in North America. Also, the host range of *P. euvitis* was recently expanded to include two species of *Ampelocissus* native to the Top End. They were found to be susceptible during research in Darwin. For these reasons, it is important to be able to rapidly and accurately confirm the identity of a rust pathogen occurring on any species within the Vitaceae family. DNA analysis provides such ability. The PCR-RFLP assay developed to identify *P. euvitis* is an important diagnostic test to have available in the event that detection of leaf rust occurs outside the quarantine area.

The protocol for PCR-RFLP analysis developed in Japan has been successfully modified and adapted for use in Darwin. The test has been used to demonstrate the difference between *P. euvitis* and a number of rust pathogens occurring locally on other host species. Subject to the availability of funds, it is intended to develop the test further to be able to detect disease in symptom-less leaf tissue and possibly extend it to real-time PCR. This technology is much faster and more sensitive than conventional PCR. It also allows testing of a far greater number of samples. The added sensitivity of the method may mean it is better suited to bulk testing of asymptomatic samples, i.e. sampling a large number of vines for testing during an eradication program. Currently identification relies on harvesting DNA from spores of the pathogen already present on diseased leaves.

Monitoring of sentinel vine canopy climate characteristics

Data logging instruments to measure temperature, humidity and leaf wetness were placed in the canopies of four grapevines in suburban yards and six native grapevines (*Ampelocissus* spp.) growing in remnant vegetation at CSIRO, Berrimah. The intention was to compare this data with laboratory generated data that demonstrates the temperature and leaf wetness influence on pathogen growth and disease development. This would help illustrate which periods of the year are most conductive to disease. In addition, if an infection did occur in one of the vines under observation, the information recorded by the instruments could be used to help explain the infection period. Differences in the data between native and *Vitis* spp. vines could also be used to explain why infection readily occurs on the cultivated vines in people's home gardens and not in native vines.

No disease occurred in the vines during the period in which the data logging instruments were in place. Throughout the experiment there were significant problems experienced with the instruments. The data recorders (despite claims from the manufacturers) were not water-tight. Replacements were provided half way into the trial. Subsequent analysis of the data showed problems with extremely high temperature spikes when exposed to the full sun. Hence, no data from any of the temperature and humidity instruments could be used. In addition, the instruments used to record leaf wetness data included a cable in their design. Many of those placed in native grapevines had their cables chewed by rats or possums. In conclusion, not enough

valid data was generated to satisfy the intended aims. The design of the experiment will be modified and it will be attempted again this year.

Fungicide assessment in East Timor

All known diseased vines in Darwin were removed as part of the GLR eradication program. Research involving live cultures of the pathogen is therefore not possible. However, the pathogen occurs widely in East Timor and there are no measures taken to control it. This provided an opportunity to conduct a trial to assess the efficacy of fungicides on actively growing vines in a field.

A shade-house in which to grow *Vitis* spp. in pots was constructed in Dili with the assistance of the East Timor Ministry of Agriculture, Forestry and Fisheries. The vines used in the assessments were from cuttings of locally grown vines. The potting mix was produced from local materials including sand from river beds and coffee bean husks. Prior to being potted the cuttings were sanitised by dipping in a fungicide (Mancozeb). However, before the trial could progress any further, civil unrest broke out in the country and DPIFM staff were prevented from further travel. It was therefore decided to formally terminate this part of the project prior to its conclusion.

Project: A Management System for Fusarium Wilt of Snake Beans

Project Officers: B. Condé and I. Arao-Arao with R. Meldrum (Graduate Trainee)

Location: Darwin

Objective:

To develop a management system for Fusarium wilt of snake beans.

Background:

Fusarium wilt of snake beans which is caused by *Fusarium oxysporum* f.sp. *tracheiphilum* (Fot) was first detected in the NT in Darwin in mid 1999. The value of the snake bean industry had peaked at $1.23 million before the impact of Fusarium wilt. The disease has seriously affected the snake bean industry. By 2004, the value of the industry had dropped to $456,000.

In early work we found that there are three strains of the pathogen in the Darwin area which can be differentiated on culture characteristics including colour. Experiments in 2001-03 showed that the three strains belong to three different VCGs. In the work reported here, the three strains are represented by the isolates 24946 (the original, 'plum' coloured isolate), 26536 (white) and 26571 (pink).

Method and results:

Races and VCG of Fot

During 2005-6, stem and root samples were obtained from three properties in three localities, Webb Road (20 samples), Lambells Lagoon Road (15 samples) and Berry Springs (four samples). The samples were assayed for Fot strain using plants of Eden cowpea as baits, followed by isolating from infected Eden plants. The pink and white strains were predominant on the three properties, while pink was the dominant strain. The ‘plum’ strain was found occasionally at the Webb Road property. The plum strain had been recorded only rarely previously, once in 1999, and once in 2004 from Webb Road.

Breeding for resistance

Previous breeding based on the cross (cowpea Arafura x snake bean green pod Kaohsiung (GPK) was abandoned because all 377 back-cross second generation F1 plants (bc2F1) derived from the first back-cross F1 generation (bc1F1) (plant # 2-2) were screened as susceptible to the white strain of Fot. The F1 (bc1F1) generation (plant #2-2) were therefore re-tested against all three strains. In contrast to previous results, they were found to be susceptible rather than resistant. This may have occurred because the present screening was more rigorous than the earlier screening. Since the Arafura cowpea is resistant to all three strains, it would appear that the resistance may be recessive rather than dominant in inheritance. Progeny of the new cross, cowpea iron x GPK was screened against Fot white strain. F1 plants were susceptible. A ratio of 199 infected to 180 uninfected F2 plants was obtained. This suggested that the inheritance of the resistance to white Fot is probably recessive. For dominant resistance, an initial cross is made followed by successive back-crosses to the commercial parent. If resistance is recessive, the F2 needs to be back-crossed to the commercial parent, with selfing steps between each back-crossing, in order to retain resistance.

This project will continue if external funding is obtained.

Project: Management Systems for Diseases of Vegetables - Tomatoes

Project Officers: B. Condé and I. Arao-Arao

Location: Darwin

Objective

To develop a management system for diseases of tomatoes.

Background:

Since the late 1980s, Asian vegetables grown by Vietnamese and other Asian growers have dominated the vegetable industry in the Darwin rural area. There has been some resurgence in demand for 'conventional' vegetables, such as tomatoes, cucumbers and other cucurbits. The diversity of vegetables has increased demand for diagnostic services and for the development of improved practices for disease management.

Method and results:

Leaf roll

Tomato leaf roll disease caused by tomato leaf curl Gemini virus (TLCV-Au) was discovered in the NT in 1970. This virus has always shown a sigmoid curve of incidence with a high level of disease early in the year, then levelling out to a very low level mid way through the dry season. However, in early October 2004, a farmer reported a significant level of the disease in his late season crop. This was found to be associated with high numbers of B-biotype sweet potato whiteflies (*Bemisia tabaci*), which had multiplied on the weed *Euphorbia heterophylla* which was growing adjacent to the crop. Abnormally high levels of leaf roll disease were also reported in early June 2006 on a farm at Darwin River. Again there were large populations of B-biotype whiteflies, this time associated with a nearby *Phyllanthus* sp. weed which was thriving on late wet season rains. Because of a recent outbreak of tomato yellow leaf curl virus (TYLCV) in south-east Queensland, the virus in the leaf roll infected tomatoes was identified and confirmed as the local TLCV-Au.

Project: Management System for Diseases of Vegetables – Cucurbit Powdery Mildew

Project Officers: **S. Bhuiyan, B. Condé, M. Boyd and C. Newbould**

Location: Katherine Research Station (KRS)

Objectives:

To determine whether the powdery mildew (PM) pathogen that affected watermelons in the Katherine region was different from those on other cucurbit crops.
To determine whether the apparent fungicide resistant PM isolate from the affected field was different from other isolates collected from unsprayed plots.
To assess the possibility of the occurrence of fungicide resistance to recommended systemic fungicides

Background:

In July 2005, DPIFM plant pathologists became aware of a problem with PM (*Podosphaera xanthii*, formerly *Sphaerotheca fuliginea*) that was causing concern in cucurbit crops in Katherine. The fungus seriously affected watermelons which are usually only mildly affected by PM. It also affected other cucurbit crops in the Katherine and Douglas Daly regions. PM can normally be effectively controlled with a range of fungicides in rotation. PM was apparent on leaves, petioles and even on fruit. Most of the growers used the recommended fungicide rotation without success. Some growers were facing a 20% loss in their crops due to PM. Growers suspected a new strain of pathogen which was resistant to at least one of the registered fungicides. Early in the investigations it was reported that a new race of cucurbit PM, *Podosphaera xanthii* f.sp. *citrullus* was affecting watermelons in Queensland, and was likely to be the one that appeared in the Katherine region.

Method:

Molecular analysis

PM-affected leaves were sent for molecular analysis to Dr James Cunnington of the Victorian Department of Primary Industries, at Knoxfield. QDPI&F also provided PM-affected watermelon seedlings from Bowen in Queensland, for molecular tests. The following samples were analysed:

- A watermelon, from a severely affected field with suspected fungicide resistant PM strain.
- A watermelon, a giant pumpkin and cucumbers from a KRS school plot that had not been sprayed with chemicals/fungicides.
- A watermelon from Bowen in Queensland.
- Kent gramma (*Cucurbita moschata*) from Berrimah Farm, Darwin

Fungicide resistance trial

Seedling bioassay

Four fungicides [Rubigan® (12% fenarimol), Nimrod® (25% bupirimate), Elect® (50% chlorothalonil) and Amistar® (50% azoxystrobin)] were used for the seedling bioassay and for the first fungicide sensitivity test. Watermelon seeds were sown in potting mix in a shade house on 23 August 20005. About three weeks after seeding, when seedlings had three expanded leaves, they were treated with fungicides. Effectiveness of fungicides was tested at the recommended label rate and also at double the recommended rate. Individual pots with seedlings were turned upside down and dipped in the fungicide solution for about 10 seconds. Four seedlings were used in each treatment, and four unsprayed seedlings served as controls. Seedlings were allowed to dry and were then taken to the powdery mildew-affected field. Treated and control seedlings were

kept overnight amongst field-grown watermelon plants with powdery mildew. After the overnight exposure to PM, seedlings were returned to the growth cabinet and maintained for two weeks for visible PM symptoms.

Fungicide sensitivity test on detached melon leaves

Watermelon seedlings were grown in pots in a shade house as described earlier. A sensitivity test was carried out with various concentrations of fungicides (0, 10, 25, 50, 100 and 200 mg a.i. /L). Seedling leaves were dipped in the fungicide/concentration solutions as described above, and left to dry. Leaves were removed and maintained on water agar in plastic Petri dishes. Using a fine paint brush, each leaf was inoculated with PM spores from infected leaves collected from an affected field and maintained in the KRS laboratory. The inoculated Petri-dishes were incubated in a growth cabinet with a 12-hour light/dark cycle at 25^{o}C. The disease severity was assessed under a dissection binocular microscope 10 days after inoculation using a standard powdery mildew scale from 0 (none) to 3 (highest).

A second sensitivity test was carried out with three more systemic fungicides [Folicur® (43% tebuconazole), Bayleton® (5% triadimefon) and Score® (25% difenoconazole)] on 4 November 2005 using the same procedure and fungal isolate as described above.

Results:

Molecular analysis

DNA sequence from the samples from various sources and locations did not reveal any differences among the isolates, nor from a 1999 sample of PM on *Vigna unguiculata* from Darwin. Dr Cunnington assigned all to Haplotype 27.

Seedling bioassay

Except for Elect®, all fungicides completely suppressed the disease on watermelon seedlings in the seedling bioassay test (Table 1).

Table 1. Efficacy of various fungicides against watermelon powdery mildew tested at KRS

Treatment	Product rate	Disease incidence (%)
Control		100
Rubigan	0.2 ml/L	0
Rubigan	0.4 ml/L	0
Nimrod	0.6 ml/L	0
Nimrod	1.2 ml/L	0
Elect	2.3 ml/L	100
Elect	4.6 ml/L	100
Amistar	0.6 g/L	0
Amistar	1.2 g/L	0

Fungicide sensitivity test

All fungicides except Elect® were assessed to be highly effective in the fungicide sensitivity tests. Amistar® showed less effectiveness at lower concentration (Tables 2 and 3). The results for Bayleton® were not included because they were erratic.

Table 2. The sensitivity* of powdery mildew against various fungicides tested at KRS in August 2005

Treatment/rate	0 mg/L	10 mg/L	25 mg/L	50 mg/L	100 mg/L	200 mg/L
Control	2.5					
Rubigan		0	0	0	0	0
Amistar		1.83	0.29	0	0	0
Nimrod		0	0	0	0	0
Elect				0.5	0.83	1.33

*The disease severity was assessed under a dissection binocular microscope ten days after inoculation using a standard powdery mildew scale from 0 (none) to 3 (highest).

Table 3. The sensitivity* of powdery mildew against various fungicides tested at the KRS in November 2005

Treatment/rate	0 mg/L	10 mg/L	25 mg/L	50 mg/L	100 mg/L	200 mg/L
Control	3					
Folicur		0	0	0	0	0
Score		0	0	0	0	0

*The disease severity was assessed under a dissection binocular microscope ten days after inoculation using a standard powdery mildew scale from 0 (none) to 3 (highest).

Discussion:

The results from the molecular test show that the PM of concern is the same species as normal (*P. xanthii*) and that it is highly unlikely that a different subspecies is present. During these investigations it was confirmed that *Podosphaera xanthii* f.sp. *citrullus* did not occur in Queensland and the existence of a specific overseas watermelon race, P. x. f.sp. *citrullus,* was dismissed.

This study demonstrated that the PM of watermelons and other cucurbits in Katherine are not resistant to the fungicides tested. The reduced control of PM in Katherine this year may be due to one or a combination of the following reasons:

- Infection and disease started earlier than in previous years. Due to the absence of visible symptoms, it is sometimes very difficult to detect the disease early enough to control with sprays.
- The development of more virulent new local or introduced strains on seedlings of watermelon.
- Inadequate spray cover, particularly on the underside of leaves, coupled with a virulent strain of PM.
- Although PM can normally be effectively controlled by a range of fungicides in rotation, the sprays in this trial may not have worked because the infection was too advanced.

The apparent reduced efficacy of Elect, which is a broad-spectrum protective fungicide mainly used for managing gummy stem rot, anthracnose and downy mildew in cucurbits, needs to be investigated further. However, neither chlorothalonil (Elect) nor copper fungicides have been traditionally recommended for PM control.

Among plant diseases, PM is known to have a high potential to develop resistance to fungicides. Reports from most of the cucurbit growing regions of Australia and around the world suggest that fungicide resistance is developed within a few years of use of new PM fungicides in cucurbits. A PM trial on zucchini at Berrimah Farm in 1978 detected resistance to Benlate ® (benomyl). Although, no PM resistance to fungicides was detected this year, it is quite possible that the NT will face this problem in future from imported interstate seedlings. Also, the incorrect use of systemic fungicides with specific modes of action, poses a potential risk for the development of a resistant fungus in the NT.

Project:	**Management of the 'Tropical' Race 4 Strain of Banana Fusarium Wilt**
Project Officers:	**A. Daly, G. Walduck, D. Cumberland and L. Chidwick**
Location:	Darwin

Objectives:

To identify banana varieties that are resistant/tolerant to tropical race 4 Fusarium wilt.
To conduct studies to improve on-farm disease management to minimize plant losses.

Background:

The Tropical race 4 strain of banana Fusarium wilt, caused by *Fusarium oxysporum* f. sp. *cubense* (*Foc* TR4), is a fungal disease for which there is no effective chemical control. It has been detected since 1997 in several localities in Darwin's rural area. The incursion highlighted the need to seek sources of resistance to the pathogen and assess ways in which the disease can be better managed. A site at the Coastal Plains Research Farm (CPRF), gazetted as the Coastal Plains Banana Quarantine Station (CPBQS), was opened in 2001 to conduct secure research and to artificially infect with the soil-borne disease. The susceptibility of a number of different varieties is being currently assessed. The varieties were planted in five stages (batches) in each year between 2001 and 2004 and a planting in early 2006. Management options for the disease are being investigated at commercially-producing properties and at CPBQS.

Results:

Variety susceptibility assessments

Table1. Banana varieties being assessed for resistance to the 'Tropical race 4' strain of *Fusarium* wilt and their susceptibility to the disease in Darwin

Variety	Batch	Genome	Susceptibility (plant crops)	Susceptibility (ratoon crops)	Market acceptance
Williams (Cavendish)	1	AAA	+++	+++	Good
GCTCV-119 (Cavendish, ex Taiwan)	1	AAA	+	+	Good
FHIA-01 (Gold finger)	1	AAAB	++	+	Variable
FHIA-17	1	AAAA	+++	+++	Good
FHIA-18 (Bananza)	1	AAAB	++	+	Good
FHIA-25 (Cooking type)	1		R	R	Poor
SH-3640 (High Noon)	1	AAAB	+++	+++	Good
Musa accuminata sub. sp. *malaccensis* (845)	1	AA	++	++	None (seeded)
Musa accuminata sub. sp. *malaccensis* (846)	1	AA	++	++	None (seeded)
Musa accuminata sub. sp. *malaccensis* (848)	1	AA	++	++	None (seeded)
Musa accuminata sub. sp. *malaccensis* (850)	1	AA	R	R	None (seeded)
Musa accuminata sub. sp. *malaccensis* (851)	1	AA	R	R	None (seeded)
Musa accuminata sub. sp. *malaccensis* (852)	1	AA	R	R	None (seeded)
Pisang Berungan	1	AA/AAA	+++	-	Good
FHIA 23 (hybrid)	2A	AAAA	++++	++++	Average
Mutiara E	2A	AAB	+++	+++	Good
Novaria D (Cavendish)	2A	AAA	+++	+++	Good
Novaria G (Cavendish)	2A	AAA	+++	+++	Good
Pisang Embun	2A	AA	++	+++	Good
Pisang Jari Buaya	2A	AA	+	+	Average
Ducasse	2B	ABB	+++	+++	Good
Grand Nain (Cavendish)	2B	AAA	+++	+++	Good
Improved lady finger	2B	AAB	+++	+++	Good
Pacific plantain (cooking type)	3	AAB	+++	++++	Good
Pisang Celan	3	AAB	++	+++	Good
GCTCV Formosana (Cavendish)	3	AAA	+++	+++	Good
D5 (ex South Africa)	3	AAA	+++	+++	-
DPM25 (ex DPI&F)	3	AAA	+++	+++	-
PKZ (ex South Africa)	3	AAAB	+++	+++	-
RSS3 (ex South Africa)	3	AAA	+++	+++	-
CJ19 (Cavendish, ex Indonesia)	4	AAA	-	-	-
Dwarf Parfitt	4	AAA	-	-	-
Blue Java	4	ABB	-	-	-
Dwarf red dacca	4	AAA	-	-	-
Williams (Cavendish)	4	AAA	-	-	-

Note: R = resistant and + = susceptible based on internal disease symptoms and the number of plant deaths (more the + symbols, greater is the susceptibility).

As shown in Table 1, there is a high degree of susceptibility for most varieties in both the plant and ratoon crop cycles. The plants in Batch 4 are still under assessment for the first signs of disease.

Some plants show resistance. However, FHIA-25, a hybrid variety developed in Honduras, is only suitable for use in cooking and the three *M. accuminata* sub. sp. *malaccensis* types are selections from a wild, seeded type that is completely unsuitable for consumption. However, its genes confer resistance and may be useful in conventional breeding programs or for genetically engineering resistant edible bananas.

Other plants show a very low level of susceptibility in successive generations of bunching (ratoon crops). GCTCV-119 is a mutant variety of Cavendish with improved resistance to *Foc* (subtropical strain) selected from infested fields in Taiwan. It produces fruit with the same edibility as Cavendish but is very poor-yielding and would not be commercially viable. FHIA-01(Gold finger), a hybrid variety from Honduras, is a dessert banana that has shown moderate resistance to *Foc* TR4 in the plant crop under very high inoculum pressure and high resistance in subsequent generations. Although it is grown quite successfully in Queensland and NSW where it is resistant to the sub-tropical strain of *Foc,* the eating quality is variable when grown in the tropics. FHIA-18 (Bananza) is a close relative of FHIA-01. It also showed moderate resistance in the plant crop and high resistance in ratoon crops. It is currently grown in NSW in very small quantities as a substitute for lady finger. These two varieties will not be considered favourably by the market as suitable replacements for Cavendish. However, they may have potential as a dessert banana in their own right and be successfully grown commercially in *Foc* TR4-infested fields. Although it produces edible fruit, Pisang Jari Buaya is mainly of interest for breeding due to its disease resistance and does not produce commercially acceptable bunches.

Disease ratings of all varieties made in the field are backed up by laboratory testing of selected plants in each replicate to confirm infection with the pathogen.

Infested site sterilisation trials

Current trials aim to reduce commercial losses by improving disease management. Results of an assessment of a temperature/time relationship for sanitation of *Foc* TR4-infected plant tissue and subsequent advice given to farmers has encouraged some to burn any newly-infected plants on their properties. The method is to surround the infected plant and the two plants on either side of it with a heat shield - corrugated iron and intense fire. It is important to leave the infected plant standing so that there is minimal disturbance of to the site and the pathogen in the plant. Fuel wood must also be continually supplied to the fire to keep it burning until all of the plant parts have been “cooked”. There is strong anecdotal evidence to suggest that the practice has led to a marked decrease in the infection rate in the plant crop by limiting the spread from plant to plant to almost nil.

Further research was conducted to determine the depth of subterranean heat transfer and the temperatures reached to provide an indication of how effective the procedure may be at reducing pathogen levels in the soil. This was essentially a preliminary investigation into the viability of a larger, more comprehensive method to treat infested sites on newly infected properties where the pathogen might be isolated to a few areas only. Seven individual burns were conducted at CPRF prior to the onset of the 2005 wet season. The burns included the use of different amounts/types of fuel loads each time (rectangle bales vs. square bales, one batch of bales vs. two and three batches). Temperatures to a depth of 50 cm below the surface were recorded. Infected pieces of banana pseudo-stem and rhizome material were buried in a radial pattern at 10 cm depths down to 40 cm for four of the burns to correlate the recorded heat with the ability to sterilise the infected material.

In general, the lateral heat transfer tended to be more limited than the vertical transfer, leading to patchy heat if there were areas not covered by hay. Recovery of the pathogen from material buried at depths of 30 cm and 40 cm was possible where the temperature only reached 50 to 55ºC. Generally, the small number of successful results obtained with buried material shows consistency within each burn but not between burns due to the different fuel loads, types and rain.

The field treatments appeared pretty effective based simply on recovery rates of the pathogen from buried material. However, literature relating to Race 1 of *Foc* indicates that chlamydospores, the long-lived survival structures that remain in the soil indefinitely, can only be found in large numbers in the cortex (outer area) of roots of diseased plants. If and when they form in the pseudo-stem and rhizome tissues, that may not occur until the diseased material begins to rot. Therefore, it was important to try to prepare cultures in the laboratory that would contain chlamydospores to determine if they were more heat-tolerant than micro and macrospores, the short-lived types of spores that predominantly form in an infected plant. Three types of

cultures containing chlamydospores were prepared: filter paper (with *Foc* grown on the surface), agar and pre-sterilised potting mix. All were then heat-treated in temperature controlled incubators. All three mediums containing chlamydospores gave similar results. After heat treatment for 24 hours, *Foc* could still be recovered from filter paper at 80ºC and from potting mix at 75ºC, indicating that chlamydospores are significantly more heat-tolerant than micro and macrospores.

The development of a successful standardised method for treating *Foc* infested sites effectively must take a "holistic" approach. For a method to be developed, there are several questions that need to be answered in future research. These include determining the depth that infected roots penetrate the soil profile, to what depth spores of *Foc* leach into the profile if re-infestation of *Foc* occurs from outside the zone of effective heat (occurs with *Fusarium* wilt pathogens of other crops), and the effect of treatment on general microbe diversity. A comprehensive approach for treatment should also include replenishment of the general microbial flora to inhibit re-infestation with *Foc* following heat treatment. Fusarium wilt pathogens are notorious for their ability to re-infest sterilised areas of soil. As such, there is a need to investigate the effect of adding organic matter on *Foc* activity and survival of existing and added microbes and the type and effect of added microbes.

Project: Management Systems for Cotton Diseases – Alternaria Leaf Spots

Project Officers: S. Bhuiyan, M. Boyd, C. Martin and R. Pitkethley

Location: Katherine Research Station (KRS)

Objectives:

To determine the effects of timing of Mancozeb applications on disease severity of Alternaria leaf spot.
To determine the survival of the two Alternaria pathogens under field conditions.
To determine the prevalence of the two Alternaria species through the growing season.

Background:

Alternaria leaf blight has been considered a minor disease in cotton-growing of areas of southern Australia. However, the disease has been reported to be severe in the last few years in the Katherine (NT), Kununurra (WA) and Burdekin (QLD) regions and may be a problem for a developing cotton industry in northern Australia. Evidence suggests that two organisms, *Alternaria alternata* and *A. macrospora* are the causal agents of Alternaria leaf spot.

Method:

Disease incidence and severity

The experiment was conducted at KRS in a completely randomised block design with five treatments as follows:

1. Control
2. Mancozeb @ 2.5 kg/ha every four days
3. Mancozeb @ 2.5 kg/ha every seven days
4. Mancozeb @ 3 kg/ha every four days
5. Mancozeb @ 3 kg/ha every seven days

Each treatment was replicated five times. Fungicide (Mancozeb) was sprayed with a hand held boom sprayer at a pressure of 400 kPa.

Ten randomly selected plants from each plot were marked with flagging tape. A plant was selected for assessment of disease incidence and severity at weekly intervals. Main stem leaves at three canopy levels (1-7 nodes, 8-14 nodes, and 15+ nodes) were assessed visually for disease incidence and severity. A modified visual scale was used for the assessment of disease severity. Disease severity on cotton bolls was assessed after 48 hours of last spray.

Survival

Survival of Alternaria pathogens was assessed by placing infected leaves at various conditions in the field and in the laboratory.

Prevalence of causal organisms

Types of causal organisms were assessed on infected leaves from the beginning of the first sign of infection and continued up to the end of the growing season.

Results:

Severity and incidence

Disease incidence and leaf shedding were higher in unsprayed controls than on Mancozeb-treated plots. No significant differences were observed among Mancozeb-treated plots. Similarly, disease severity was higher on leaves and bolls of non-treated plots than of treated plots (Figure 1 and 2), and no significant differences were observed among Mancozeb-treated cotton plots.

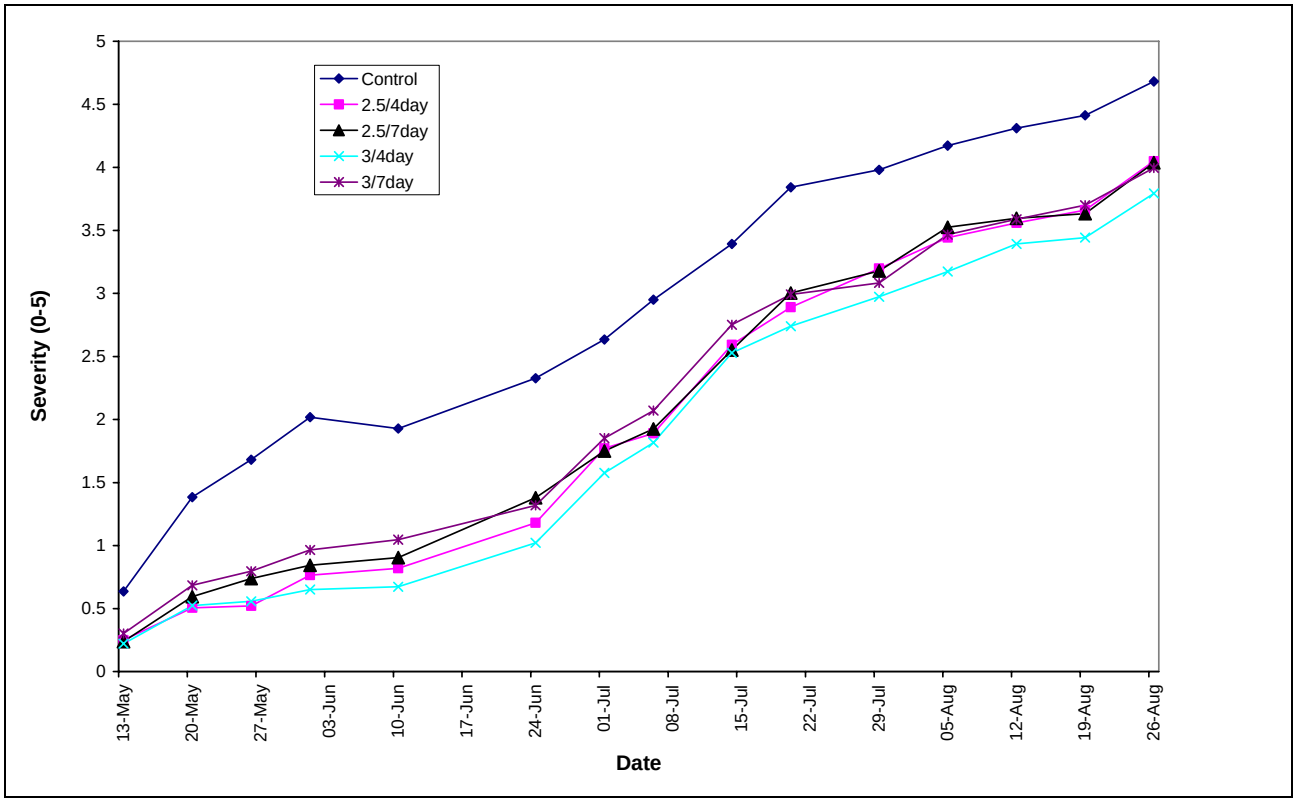


Figure 1. Severity of Alternaria spot on cotton leaves during the cotton growing season at KRS, 2005

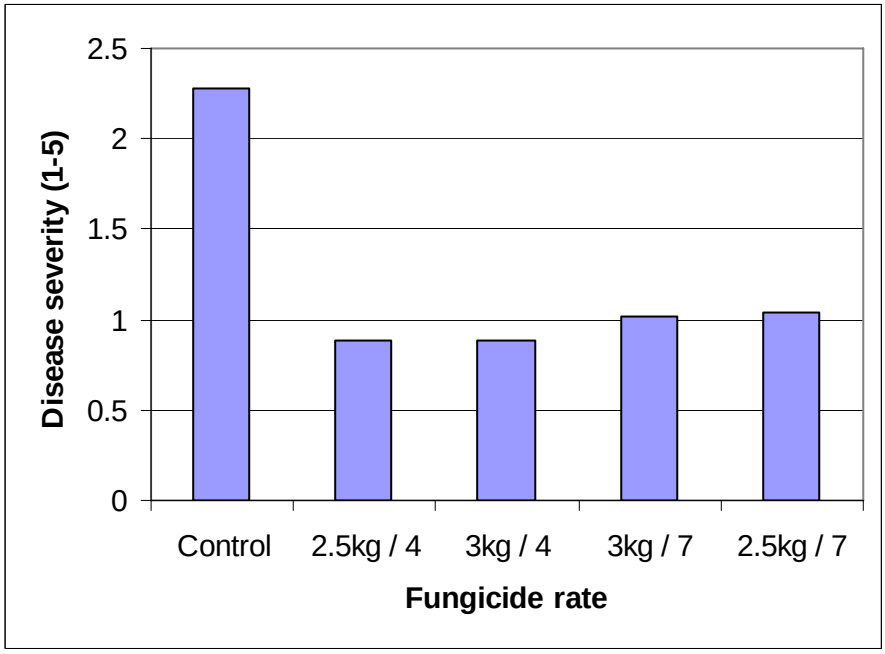


Figure 2. Severity of Alternaria spot on cotton bolls during the cotton growing season at KRS, 2005

Survival

The causal organisms of Alternaria leaf spot survived for more than six months in the laboratory, and for four and a half months on cotton debris in the field (Figure 3). This suggests that cotton debris in the field may be a reservoir of disease inoculum for the following year.

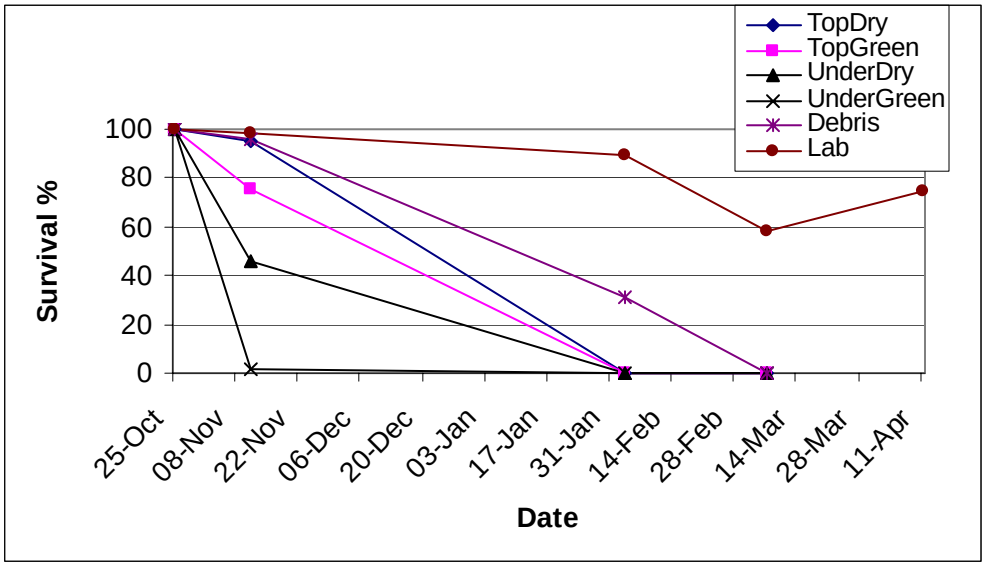


Figure 3. Survival of causal organisms of Alternaria leaf spot under various conditions, 2005

Prevalence of causal organisms

The incidence of *Alternaria macrospora* was higher on cotton leaves at the beginning of the growing season, decreasing towards the end of the season. On the other hand, the incidence of *A. alternata* was lower at the beginning and gradually increased towards the end (Figure 4). Climatic conditions and age of the plant may be responsible for differential prevalence of both causal organisms.

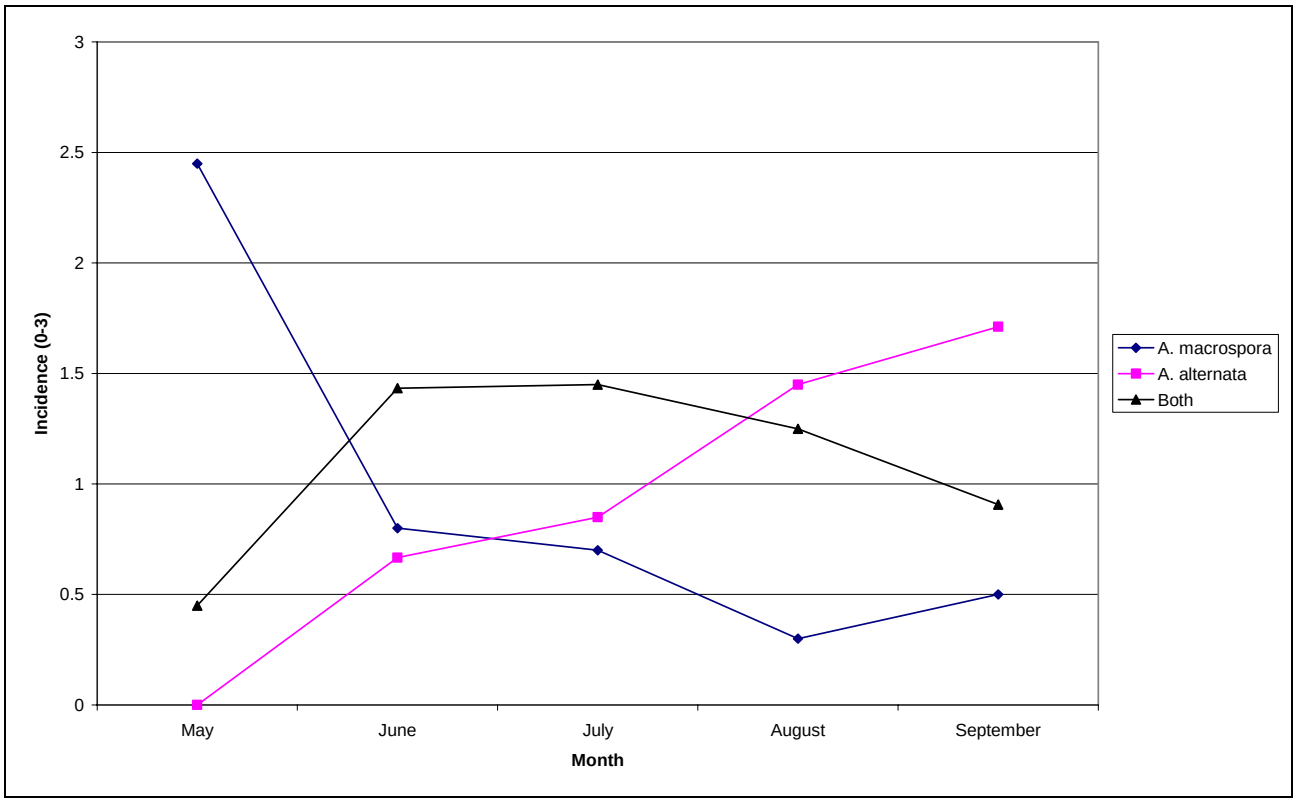


Figure 4. Prevalence of causal organisms (*Alternaria macrospora* and *A. alternata*) at various times of the growing season

Project: Management of Leaf Spot Disease in Peanuts

Project Officers: S. Bhuiyan, M. Bennett and M. Kahl

Location: Katherine Research Station

Objective:

To develop a fungicide spray model for the management of leaf spot disease in peanuts in the Katherine and Douglas Daly regions based on weather variables.

Background:

Peanuts (*Arachis hypogaea*) are becoming an important crop in the NT where they are grown in winter. In contrast, peanuts are grown in summer months in Queensland and New South Wales. Therefore, peanuts grown in the NT supply a market niche both nationally and internationally.

Early and late spots caused by *Cercospora arachidicola* and *Cercosporidium personatum,* respectively are the most important diseases of peanuts throughout the world including Australia. These diseases can devastate a peanut crop by reducing yield by up to 70%. Currently no varieties are resistant to leaf spot diseases. The current management recommendation is to initiate chemical fungicide application four to five weeks after sowing and continue on a 10 to 14-day schedule until 14 days prior to harvest. Excessive use of chemical fungicide could hamper future peanut production by affecting soil chemistry and soil microbial activity, as well as contributing to the development of resistant pathogens.

Method:

A model (Virginia Advisory) developed by Cu and Phipps (1993) in the USA for scheduling peanut leaf spot fungicide application is being used as the basis for this research. The field experiment is being conducted at the farm of the Peanut Company of Australia in Katherine, using a completely randomized block design. The experiment, which will be running for at least three years, started in April 2006. It will be modified to suit the climatic conditions of the Katherine region.

Expected outcome

- Better timing of fungicide application may result in reduced fungicide use.
- Improved environmental and economic sustainability for the NT and Australian peanut industry.
- Potential use of the weather-based model for managing other agricultural and horticultural crops in NT

Reference:

Cu, R. M. and Phipps, P. M. (1993). Development of a pathogen growth response model for the Virginia peanut leaf spot advisory program. *Phytopathology* **83**, 195-201

Project: Survey for Banana Leaf Spot Diseases

Project Officer: A. Daly

Location: Darwin

Objective:

To survey banana plants and collect samples of leaf spot diseases for laboratory identification to ensure freedom from Black Sigatoka.

Background:

As part of national surveys to detect Black Sigatoka on bananas, 11 suspect leaf samples were collected from seven localities in Darwin residential, Darwin rural and Gove. These included three commercial and four residential properties. As Black Sigatoka cannot be easily distinguished from other specific leaf spot diseases in the field, suspect samples were forwarded to QDPI&F (Mareeba) for identification of the pathogen by microscopic and DNA analysis.

Results:

The causal organisms of the various collected leaf spots were:

- *Mycosphaerella musae* (Mycosphaerella leaf speckle).
- *Mycosphaerella musicola* (Yellow Sigatoka leaf spot).
- *Guignardia musae* (Freckle).

Black Sigatoka was not detected.

Project: Post-harvest Disease and Disorder Assessment of Sea- freighted Mangoes

Project Officers: S. Bhuiyan, M. Boyd, D. Owens and J. Bird

Location: Katherine Research Station

Objectives:

To assess post-harvest quality of sea-freighted mangoes.
To determine the causal organisms associated with sea-freighted mangoes from Katherine and Kununurra.
To determine the effects of time on the prevalence of causal organisms on diseased mangoes.

Background:

Mango growing is a fast growing industry in Australia. As a result, local markets are being saturated rapidly. Recent research indicates that mangoes can be stored for up to six weeks by lowering the temperature to ~13^{o}C and the O_2 level, and by increasing the CO_2 of the surrounding atmosphere. Shipping containers equipped with controlled atmosphere (CA) technology, have opened a window of opportunity for Australian mangoes to be sent to distant overseas markets relatively cheaply. The performance of each consignment depends on infection and inoculum levels of post-harvest diseases associated with the export of fruit. Post-harvest diseases are the main constraint to long-term storage and transport to overseas markets. Little is

known about the post-harvest diseases of mangoes and their causal organisms in the Katherine and Kununurra regions.

Method:

Five growers from Katherine participated in the sea-freight static trial by providing 40 export quality ('A' grade) mangoes each. The mangoes were maintained at 13^{o}C in export boxes. The fruit was inspected at weekly intervals for up to four weeks. Then the fruit was maintained at about 22^{o}C for two weeks. Visual assessment was conducted of 400 mangoes for post-harvest disease incidence. Causal organisms of fruit infections were determined by standard laboratory procedures.

Ten growers from Kununurra also participated in the sea-freight static trial. Fruit was maintained at 13^{o}C for four weeks at Western Australia's Kimberley Research Station. Fruit exhibiting post-harvest diseases was sent to Plant Pathology in Katherine for identification.

Results:

Disease incidence

The overall disease incidence on mangoes from the Katherine region was approximately 13.5%. Disease incidence varies within growers' fruit from 2.5 to 27.5% (Figure 1). The wide range of differences of post-harvest diseases between individual grower's fruit may be due to variations in orchard condition, age of tree, position of fruit, canopy density, pruning, sanitation practices and pre-harvest treatment activities.

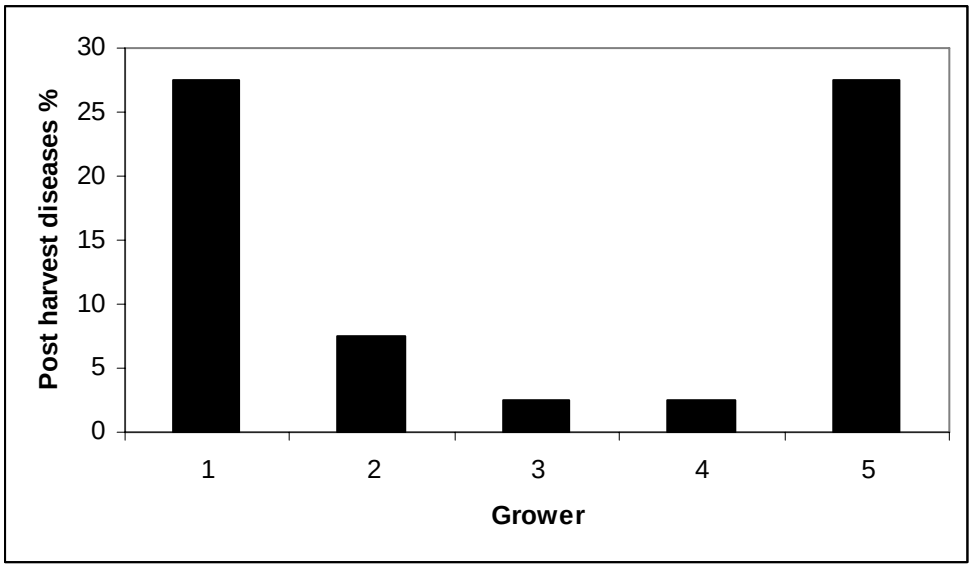


Figure 1. Incidence of post harvest diseases of sea-freighted mangoes from the Katherine region, 2005

Post harvest disorder

Post-harvest disorders were high among sea-freighted mangoes (Figure 2). The overall incidence of lenticel spotting was more than 40% from the beginning of the assessment and reached 90% after five weeks of maintenance at 13^{o}C. Other types of post-harvest disorders remained within 5% to 28%. Most of the post-harvest disorders were related to pre- and post-harvest treatments, fruit handling and plant nutrition. The higher percentage of post-harvest disorders in Katherine fruit warrants better management practices.

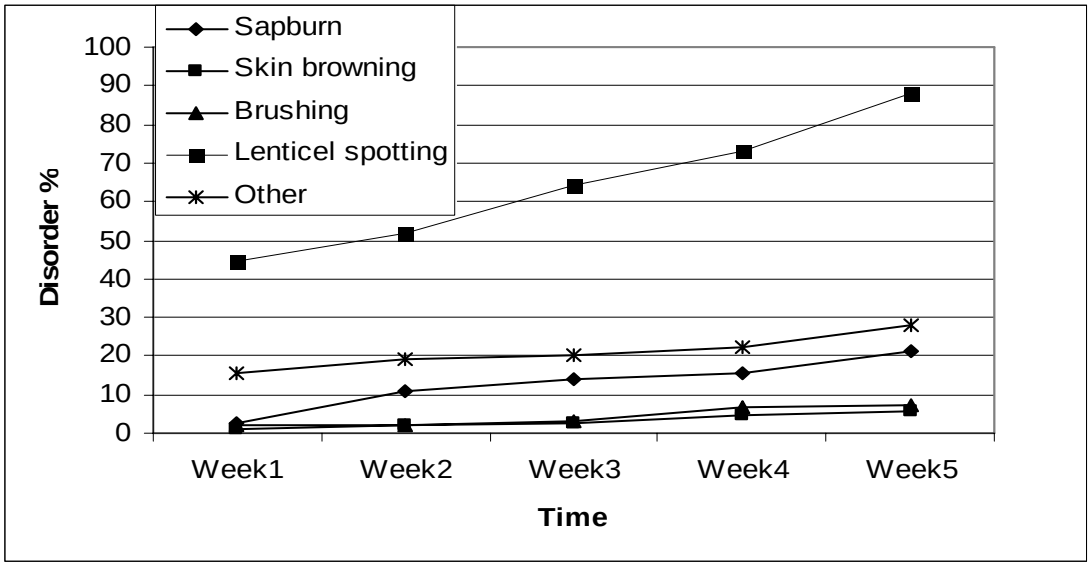


Figure 2. Post harvest disorder of sea-freighted mango from the Katherine region, 2005

Causal organisms and their prevalence at various times

More than 25% of fruit collected from Katherine was invaded by *Penicillium* sp. followed by *Fusicoccum* sp. at 20%, *Aspergillus niger* and *Alternaria alternata* at 16%, after four weeks of incubation at 13^{o}C (Figure 3). After five weeks, *Fusicoccum* sp. was the most prevalent at 78%, followed by *Pestalotiopsis mangiferae, Alternaria alternata* and *Fusicoccum parvum* (Figure 4). After six weeks, the most prevalent organism was *Fusicoccum* sp at 50% followed by *Pestalotiopsis mangiferae* at 36% and *Aspegillus niger* at 14% (Figure 5).

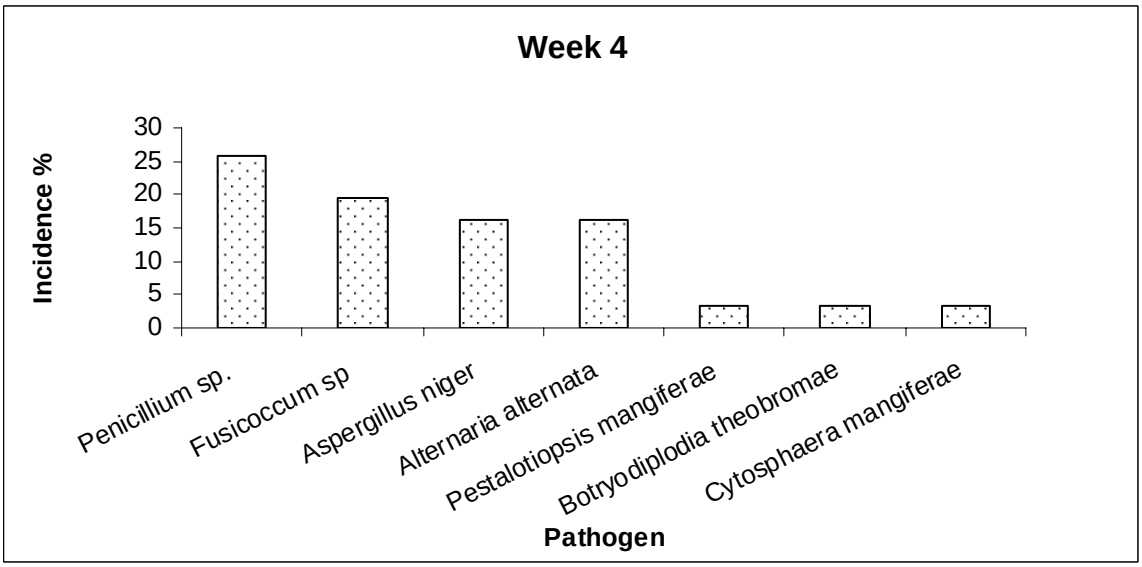


Figure 3. Organisms associated with post-harvest diseases of mangoes from the Katherine region after four weeks of maintenance at 13^{o}C, 2005

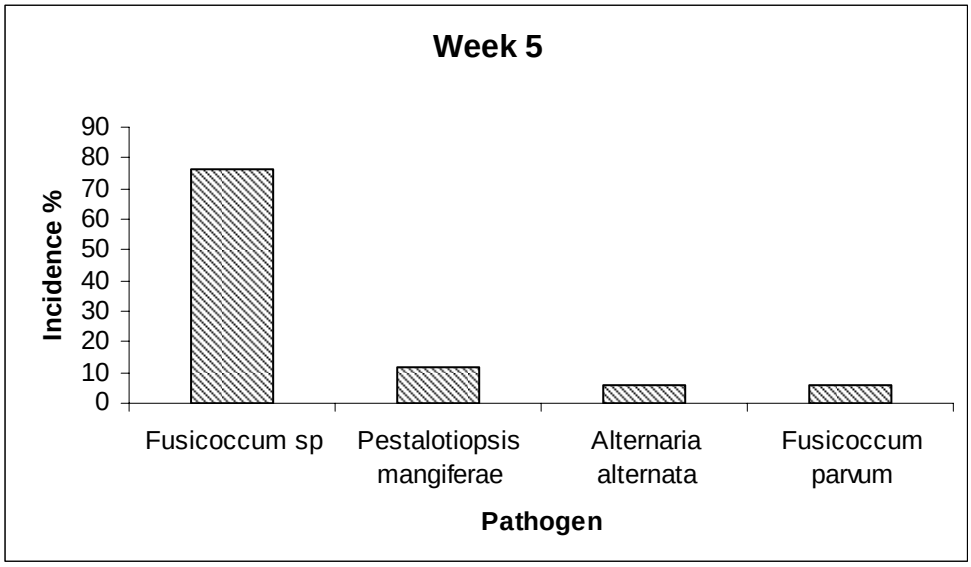


Figure 4. Organisms associated with post-harvest diseases of mangoes from the Katherine region after four weeks of maintenance at 13°C and then one week at 22°C, 2005

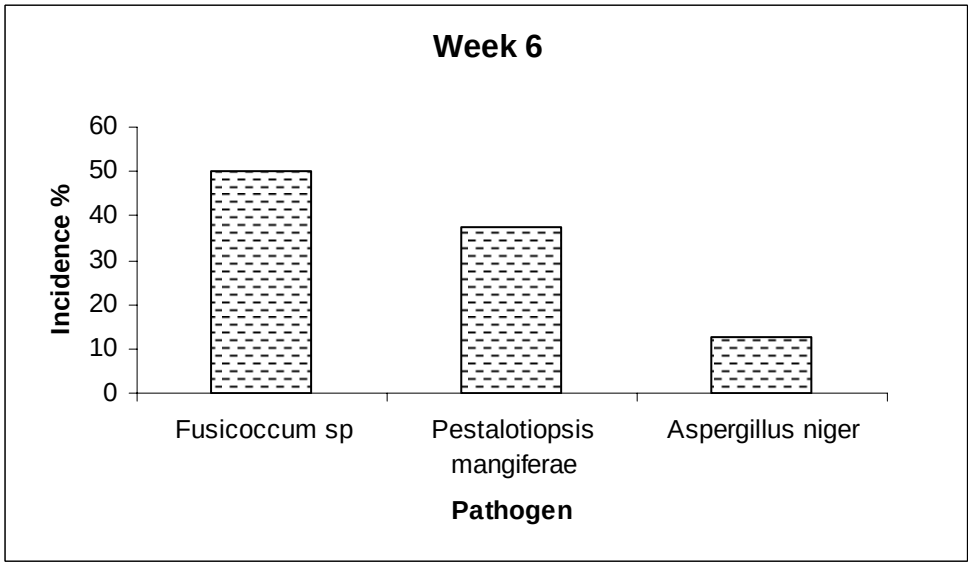


Figure 5. Organisms associated with post-harvest diseases of mangoes from the Katherine region after four weeks of maintenance at 13°C and then two weeks at 22°C, 2005

About 30% of fruit collected from Kununurra was invaded by *Fusicoccum* sp and *Alternaria alternata* followed by *Fusicoccum mangiferum* at 10%, *Pestalotiopsis mangiferae* and *Phomopsis mangiferae* at 5% (Figure 6)

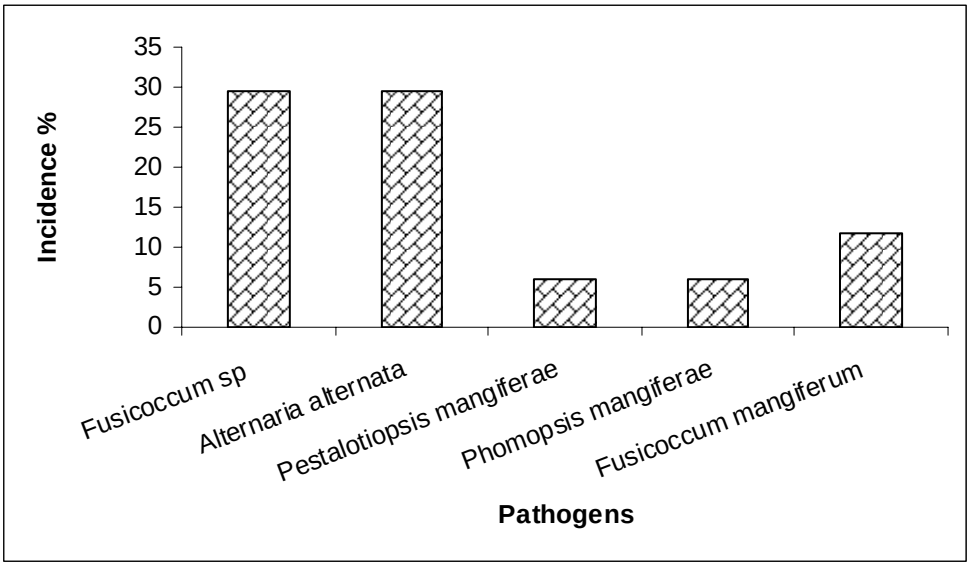


Figure 6. Organisms associated with post-harvest diseases of mangoes from the Kununurra region after four weeks of maintenance at 13^{o}C, 2005

A high percentage of *Penicillium* sp. and *Aspergillus* sp. were associated with post-harvest diseases of mangoes from Katherine. Use of clean machinery, equipment and packing material will reduce disease incidence due to these organisms. The two most prevalent organisms, *Fusicoccum* sp. and *Alternaria alternata* recorded in both Katherine and Kununurra mangoes are, in contrast, rarely recorded at high levels in Queensland and New South Wales mangoes. The implications of these two organisms on post-harvest diseases and their management are not known. More work needs to be done to understand the biology, ecology and epidemiology of these two organisms in order to develop an effective management strategy.

Program: Seed Testing

Project: Seed Testing Laboratory

Project Officers: A. Simonato and L. Simington

Location: Berrimah Farm

Objective

To provide an accurate and reliable seed testing service to the pastoral industry, Government and the public in the NT.

During the year 276 consignments were submitted for testing.

The following tests were carried out on the submitted lots.

Test	Number
Certification	2
Purity	6
Germination	241
Bulk search	8
Quarantine inspection	33
Quarantine identification	48
Comparative test	0
Tetrazolium test	21
Import examination international	0
Export examination interstate	8
Seed count	2
Identifications	5
Audit samples	2
Total	376

Other seeds issues

1. During 2005, 22.6 tonnes of seed was certified.

2. A seed sampling course was presented in Katherine.

3. Two germination cabinets were upgraded in the Seed Laboratory.

4. Ongoing issues included the sale of *Digitaria* spp. as Jarra seed (*Digitaria milanjiana*). Seed of Jarra (an improved pasture grass from Queensland) is often contaminated with other *Digitaria* sp. such as summer grass (*Digitaria ciliaris*). Samples of Jarra seed are sent to Queensland laboratories. The laboratories are not asked to identify the grass before testing. The NT laboratory can confidently identify the various *Digitaria* species, as has been shown in the past when NT growers sent tested seed back to the sellers because it was shown to be contaminated. Now the samples are harder to identify as the seeds are either coated or pelleted and the coating has to be removed before identification can take place.

Seeds advisory activities in 2005-06

1. Type/number of requests

a)	Letter	
b)	Visit	9
c)	Telephone	132
d)	E-mail	10
e)	Total	151

2. Topics of requests

a)	Pasture species	45
b)	Fertiliser	3
c)	Seeds and planting material	49
d)	Hay and silage	
e)	Lawn and turf	
f)	Pasture establishment	27
g)	Pasture quality	
h)	Identifications	54
i)	Irrigation	
j)	Weeds and herbicides	17
k)	Yield	
l)	Seed production	120
m)	Copies of publications	
n)	Other	7
o)	Seed testing	94
p)	Seed quality	37
q)	Seed export	5
r)	Seed machinery	4
s)	Quarantine	22

3. Information supplied to

a)	Primary Producers	55
b)	QDPI	
c)	Interstate	5
d)	Other NTG	23
e)	CSIRO	
f)	Overseas	
g)	Other	11
h)	Agribusiness	
i)	Student	10
j)	DPIFM	38

Program: Water Chemistry

Project: Water Chemistry

Project Officers: K. Timms, K. Cooper, S. Skliros, D. McBean and L. Simington

Location: Darwin - Berrimah Farm

Objective:

To provide a high quality, timely and cost-effective water testing service that meets the needs of the government and the private sector in the Northern Territory.

Background:

The water chemistry laboratory is one of three NT Government testing laboratories which are responsible for monitoring water quality in the NT. The other two are the Darwin and Alice Springs water microbiology laboratories. The major client is the NT PowerWater. Other clients include NTG agencies such as Department of Natural Resources, Environment and the Arts (NRETA) mining and exploration companies, private land-owners, manufacturing and the aquaculture industry.

The laboratory tests samples for parameters along three main lines – stock and domestic, waste discharge and environmental monitoring. The laboratory helped to ensure drinking water in the NT was within safe chemical limits.

Results:

In 2005-06 the laboratory tested 2900 samples, of which about 800 were from PowerWater. The workload and cost is determined by the number of tests required per sample. The total number of tests performed by the laboratory reached 12 000 out of which 7800 were for PowerWater.

The number of samples has been relatively stable overall, with a slight change in sample types. Bore testing by government and private clients has slowed, while industry monitoring of potable water has increased. There has been an increase too in the number of companies in the private sector testing waste output for both traditional waste parameters such as solids, nitrogen and biological oxygen demand and nutrient loading parameters such as nitrate / nitrite and phosphates.

The creation of the EPA group within NRETA has also seen an increase in clients monitoring for a range of parameters for discharge licensing. In the last year these requests from clients were preceded by work generated by environmental consultants as part of the environmental impact study related to client activities. In particular, the chlorophyll-a and pheophytin-a work was directed to the water chemistry laboratory as the only provider of this service in the NT.

The national association of testing authorities' accreditation is expected for the water chemistry laboratory by the end of 2006.

Program: Water Microbiology Laboratories

Objective:

To conduct bacteriological analyses of water for government departments, the private sector and the general public.

The Department's water microbiology laboratories (WML) provides a testing service for numerous water types including potable water, waste water, recreational water, bottled water, food processing water and dialysis water. WML provides advice and assistance on water quality monitoring, water sample collection, water sample transport logistics and the rectification of water quality problems including disinfection of potable water. WML also functions as a referral service for water quality issues directing enquiries to the appropriate government or private agencies.

WML has a large client base. All analytical services provided by WML are on a fee-for-service basis. WML is currently preparing to become a national association of testing authorities' accredited laboratory in the field of biological testing.

DPIFM has two water microbiology laboratories, one in Darwin and one in Alice Springs.

The Darwin WML

The Darwin laboratory is located in the Berrimah Veterinary Laboratories and services the northern region of the NT.

	2004-05	2005-06	Difference from 2004-05
Submissions	1946	1939	-0.4%
Total samples	6175	5965	-3.5%
Tests	21 612	19 386	-11.5%
PWC samples	3218	3181	-1.2%
NT Gov	1180	956	-23.4%
Sewage (all)	340	395	13.9%

Submissions for the 2005-06 period were slightly down compared with 2004-05, registering a decrease of 0.4%. Total samples decreased by 3.5% compared with last year which indicates some clients are electing to test fewer sample sites per testing episode. There was an increase of 13.9% in sewage testing. This is a result of PowerWater creating annual testing regimes for additional sites throughout remote areas of the NT. The number of NT Government samples declined by 23.4%, primarily due to a reduction in submissions from NT Parks and Wildlife.

WML is still providing an important service to the oil and gas rigs in the Timor Gap.

The Alice Springs WML

The Alice Springs laboratory is located at AZRI and services the southern region of the NT.

	2004-05	2005-06	Difference from 04/05
Submissions	171	311	81.9%
Total samples	2285	2421	6.0%
Tests	7199	7685	6.75%
PWC samples	2072	2058	- 0.7%
NT Gov.	42	52	23.8%
Sewage (all)	190	178	- 6.31%

Samples increased by 6.0% overall from 2004-05. This is due in part to Alice Springs taking over the weekly testing of Tennant Creek water supplies and the annual bore testing for Tennant Creek. Submissions increased 81.9% from 2004-05 due to the Granites Gold mine becoming a new client. Also new food licensing legislation, which is in its second year, requires private enterprises which provide food service from private water supplies, to test their water annually. Increasing public awareness of the services offered by WML has captured a larger number of private clients.

Government samples increased by 23.8% over last year, but are still less than in the 2003-04 financial year because roadside rest areas are no longer routinely monitored.

Sewage samples significantly decreased by 6.31% due to changes in the PowerWater sampling regime for sewage.

BIOSECURITY AND PRODUCT INTEGRITY

Program: Plant Market Access

Project:	**Provision of a Government Certification System**
Project Officers:	**J. Swan, P. Cawdrey, A. Mullins, J. Lindsay, S. Cross, B. Dilley, C. Ellis and A. Jacks**
Location:	Darwin, Katherine and Alice Springs

Objectives:

To provide NT produce access to markets in other Australian jurisdictions.
To provide plant health certificates specifying that entry conditions for those jurisdictions have been met.

Background:

NT produce - fresh fruit and vegetables, cut-flowers and nursery stock - consigned to jurisdictions which have quarantine entry requirements must be certified by either a plant health certificate (PHC) or interstate certification assurance (ICA) arrangements that those requirements have been met. Most producers have opted for ICA accreditation where an approved arrangement has been developed to enable certification. Where ICA is not available for a particular product, or consignments are irregular or few in number, or the ICA option is uneconomic, DPIFM may provide a PHC based on inspection or other procedures.

Nationally agreed ICA arrangements for cut-flowers and nursery stock have either not been developed, or are not yet approved. Industry members therefore need to seek departmental inspection and government certification prior to sending consignments to jurisdictions where entry restrictions exist.

Method:

The method for providing these services has been explained in previous Technical Annual Reports.

Results:

During the financial year to 30 June 2006, 1053 “on farm visits” were made for product certification or endorsement.

Project: Interstate Certification Assurance (ICA)

Project Officers: **J. Swan, P. Cawdrey, A. Mullins, S. Cross, S. Chester, J. Lindsay, C. Ellis and A. Jacks**

Location: Darwin, Katherine and Alice Springs

Objective:

To maintain market access for NT horticultural produce in Australia under approved ICA arrangements.

Background:

ICA is a system of plant health certification based on quality management principles. ICA provides an alternative to the traditional plant health certificate (PHC) through DPIFM inspectors. Traditionally, inspectors supervised treatment and/or inspected produce and issued a PHC for transporting produce intrastate or interstate.

Under ICA, a business can be accredited to issue plant health assurance certificates for its produce. To be accredited, a business must be able to demonstrate it has effective in-house procedures that ensure produce consigned to intrastate and interstate markets meets specified quarantine requirements.

The NT participates in a national auditing scheme whereby all States are systematically audited by another jurisdictional authority for compliance with the national memorandum of understanding.

Method:

The method for providing these services was described in the 2003 Technical Annual Report.

Results:

Operational procedures have been developed for a range of treatment and condition requirements including:

- dipping
- flood spraying
- low volume non-recirculating spraying
- fumigation
- heat treatment (vapour heat and hot water)
- cold treatment
- hard green/mature green/unbroken skin condition
- pre-harvest treatment and inspection
- splitting and reconsigning certified produce.

Over 450 arrangements are being currently utilised by over 230 businesses in the NT.

Further operational procedures will be developed as needed.

Project: Inspection of Imported Plant Material for Pests and Diseases

Project Officers: **J. Swan, P. Cawdrey, S. Cross, B. Dilley, A. Mullins, J. Lindsay, B. Gower, C. Ellis and A. Jacks**

Location: Territory wide

Objective:

To ensure that any plant products entering the NT from other regions of Australia comply with movement conditions under NT legislation.

Background:

The local horticultural industries are advantaged by reduced production costs and market opportunity as the NT is free from pests and diseases that occurring in other regions of Australia.

Plant material (fresh fruit and vegetables, cut flowers and nursery stock) entering the NT must comply with legislation and have accompanying certification that these requirements have been met.

The NT accepts plant health certification and interstate certification assurance (ICA) arrangements.

Method:

An ongoing inspection program is maintained at NT florists, nurseries, and fresh fruit and vegetable importers to inspect products from risk areas of Australia.

Targeted pests include western flower thrips, Mediterranean fruit flies, banana flies, cucumber flies and red imported fire ants (RIFA).

The NT considers RIFA as a particularly serious environmental and agricultural pest and high risk materials which may harbour this pest are routinely inspected by surveillance officers on arrival.

Results:

The NT detected pawpaw black spot on consignments of papaya from Queensland. The fruit was destroyed under quarantine supervision.

The spiralling whitefly was detected in Darwin suburbs and the immediate rural area. It is now established.

Program: Plant Biosecurity

Sub-program: Surveillance

Project: Surveys for Plant Pests and Diseases

Project Officers: **B. Gower and other Market Access Officers**

Location: Darwin Region

Objective:

To conduct surveys to detect incursions of targeted plant pests, diseases or weeds.

Background:

A range of general and targeted surveys are conducted to detect exotic plant pests and diseases to maintain the NT's free status from these organisms.

In addition to general surveillance conducted on most properties during visits for other regulatory or extension activities and when responding to reports from primary producers, government officers and the general public, the Division carries out targeted plant pest and disease surveillance. A surveillance program was conducted in the Darwin rural area targeting horticultural land parcels of mostly 2 to 20 hectares in size, to detect exotic plant pests and diseases. Over the 12 months to June 2006, 1019 blocks were inspected in four subdivisions as shown in Table 1.

Table 1. Exotic pest and disease survey in the Darwin rural area

Area	Number of blocks surveyed	Proportion of blocks surveyed (%)*
Wanderrie North	375	86
Virginia Road	236	90
Humpty Doo (A)	211	83
Humpty Doo (B)	193	87

* Some properties could not be surveyed because their gates were locked

The survey indicated that:

293 properties (29%) had banana plants
343 properties (34%) had mango trees
280 properties (27%) had citrus trees
14 properties (1%) had tropical vegetables
1 property (0.1%) had at least one grapevine.

The following items were reported to specialist diagnostic services:

Eight specimens/enquiries were forwarded to Plant Pathology
One specimen was forwarded to the RIFA Surveillance Officer
One grapevine location was reported to the NGLREP
Fifteen specimens were reported to Entomology
Six specimens were forwarded to the Weeds Branch. They included two aquatic weed species and one declared weed.

No new or targeted insects or fungal diseases of economic importance were identified.

Project: Exotic and Endemic Fruit Fly Monitoring

Project Officers: B. Dilley, A. Jacks, C. Ellis, E. Conway and D. Salter

Location: Territory wide

Objective:

To detect and identify exotic fruit flies and interstate fruit flies which are not endemic in the NT.

Background:

During the dry season, monitoring for exotic pest fruit flies is conducted fortnightly or more frequently if needed.

Strategic monitoring grids are located at the first ports of call (Darwin and Nhulunbuy) for international aircraft and shipping.

The NT also monitors for endemic interstate pest fruit flies that are not found in the NT. Several monitoring grids consisting of about 200 traps are located within the production areas of Darwin, Nhulunbuy, Katherine, Ti Tree, Tennant Creek and Alice Springs.

The early detection of pests reduces the cost of eradication.

Method:

Lures are assembled in Darwin and sent to the regions monthly. Since December 2003 the Nhulunbuy exotic fruit fly monitoring program has been conducted by AQIS. However, DPIFM still retains the identification and reporting functions.

An identification training workshop was conducted by Professor RAI Drew at the AQIS laboratories. Attendees included AQIS and NAQS personnel, Indonesian scientists and the senior author (B. Dilley).

All specimens collected from traps are sent to the Darwin office fortnightly for identification.

Results:

Two declared outbreaks of the Queensland fruit fly near Ti Tree are currently being eradicated. It is expected that the pest-free status of these areas will be regained by the start of the grape picking season.

No other targeted specimens were trapped during this period.

Project: Plant Pest Surveillance - National Requirements

Project Officers: **E.S.C. Smith, J. Swan, B. Gower, A. Jacks, B. Dilley, C. Ellis and A. Daly (Diagnostic Services)**

Location: Territory wide

Objective:

To conduct post-border surveillance to detect new incursions of targeted pest species.

Background:

The project enhances on-farm bio-security, increases public awareness of plant pests and diseases, contributes to the national plant-health knowledge base and underpins many of the requirements for interstate and international market access for NT plant products. Surveillance activities are intended to provide an early warning of incursions and to meet trade requirements.

Method:

Surveys for targeted pests and diseases are made on a routine basis and reported quarterly to the Commonwealth Department of Agriculture, Forestry and Fisheries. Visits were conducted under NT or national protocols to properties and areas with known hosts of targeted pests and diseases.

Results:

Currently, the NT reports quarterly on 27 surveillance activities, including:

- The red imported fire ant
- Citrus canker
- Panama disease
- Banana leaf diseases
- The European house borer.

Market access has been maintained for a range of NT horticultural products.

Following its detection in March 2006 and subsequent surveillance, it is confirmed that the spiralling whitefly is now an endemic pest in the Darwin and immediate rural area of the NT. It was previously known to be endemic only in coastal Queensland.

Sub-program: Incursion Response and Eradication

Project: The National Grapevine Leaf Rust Eradication Program (NGLREP)

Project Officers: S. West, G. Schultz and G. Hore

Location: Darwin

Objectives:

To continue surveillance for grapevine leaf rust (GLR) on all residual grapevines in the declared quarantine area (QA) within a radius of 50 km of the Darwin CBD and continue additional monitoring on grapevines outside the QA.
To remove any grapevines diagnosed with GLR and revisit all removed sites to ensure quarantine requirements are met.
To conduct surveillance for GLR on Ampelocissus acetosa and A. frutescens during their growth period of the wet season.

Background:

The fungus *Phakopsora euvitis* was detected on grapevines (*Vitis vinifera* L.) in July 2001 in Darwin. NGLREP was established to eradicate this exotic disease. All properties in Darwin, Palmerston and selected peri-urban blocks were surveyed and all identified vines were tested under Phase 1 of the program. Diseased vines were removed and destroyed by deep burial. A total of 38 934 properties were surveyed during that phase and 817 grapevines were identified on 482 properties. Phases 2 and 3 continued the monitoring, testing and removal of diseased vines. A scientific advisory panel (SAP) reviewed the eradication program, a research project on GLR, and resistance testing.

The research project identified that the native grapevine species *Ampelocissus acetosa* and *A. frutescens* could host GLR which resulted in the inclusion of monitoring of these species in the NGLREP program.

At the commencement of Phase 4 in July 2004, only 210 grapevines remained on 164 properties within the QA. Between November 2004 and March 2005 no GLR was detected. However, in April 2005, three GLR-positive grapevines were identified on two properties and were subsequently removed. In the same area, *Ampelocissus acetosa* had limited infection, which was the first recorded field infection by this species. Area freedom was proposed which required 12 months of negative testing before it could be declared.

Results:

Surveillance between April 2005 and April 2006 detected no GLR, leading to an application for area freedom status and the conclusion of the program in June 2006.

However, continued surveillance in April 2006 detected a GLR-positive grapevine in the Darwin suburb of Cullen Bay. The infection was recent and was considered to have occurred during the January to April 2006 samplings. Response protocols were followed. The vine was removed and all properties within a 2-km area were resurveyed. No *Vitis* or *Ampelocissus* plants were detected. It was concluded that a new incursion had occurred, which was backed by circumstantial evidence of a connection to Timor Leste where GLR is widespread on grapevines in the Dili area.

Monitoring continued during May 2006 and a second GLR was detected in Stuart Park. Again the infection was recent. A new response plan was prepared and protocols were followed. Buses of a neighbouring bus company which transport civilian contractors, oil and mining company personnel and military personnel who worked in Dili from the airport to their hotels were suspected. Cleaning of the vehicles was through sweeping into the open air or deposition into a nearby bulk bin, which was thought to be the likely infection route.

The SAP reviewed the program as a result of these new incursions and the NGLREP responses, trace backs and outcomes in relation to the amended work plan. It advised that the eradication of GLR was still possible.

All grapevines in Palmerston, the peri-urban area and outside the QA remain free of GLR.

As an additional research program on GLR, a shade house was constructed and local grapevines were planted in it in Dili with the assistance of the Timor Leste Department of Agriculture, Forestry and Fisheries. However, when new internal security problems surfaced in Dili in April 2006, this part of the project was cancelled.

The eradication of GLR is still considered feasible. Submissions have been made to maintain the cost-shared program and monitor all grapevines in the QA until 2007 when a formal declaration of freedom may be achievable

Media and Consultation

To keep the community informed on the progress of NGLREP, ongoing coverage is provided through the local media, a website and letters to householders.

Project: Management and Responses to Incursions of New Pests, Diseases and Weeds

Project Officers: All Branch Officers

Location: Territory wide

Objective:

To provide a timely response to incursions or potential incursions of new exotic pests, diseases and weeds to increase the feasibility of eradication and minimise its cost.

Background:

The NT has the potential to be the first place of entry for both interstate and international exotic pests, diseases and weeds that can affect the horticultural and agricultural industries and the community. Experience has shown that early detection and rapid response can increase the feasibility of eradication and greatly reduce costs. The Plant Health Branch has primary responsibility for the surveillance, detection, identification and (at least) the initial response to any incursion of a previously unreported plant pest, disease and weed.

Method:

Detection of an organism considered not present in the NT requires a situation report, which then requires the involvement of a specialist to identify a potentially new pest, disease or weed. The report must be confirmed and notification must be given to appropriate senior staff, legal officers, and Ministerial staff, specialist interstate plant pest/disease committees and Commonwealth and State authorities.

Management team structures and tasks have been established and any incident is managed according to the departmental response plan.

The Quarantine Section conducts an early investigation of the incident, puts in place containment operations and arranges resources. It would also be required to assist in developing procedures to maintain market access of plant material, in case it is affected.

Results:

The Branch was involved in several incidents relating to exotic pest, disease and weed incursions during the year.

Neptunia plena are a potential weed, which is prohibited from entering Australia. It was found growing in a waterhole on a property at Virginia. It was controlled with fluroxypyr starting in October 2004. Follow-up control continued in 2005 and 2006 including hand removal. By the end of May 2006, no plants were detected but the seed of *N. plena* has potential to remain dormant for many years. The area will be monitored to check for re-growth and conduct control if necessary.

Program: Reporting and Legislation

Sub-program: Plant Health

Project: Dissemination of Plant Quarantine Information

Project Officers: All Plant Biosecurity Officers

Location: Territory wide

Objective:

To provide relevant information and awareness on plant health requirements and arrangements in the NT to industry, DPIFM staff, other NT government departments, the Commonwealth and interstate primary industry and environmental agencies and the general public.

Background:

DPIFM officers are responsible for keeping industry, government departments and the public well informed of quarantine movement requirements for plant material between regions of Australia.

Various arrangements have been developed for market access to plant material under an interstate certification assurance system approved nationally. Advice regarding this and the alternate Government Certification methods are provided.

Method:

Various officers represented the NT at teleconferences or meetings both locally and interstate. The interaction during these meetings ensures that current information is provided and received and that new strategies are developed to maintain plant health status in the NT and in other jurisdictions. This information

is also distributed to industry bodies after approval at national level through the Plant Health Committee, Domestic Quarantine Market Access Working Group and the Interstate Certification Assurance Working Group.

Members provided a range of briefings and advice on plant health matters to DPIFM executives, other NT government departments, and interstate and Commonwealth primary industry and environmental agencies.

A DPIFM website has been developed for the general public and industry on quarantine, ICA, plant health, plant pests and diseases, exotic incursions and other relevant information.

Branch staff responded to email, telephone and direct enquiries from both industry and the general public on plant health matters.

Reference material and other documented information was produced and distributed to industry and other relevant stakeholders by post, electronic communication and, when required, by personal visits.

Training packages were delivered to industry and staff through a range of mechanisms.

Staff routinely attended regional shows and provided media interviews to highlight current issues and disseminate timely information.

Results*:*

During 2005-06 staff:

- Responded to more than 2000 telephone enquiries from the general public and industry.
- Attended grower properties, nurseries, florists and fresh fruit and vegetable outlets on a routine basis to check compliance and to advise on new conditions.
- Attended appointments and responded to enquiries for industry and the general public. More than 450 arrangements are currently utilised by over 230 businesses in the NT. All are maintained on the *Plant Health Information System* database, parts of which are available to interstate quarantine authorities.
- Continued to develop the NT quarantine website to provide the public ready access to information on current plant and plant product movement conditions and other issues of quarantine interest.
- Provided an in-office advisory service on market access to growers and the general public.
- Attended various national plant health meetings and provided information as part of national requirements.
- Maintained NT representation on over 80 plant health technical meetings, mostly by participating in teleconferences.
- Participated in 13 workshops and other focussed meetings to present relevant information.
- Attended a range of plant biosecurity meetings, including those at national and Territory level.
- Attended professional meetings and delivered presentations to technical groups.
- Delivered 10 media interviews and provided articles for dissemination of information.

Project: National Plant Health Reporting Requirements

Project Officers: I. Kilduff, E.S.C. Smith, I. Miller, J. Alcock and V. Kawaljenko

Location: Darwin

Objective:

To provide timely and appropriate reports on plant health policy and operations.

Background:

The Division has prime responsibility for plant quarantine within the NT and for maintaining interstate trade in plant products. To operate effectively, these functions require an appropriate framework for operational procedures and a reporting system to meet the Territory's jurisdictional, national and international obligations.

Method:

Various members of the Branch are delegates on national committees to provide consultation and reporting functions necessary for the effective operation of national and State/Territory plant health responsibilities.

Results:

During the year, the Division maintained representation on, and reported to, the following plant health technical committees:

- Plant Health Australia
- the Executive Committee of the CRC for Tropical Plant Protection
- the AusBIOSEC Risk Mitigation Steering Committee
- the AusBIOSEC Risk Mitigation Working Group
- the Product Integrity and Security Committee
- the Signatories Working Group
- the National Management Group for Emergency Plant Pests
- the Consultative Committee on Exotic Plant Pests
- the Consultative Committee on Exotic Plant Incursions
- the Plant Health Committee
- the Domestic Quarantine Market Access Working Group
- the Interstate Certification Assurance Working Group
- the Registration Liaison Committee
- the NT Weed Risk Assessment Technical Committee
- the North Australian Quarantine Strategy Stakeholders' Committee
- the North Australian Quarantine Strategy Technical Advisory Panel
- the North Australian Quarantine Strategy Joint Operational Group
- the Black Sigatoka Technical Working Group
- the National Diagnostics Network Steering Committee
- the National Vegetable Pathology Working Group
- the Torres Strait Fruit Fly Technical Advisory Panel
- the Scientific Advisory Panel for the National Grapevine Leaf Rust Eradication Program
- the National Monitoring Group for the Imported Fire Ant Eradication Program.

Appropriate NT responses were carried out for surveillance and eradication programs within the NT (as reported elsewhere in this Technical Annual Report) and for pest incursions in other States. The latter included participation in the decision-making processes, generally via teleconferences, of the Red Imported Fire Ant Eradication Program, the National Citrus Canker Eradication Program, the National Grapevine Leaf Rust Eradication Program, and incursions of the European House Borer, *Alternaria* on parsley, leaf disease on willows, anthracnose on lupins, electric ant and sugarcane smut.

Project: Plant Health Legislation

Project Officers: I. Kilduff, I. Miller and E. S. C. Smith

Location: Darwin

Objective:

To facilitate appropriate legislation to enable the NT to trade in plant products and maintain its relative freedom from incursions of plant pests and diseases.

Background:

In 1999 an NT Quarantine Review identified deficiencies in the existing *Plant Diseases Control Act 1979*. Occurrences of the exotic fruit fly and Panama disease have also tested the usefulness of the Act, while control of diseases such as grapevine leaf rust requires legislative provisions that enable effective survey and eradication activities.

Method:

The process to seek approval to draft new plant health legislation in the NT began in November 2002, based on a recommendation in the 1999 NT Quarantine Review on procedures. Consultations were held with interested parties in the Territory's plant-based and related industries as part of the initial process.

In June 2003, the NT Government approved the drafting of a new Plant Health Bill and the release of a public discussion paper. The discussion paper was widely distributed and outlined the necessity to create awareness for new plant health legislation and the type of changes being proposed. The paper invited public comment to assist in the preparation of drafting instructions. The discussion paper was explained at a series of public meetings during the latter half of 2003.

As a result of public consultation, an examination of interstate legislation and consideration of the existing NT legislation, the drafting instructions for the proposed Plant Health Bill were forwarded to Parliamentary Counsel in June 2004.

Results:

A Plant Health Bill was drafted between late 2004 and early 2006. Drafting instructions for Plant Health Regulations, which will assist in giving effect to the Act, are also being developed. Approval was given on 29 May 2006 to release a ‘Discussion Draft for a Proposed Plant Health Act’ for public comment. In early June, the draft was mailed to 90 stakeholders and advertised in the Territory media inviting comment.

Comments from public consultations will be assessed and further drafting instructions will be prepared recommending changes to the Bill before seeking approval to introduce it to the Legislative Assembly. The outcome of a competition impact analysis may also require amendments to the Bill.

Sub-program: Animal Health

Project: Legislation and Compliance

Project Officers: B. Radunz, Project Leaders and Parliamentary Counsel

Location: Territory wide

Objectives:

To amend stock and meat legislation as required.
To amalgamate the various stock legislations into a Stock Act.
To conduct a legislation and compliance program.

Currently, there are five Acts with associated Regulations, relating to stock: the *Stock Diseases Act,* the *Stock and Travelling Stock Act,* the *Brands Act,* the *Exotic Disease Compensation Act,* and the *Hormonal Growth Promotants {Stock} Act*). The goal is to amalgamate the legislation into a Stock Act and concurrently remove outdated and unnecessary legislation.

To prevent the spread of disease, notices by the Minister or the Chief Inspector of Stock are prepared to provide the necessary legislative powers to control stock movements within the NT and/or the importation of stock into the NT.

There is a program to audit compliance with the more important regulatory controls. If non-compliance is detected the response may be to initiate a prosecution, issue an infringement notice, or provide education and a warning.

Activities:

Due to higher priorities in the government's legislation program, there was slow progress in the revision of the draft Livestock Bill planned for introduction early in 2007

The following notice was gazetted: G 25 21 June 2006 Approval of Identification Devices

Compliance

The following number of audits completed:

Abattoir	0
Export depots	8
Saleyard	60
Tick conditions – (horses)	9

No cases of non-compliance detected during the audits.

Program: Animal Market Access

Objective:

To support the trade in animals and animal products by maintaining internationally and nationally acceptable standards for animal health assurance.

Projects in the Animal Market Access Program deliver services to protect and enhance the health and marketability of NT livestock and livestock products.

Consistent with the national animal health performance standards, there are six core functions and nine core capabilities:

Core functions

- Consumer protection.
- Trade and market access.
- Disease surveillance.
- Endemic disease management.
- Emergency preparedness and response.
- Livestock welfare.

Core capabilities

- Policy development.
- Management.
- Service capability/capacity.
- Information management.
- Livestock tracing.
- Training.
- Communication.
- Research and development.
- Legislation and regulation.

Disease surveillance is required to:

- Detect emergency animal diseases and emerging diseases early
- Ensure freedom from disease regionally and nationally to support trade
- Provide data to justify the issuing of property of origin certificates for the export of livestock.

Certification, inspection and treatment are provided in the NT for domestic and export trade in livestock. The project facilitates domestic livestock marketing and provides property of origin certificates for the export market. Annually, between 500 and 600 property visits are made, 100 000 to 110 000 animals are inspected and 400 to 600 property of origin certificates are issued.

The tuberculosis eradication and surveillance program is almost complete. There are national surveillance programs such as the Transmissible Spongiform Encephalopathy Freedom Assurance Program, the National Animal Health Information System and the National Arbovirus Monitoring program to support trade. Risk management programs such as bans on swill feeding, bans on ruminant feeding and biosecurity plans contribute to the protection and development of trade in livestock and livestock products.

Livestock welfare outcomes are achieved for farmed livestock to the satisfaction of consumers and markets. Acceptable livestock welfare is increasing in importance for market access for animals and animal products.

Internationally and nationally acceptable standards for animal health assurance must be maintained to support the trade of animals and animal products. The estimated annual turnoff of cattle is between 500 000 and 550 000 with only about 1500 slaughtered in NT abattoirs. The remainder (both slaughter and feeder animals) are slaughtered at abattoirs in other States or overseas. About 1000 camels and up to 2500 buffalo are exported annually. Destination market health and welfare requirements must be met.

A key function is to provide health certificates for consignments of livestock and livestock products produced in the NT to comply with requirements of importing States and countries. In order to provide credible health certificates, the program monitors the disease status of NT livestock by investigating disease incidents and conducting planned surveillance activities. Information is collected on the prevalence, incidence and distribution of bacterial and viral animal diseases, plant toxins and other toxic and deficiency problems. Disease investigations provide surveillance data which facilitates trade and also assists in providing advice on options to control disease. Planned surveys may be done to maintain or increase market access.

Berrimah Veterinary Laboratories (BVL) plays an important role in gathering objective information on disease status of NT livestock.

Programs are also in place to satisfy consumer demands for animal products that are free from disease and chemical residues. Such programs also help protect the community from zoonoses (diseases transmitted from animals to humans).

The NT is represented by the Chief Veterinary Officer on the national Animal Health Committee and the national Consultative Committee on Emergency Animal Disease.

The programs depend on a team of professional and dedicated stock inspectors, veterinary officers and clerical support staff, in close collaboration with BVL staff.

Project: Animal Health Information System

Project Officers: F. Human, R. Wilson, BVL Staff and Veterinary Officers

Location: Territory wide

Objectives:

To maintain an efficient and reliable database to store animal health and disease information.
To coordinate the NT component of a national animal health information network.

An accurate and reliable mainframe database called ANDI is used for storing animal health and disease information. ANDI is used by both laboratory and field animal health staff for storing and retrieving investigation details and test results. Quantitative data from ANDI is used for preparing NT reports to the National Animal Health Information System, the National Arbovirus Monitoring Program and any other requested reports. Significant disease event information is stored on ANDI.

ANDI is used to record and report details and results of all submissions to Berrimah Veterinary Laboratories from a wide variety of clients, such as DPIFM staff in animal production, agriculture and fisheries, private veterinary clinics, livestock exporters and the public.

The NT participated in the National Information Managers Technical Group to propose a national approach to a national animal health information management system. A flexible approach is being considered to include plant diseases and pests. It has three components:

- Surveillance, quarantine, control and recovery.
- A resource management program.
- MiniCRIS - a spatial database linked to an attribute database.

Project: Animal Welfare

Project Officers: M. Perez-Ruiz and Pastoral Division Staff

Location: Territory wide

Objectives:

To participate in the development and implementation of appropriate national welfare standards for animals.
To represent the NT on relevant national and local committees.
To attend to livestock welfare incidents as required.

Departmental officers are primarily responsible for livestock issues under the NT *Animal Welfare Act*. A memorandum of understanding to define roles and responsibilities is currently being developed between DPIFM and the Department of Local Government, Housing and Sport, which is the agency responsible for administering the *Animal Welfare Act*. Veterinary staff represent the Territory Government on animal welfare matters in a variety of forums, including:

The animal welfare working group (AWWG)

AWWG reports to the Animal Health Committee under the Primary Industries Ministerial Council (PIMC) and met for the 14th and 15th time in 2005-06. The terms of reference of the group were expanded during the previous financial year from livestock to dealing with all animal welfare issues of national significance. However, with the implementation of the Australian Animal Welfare Strategy, there is an impending review of AWWG which is likely to be rearranged and become the proposed Production Animal Standing Committee or Production Animal Technical Subcommittee, removing companion animal management issues from its agenda.

AWWG has advised that there is no provision for consideration of companion animal management and planning issues in the Coalition of Attorney Generals' Ministerial committee structure. The majority of members on PIMC and its committees have no legislative responsibility for companion animal management. The Local Government and Planning Ministers' Council coordinates State and Territory local government planning and management activities and is viewed by the working group as the most appropriate council to determine companion animal management policy.

A major business of AWWG is the national Model Code of Practice for the Welfare of Animals. Codes of practice under revision or being drafted include those on pigs, crocodiles, land transport of sheep, goats, poultry, emus, deer, horses, and destruction or capture, handling and marketing of feral animals. They are at various stages in the process, and some will be available soon. The relevant codes are progressively adopted under the NT *Animal Welfare Act*.

The revision of the camel code, which is coordinated by the Territory, started in 2003. A major change was the reduction in resting hump height clearance and pen area. A regulation impact statement was prepared and the revised code was endorsed by PIMC and published in 2006. The ostrich code was finalised and

published. The revision of the pig code has proven to be a logistical challenge and has taken longer to complete than was expected.

For the past 20 years, the welfare of livestock in Australia has been supported by the Model Codes of Practice for the Welfare of Animals. As community values and expectations have changed and our international trading partners have placed greater emphasis on animal welfare, the usefulness and relevance of these codes has been called into question, as has the process by which these codes are revised and developed.

To address these issues, the Primary Industries Standing Committee (PISC) commissioned a consultancy, managed and funded by the Department of Agriculture, Fisheries and Forestry (DAFF), to consider arrangements for reviewing and developing the codes as a basis for Australia's future animal welfare regulation. This review, called the Neumann report, contains a number of recommendations and proposed options for on-going arrangements. The report was extensively circulated. Responses were provided by all interested jurisdictions, industry organisations and key welfare groups.

There is broad consensus among all governments and peak industry bodies regarding a preferred future process for revising and developing new welfare standards and guidelines. Under the Australian Animal Welfare Strategy, it is proposed that the existing Model Codes of Practice be re-written in a new format to incorporate both the national welfare standards and industry 'best practice' guidelines for each species or enterprise such as saleyards and abattoirs. The initial task is to re-format each of the 22 existing Model Codes into a document that combines Australian welfare standards and supporting guidelines for that species or enterprise, using a standard template.

Final agreement on the new expanded arrangements has yet to be reached, but it is expected that the national animal welfare standards, with complementary industry guidelines, will provide welfare outcomes that meet community and international expectations and reflect Australia's position as a leader in modern welfare practice.

AWWG is examining the issue regulating the transport of livestock across jurisdictions. A paper is being prepared for discussion with all relevant parties and for consideration by PISC in the future.

The national consultative committee on animal welfare (NCCAW)

NCCAW reports to the Federal Minister for Agriculture, Fisheries and Forestry and met for the 36th and 37th time in 2005-06. NCCAW is due for review and may be substantially reduced or even disbanded with the establishment of an Australian Animal Welfare Policy Committee with the NT representative to be nominated from Primary Industries and/or NT Animal Welfare Advisory Committee (NTAWAC).

Version 2 of the Australian Standards for the Export of Livestock was modified in part to ensure the standards are verifiable and enforceable. The standards were developed from comments received from stakeholders and welfare organisations on version 1 that became enacted in 2005. These comments were considered by the Livestock Export Standards Advisory Committee and the Technical Working Group.

Commencement of the WSPA campaign against long distance transport has now been delayed until 2007. WSPA is reported to be conducting further research, including economic analyses of the transportation industry. Discussion regarding contingency arrangements for off-loading animals in emergency situations, such as truck breakdowns, is yet to progress. Availability of yards, watering and feeding facilities on long-haul routes are relevant issues for the NT.

One of many functions of NCCAW is to produce Position Statements which serve as policy guidelines. NCCAW Position Statements are discussed in the interests of achieving a national approach. Topics under discussion include animal welfare, animal liberation and animal rights; guidelines for welfare of pet birds; rodeo guidelines; layer hen housing; rodent traps; circuses; ritual slaughter standards; dog and cat codes

and related companion animal management issues; jumps racing; animal welfare in emergency animal disease response and a national code of practice for zoos. This material is available at www.affa.gov.au/docs/animalplanthealth/animal_welfare/nccaw.

The Australian animal welfare strategy (AAWS)

DAFF is funding and coordinating the strategy. There are three goals:

- To achieve an enhanced national approach to animal welfare.
- To achieve sustainable improvements in animal welfare.
- To achieve effective communication, education and training across the whole community to promote an improved understanding of animal welfare.

DAFF advised that recruitment for the AAWS implementation program was completed by May 2005. The next step was to convene an AAWS steering committee to focus on three activities: documenting existing activities in 25 areas of animal welfare, defining gaps in animal welfare, and setting priorities and timeframes. NCCAW has assumed responsibility for reviews of AAWS and monitoring of its implementation and is organising a national workshop to discuss the next steps of the AAWS implementation process, evaluate sectoral plans, identify priorities and update on communication activities. Further details can be found on the DAFF website.

NTAWAC

The *Animal Welfare Act* is under review and a draft is expected to be circulated to members by the end of 2006. The independent group, the Animal Management in Rural and Remote Indigenous Communities was appointed in April 2006 as the 10th member of NTAWAC.

The department has a representative on NTAWAC which met for the 14th and 15th time. A number of issues that have relevance to the Territory were discussed. They included companion animal management issues, care and treatment of rodeo livestock, the national curriculum for training inspectors, harmonisation of legislation, guidelines for the housing of caged birds, the Neumann Report, live export standards, the pig code, AAWS, dangerous dogs, collection and reporting of statistics for use of animals in research in the NT and the ban on mulesing. Model Codes of Practice for the Welfare of Animals and NCCAW Position Statements of relevance to the NT are discussed with a view for adoption under the Act in the interests of achieving a consistent national approach.

Two model codes of practice for the welfare of animals were adopted: Cattle 2nd edition and Domestic Poultry 4th edition. Two position statements were adopted: Recommended National Circus Standards and Rodent Traps.

Animal welfare incidents

All reported animal welfare incidents were investigated. No significant cases were reported of starving, injured or perishing livestock. Ten incidents required attention by departmental staff. Necessary remedial action was undertaken and there were no prosecutions.

The animal ethics committee

The department supplies an expert member to the Charles Darwin University Animal Ethics Committee. The committee scrutinises all department projects that use animals, in accordance with the NT *Animal Welfare Act.*

Project: Accreditation Program for Australian Veterinarians (APAV)

Project Officer: **R. Morton**

Location: Territory wide

Objective:

To provide training and accreditation to private veterinarians to enable them to participate in national animal health programs.

APAV is a national program designed to integrate private veterinary practitioners into the national animal health system to support Australia's international standing in animal health service capability. Animal Health Australia manages this program on behalf of members.

The program aims to have an internationally recognised process for accrediting non-government veterinarians for involvement in government and industry animal disease programs and to effectively use their skills and knowledge.

APAV has two key parts – an "accreditation" process that provides a veterinarian with basic information about Australian animal health services and other issues relevant to the role of an accredited veterinarian, and an "operational" process that provides newly accredited veterinarians with specific knowledge and skills to enable them to participate in one or more programs requiring accredited veterinarians.

Currently there are nine APAV accredited veterinarians working in the NT. All work in the livestock export industry.

In June a meeting was held in Canberra to review the APAV program. It was decided that an on-line training and assessment program be developed for introduction in 2007.

Project: Chemical Residues and Hormonal Growth Promotants

Project Officer: **M. Perez-Ruiz**

Location: Territory wide

Objectives:

To provide chemical residue-free animal products to the consumer and protect and maintain the NT meat and milk markets.
To provide an independent, authoritative and scientifically competent advisory service to industry, government, trading partners and the public, on chemical residues and contaminants.
To represent the NT on relevant national committees.

NT animal industries do not have a chemical residue problem. Nevertheless, there is a need for ongoing programs to monitor the situation to demonstrate the absence of residues. Residue monitoring, testing and management have become increasingly important in maintaining and gaining access to markets and will continue to do so in the future. The functions of the National Residue Survey (NRS) are continually being reviewed as part of a national approach to technical market access risk management. An advisory panel for NRS was established in 2003, which had its first meeting in February 2004.

This program has four components:

- NRS.
- Beef organochlorines, organophosphates and synthetic pyrethroids residues.
- Hormonal growth promotants (HGP) including EUCAS and HGP-free system.
- The national antibacterial residue minimisation program.

NRS

NRS is a random sample survey to monitor residues in Australia's agricultural food commodities. It has been operating to some extent since the 1960s. Since 1996 the need for the domestic market as well as the export market to participate in NRS has created an additional cost for small industries. There will be one more component in this program (natural toxins) that is still undergoing assessment to allow for implementation in the near future.

During 2001-02, DPIFM signed an agreement with NRS to follow-up trace backs greater than the residue action level (RAL), which is usually twice the maximum residue limit (MRL) and take appropriate action. During 2005-06, the NRS trace back agreement was updated following new arrangements for NORM and NARM programs. DPIFM signed a memorandum of understanding with DAFF for trace back of chemical residues violations.

Activities

During 2005-06, 30 samples (50 less than last year) were collected from NT stock. All except one were sourced from abattoirs. The exception faecal sample was collected from a farm. Twenty cattle samples, three horse samples, six farmed pig samples and one sheep sample were analysed. Two were found to have residues – cadmium in a cow's liver and zeranol in a cow's faeces. Two cattle livers had traces. No violations were reported. Consequently, no trace back investigations were initiated. The traces (both in cow livers) were mercury of environmental origin. There were no violations of antimicrobials, organochlorines or organophosphates from NT sourced stock.

Beef organochlorines, organophosphates and synthetic pyrethroids

The national organochlorine residue management (NORM) program is the watchdog for the Australian beef industry for managing the risk of organochlorine in beef. NORM protects domestic consumers and the access to international markets. It was reviewed intensively in 2004 and 2005. NORM is co-funded by the State and the beef industry, which provides over $1m annually. Such ongoing cost drained beef industry reserves held at NRS prompting a review of the program. CCA and ALFA suggested that NORM adopt a cost-recovering system where property owners would pay for tests conducted to assess risks on their properties.

The new system was expected to be implemented on 1 July 2005. However, significant differences between State/Territory coordinators, the Commonwealth and MLA delayed implementation. After more discussions agreement was reached and NORM III was eventually launched on 1 January 2006.

The main change associated with the implementation of NORM III was the allocation of new property identification codes (PIC) on the extended residue program (ERP) statuses submitted to the NLIS database. Changes have been made to the arrangements for payment for organochlorine testing. ERP statuses T1, T2 and T3 were amended with an 'F' or a 'V' suffix. Industry funding is available only for testing undertaken on sentinel animals within the first year following the discovery of organchlorine risk and the assigning of a 'T' status to the property. Properties eligible for this funding have ERP statuses with an 'F' suffix. Properties that have been assigned a 'T' status for longer than one year have a 'V' suffix, indicating the payment for testing is to be under commercial arrangements between the abattoir and the vendor.

A major development has been the introduction of the national vendor declaration (NVD) system underpinned by livestock production assurance (LPA) to communicate organochlorine residue status of livestock. From 1 January 2006, the management of persistent organochlorine residues has been integrated with LPA, which constantly audits submissions. Consequently, cattle sourced from LPA-accredited holdings have a lower residue risk. SAFEMEAT has noted that the only organochlorine monitoring outside this process is the random monitoring conducted by NRS and questions whether this level of testing is sufficient, particularly with much of eastern Australia under drought conditions which are known to increase the risk of organochlorine residues.

There is a very low risk of violations in the NT because of the extensive nature of the cattle industry. Random monitoring programs are in place as part of NRS testing both of cattle slaughtered in the NT and interstate for chemical residues including organochlorines. There is an agreement between NRS and DPIFM on the roles and responsibilities in the event of a chemical residue trace back investigation in animal products. No organochlorine residues have been found in cattle from the NT for at least 10 years. There are no organochlorine contaminated properties in the NT (no 'T' or 'R' statuses) and consequently there are no NT properties listed on the ERP database, there are no property management programs and no auditing is required.

Hormonal growth promotants (HGPs)

Many domestic and export markets are sensitive to cattle products derived from animals implanted with HGPs. A national program to comply with the European Union (EU) import requirements was developed in 1993. This program consisted of two components - controls on the use of HGPs in the cattle industry, and systems for the recognition of stock which have not been implanted with HGPs. Controls on HGP use are provided under the *Control of Hormonal Growth Promotants (Stock Ac*t) (NT).

The EU cattle accreditation scheme (EUCAS) was designed and implemented in 1999-2000 in response to EU demands for the individual identification and traceability of animals raised for that market. EUCAS requires the use of national livestock identification scheme (NLIS) permanent devices containing electronic transponders from which individual identification can be read electronically. Approved devices may be rumen pellets or ear tags applied at weaning which then will remain with the animal for life. This system also requires the use of EU vendor declaration (EUVD) forms which since 1 July 2004 are no longer the responsibility of State authorities. MLA has been since in charge of control and distribution of EUVD.

AQIS took the opportunity to then use EUCAS to underpin its HGP-free certification by legislating for individual property accreditation, animal tagging, transaction reporting and vendor declarations attesting to compliance with scheme rules. Provided strict controls are maintained to ensure HGP-treated cattle are kept out of the EU supply chain, the existing HGP control system will eventually become largely redundant, which will lead to its dismantling.

The cattle industry introduced the LPA scheme which is managed by MLA. LPA is a basic quality assurance scheme that underpins the veracity of NVD. The LPA scheme requires producers to keep auditable records of purchased cattle and to link those records to the NVDs supplied for the cattle when they are sold or purchased. NVDs are widely used when cattle are sold and their use is driven largely by market forces with limited regulatory rules in relation to false declarations. The vendor declares whether the cattle have been treated with an HGP on the NVD.

A review of the EUCAS system was conducted by AQIS in 2005 to audit how State and Territory Governments managed the administrative function of the system. This was necessary in the early stages of the scheme due to the large number of properties applying for accreditation. The number of entrants to the scheme has stabilised (currently more than 2000 properties) and it was decided that some anomalies revealed by the review can be better managed by a central administration from Canberra. Since then, AQIS has taken over the administration of the system from State and Territory coordinators. Audits are carried out by AUSMEAT, DPIFM and DPIWE Tasmania officers.

After the EU Commission visit to Australia in March 2005, EUCAS cattle eligibility rules were amended to allow the purchase of cows/heifers from outside the scheme provided they were identified with NLIS approved tags applied by the vendor and accompanied by an NVD attesting to HGP freedom. These animals would be shown on the database as ineligible but their progeny will be accepted in the scheme. Approvals must be sought from AQIS and records must be kept for auditing purposes. This component is now covered under the Federal *Export Control Act*.

Another important outcome of the EU Commission's visit was that AQIS has made a commitment to the Commission that whenever a property voluntarily relinquishes accreditation, it will not be allowed to reaccredit unless it has been audited prior to approval of reaccreditation. In the same fashion, accreditation is granted to the person making the application and if that person ceases to work for the property, the new owner/manager will have to apply for accreditation.

Four properties - Palmer Valley, Alcoota, Lyndavale and Newcastle Waters - relinquished their accreditation and three properties - Mt. Riddock, Ooratippra and West Mathison - gained EUCAS accreditation in 2005-06. This brings to seven the number of EUCAS properties in the NT. Four of them were audited - Napperby, Mt. Riddock, Ooratippra and Mulga Park - for compliance in 2005-06. All passed but had corrective action reports (CAR) issued to them: one to Mulga Park, two each to Ooratippra and Mt. Riddock and three to Napperby. Zeranol metabolites were found in a faecal sample from the Napperby audit. But they were of natural origin (ingestion of *Fusarium*-infected pasture or grain) and no action was required.

Two properties using HGP were audited for compliance in 2005-06. Both properties passed the audits and no CARs were issued. No HGP offences were recorded from NT cattle during the same period. A register of HGP users is maintained in the NT as a requirement of the national HGP control system. During 2005-06, 58 properties in the NT, compared to 92 last year, purchased 147 780 doses of HGPs, compared to 305 210 the previous financial year. This indicates a decrease of about 52% compared to the previous financial year.

Since 2001, pink tags bearing the phrase "HGP Free" were allowed to be used as transaction devices to declare cattle HGP-free. However, they were no longer accepted for the purposes of the EU market. Industry requested this system to remain for use in other markets such as Saudi Arabia, the US, Korea and Jordan. AQIS now uses the pink tag together with the appropriately endorsed NVD as the basis for the non-EU HGP free certification system.

NARM, which is a random national program to monitor antibiotic and antibacterial contaminants, is under review. The national program is now targeted to high-risk areas, which excludes the NT. Another initiative by DAFF is the targeted antibacterial residues testing minimisation program, which allows AQIS officers to select high-risk animals in abattoirs for sampling for antibiotic residues. The NT represents a very low risk category for these two programs and no activity was recorded during 2005-06.

Project: Crocodile Farming

Project Officers: V. Simlesa and R. Morton

Location: Darwin and Katherine Regions

Objective:

To provide a regulatory service to crocodile farms in the Northern Territory.

In order to carry out regulatory duties under the *Territory Parks and Wildlife Conservation Act* on crocodile farms in the NT, two DPIFM officers are appointed as honorary conservation officers. In addition, the veterinary officer is authorised to provide certification under the Commonwealth *Export Control Act*.

Regulatory duties include:

- The inspection and certification of export shipments.
- The collation of monthly reports from all NT crocodile farms to Environment Australia.
- Regular full audits and/or inventories of all stock on NT crocodile farms to conform to welfare regulations and to the requirements of the Convention of International Trade in Endangered Species of Fauna and Flora (CITES).
- The issuing of export or import permits involving farmed crocodile products produced in or entering the NT.
- The regular inspection of NT crocodile abattoirs and the issuing of health certificates to accompany crocodile skins, as required by importing countries.

A disease investigation service is provided to all NT crocodile farms on request.

Activities

DPIFM is responsible for all regulatory duties associated with the crocodile industry in the NT.

The Technical Officer made a number of educational presentations to school children on the crocodile industry.

Two research projects were conducted at Berrimah Farm on behalf of Porosus Pty Ltd, one on vitamin injections and the other on a new liquid supplement.

Activities included issuing 48 NT movement permits, 30 of which were for export overseas; inspecting 30 skin shipments and issuing 22 health certificates. The industry exported 4584 crocodile (*Crocodylus porosus*) belly skins, sold 162 in the domestic market, processed 5206 crocodiles, yielding 20 180 kg of flesh and sold 5134 live crocodiles interstate.

Skin quality issues are the main concern for the NT crocodile industry.

Project: Disease Surveillance

Project Officers: F. Human, Veterinary Officers and Stock Inspectors

Location: Territory wide

Objectives:

To provide credible disease surveillance information to support the sale of livestock and livestock products.
To investigate the occurrence of diseases in the NT livestock industry.
To participate in national animal health surveillance programs.

Surveillance of the animal population in the NT consists of collecting health and disease data, analysing and interpreting it so that it adds to our knowledge of endemic diseases, identifying new diseases, elucidating risk factors for diseases, which allow planning and implementation of ways to control diseases. Surveillance encompasses:

- The collection of animal health data during disease investigations initiated by the producer (passive/general surveillance).
- Planned surveys to target a specific disease (active/targeted surveillance).
- The provision of NT information as part of national programs to enhance Australia's trading status.
- A secure and reliable computer system to store and retrieve the data and communication of results to relevant parties.

Departmental investment in surveillance activities described in this and other projects in this Technical Annual Report is around $1.2 million for 2005/06 (this figure excludes external funding). The surveillance activities provide protection for a livestock industry worth over $210 million to the NT in 2004-05.

The activities described below are major components of this project. The diagnostic highlights are an interesting summary of passive surveillance investigations for the period, and as such do not cover all investigations carried out. Surveillance activities are also covered in other reports (e.g. TSE surveillance).

National Animal Health Information System (NAHIS)

NAHIS is a surveillance program coordinated by Animal Health Australia that has input from the State/NT Governments and the Commonwealth. NAHIS provides timely and accurate summary information on Australia's animal health status to support trade in animal commodities and meet Australia's international reporting obligations. It also provides information on Australia's capabilities and activities with regard to animal disease surveillance and control.

A quarterly report is provided to NAHIS on NT animal health status, specific testing carried out at Berrimah Veterinary Laboratories and significant animal disease events. Similar reports from all the agriculture/primary industry departments, as well as information from AQIS, Northern Australia Quarantine Strategy, the National Arbovirus Monitoring Program, the National Residue Survey, the Commonwealth Department of Health and Ageing, and various national reference laboratories are collated.

The *Animal Health Surveillance Quarterly* is produced and circulated to various addressees in the NT including livestock industry groups. There is also information about NAHIS on the Animal Health Australia website at: www.animalhealthaustralia.com.au

Animal health newsletter

Animal Health News from the Northern Territory is a quarterly publication produced by veterinary laboratory and animal health staff. It started at the beginning of 1996. It is sent to all registered veterinarians in the NT and bordering towns in WA and Queensland, stock inspectors, NT livestock industry organisations and other interested people both in and out of the department. The articles from laboratory and field staff in southern and northern regions cover topical animal disease events, animal health surveillance news, information from Berrimah Veterinary Laboratories and other items. Issues 38 to 41 were produced during 2005-06. About 200 copies were distributed each quarter.

Passive surveillance

Investigation of disease events in livestock reported by producers achieves two objectives. It provides a diagnostic service by veterinary officers and stock inspectors for sick animals which assists producers to treat, prevent and control disease in their animals, and thereby enhances profitability and animal welfare. It also facilitates documenting passive surveillance for both exotic and endemic livestock diseases. Information from passive surveillance can be used for market health assurances in trade. The accumulation of knowledge over time regarding endemic disease conditions in livestock also improves the advice and extension information that is provided to producers.

There is an active extension program on prevention of diseases such as botulism, tick fever and coccidiosis across the NT. Advice to property owners is provided on request or following a disease investigation.

Advice may be offered over the phone, or a property may be visited to investigate the history of disease, conduct clinical examinations of stock, perform post mortems and collect samples. Following assessment of the property visit and the results of laboratory findings, producers are advised of the outcome and control measures are discussed.

Endemic disease

Table 1 shows the number of submissions, by region, for the July 2005 to June 2006 period. Field veterinary officers and stock inspectors conducted these activities, usually by a visit to the property or advice over the phone. This is a crude estimate of activity because a submission can range from a phone call, to examining one animal, to examining and sampling many animals.

Table 1. Record of activities by staff to support industry during 2005-06

	Darwin			Katherine			Tennant Creek			Alice Springs			Total
	P	A	R	P	A	R	P	A	R	P	A	R	
Bees	1	1	-	1	-	-	-	-	-	-	-	-	**3**
Birds	3	-	-	1	-	-		-	-	-	-	-	**4**
Buffaloes	1	2	-	-	-	-	-	-	-	-	-	-	**3**
Camels	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	-	**1**
Cattle	**2**	**4**	**-**	**4**	**25**	**-**	**5**	**12**	**-**	**3**	**13**	-	**68**
Crocodiles	2	-	-	-	-	-	-	-	-	-	-	-	**2**
Deer	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Goats	-	-	-	1	-	-	-	-	-	-	-	-	**1**
Horses	2	-	-	1	-	-	4	-	-	-	-	-	**7**
Insects	3	-	-	-	5	-	-	8	-	-	8	-	**24**
Pigs	3	-	-	-	-	-	-	-	-	-	-	-	**3**
Poultry	10	-	-	2	8	-	-	8	-	-	24	-	**52**
Sheep	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Total	27	7	-	10	38	-	9	28	-	4	45	-	**168**

P = > Passive (general) investigations

A = > Active (targeted) surveillance activity (includes NTSESP, bluetongue surveillance, tuberculosis surveillance, JD targeted surveillance, tail rot survey, Elsey/Florina virus survey and sentinel herd/flock/insect sampling)

R = > Regulatory/Movement activity (includes movement tests)

(Sourced from ANDI – the animal health information system)

The 68 cattle activities included 54 submissions from sampling sentinel and surveying cattle herds. There were also 40 submissions from sampling sentinel poultry flocks and 24 submissions from insect collections associated with sentinel herds.

Table 2. Comparison of submissions between 2001-02 and 2005-06

Year	Total submissions	Cattle submissions	Cattle submissions excluding active surveillance and regulatory work
2001-02	209	101	Not available
2002-03	262	183	35
2003-04	248	124	29
2004-05	283	171	60
2005-06	168	68	14

Diagnostic highlights 2005-06

Coccidiosis in weaner cattle

Deaths occurred in a group of 3 to 6 month-old cattle soon after weaning. The clinical signs were diarrhoea and depression. During the first three days of the outbreak, 18 weaners died suddenly. A further 20 died over the next week. Emaciation and diarrhoea were the prominent signs. A post mortem examination revealed abomasal ulceration and watery, blood tinged, intestinal fluids. Coccidial oocyst counts from live and dead animals were very high. *Eimeria zuernii* was identified as the causative agent. Coccidiosis is a sporadic clinical disease in beef cattle weaners under the stress of weaning.

Babesiosis in a cow

A four-year-old Friesian-cross cow showed progressive signs of depression, inappetence, weight loss, fever, fetlock knuckling, tremor and convulsions before finally becoming recumbent and dying. Haemorrhages were present on the vulva, mouth, bladder and heart. The spleen was enlarged, with a “raspberry-jam consistency”. *Babesia bovis* parasites were identified on peripheral blood and brain smears. The cow had

been kept alone on a rural block since it was calf. However, a recently introduced steer probably exposed the cow to ticks.

Respiratory disease in turkeys

Four out of a batch of 15 eight-week-old turkeys showed clinical signs of upper respiratory tract infection. The most prominent sign was oedema of the cheeks and eyelids. The birds were also depressed and had a nasal discharge. A post mortem examination revealed sinusitis and tracheitis. *Bordetella avium,* the causative agent of turkey coryza was isolated from nasal swabs. Samples were also tested to exclude avian influenza infection.

Bovine brucellosis reactors during export testing

Three heifers from a group of 604 being prepared for export had a complement fixation test titre of 8. The heifers originated from two NT properties. Further testing at the Australian Animal Health Laboratories was negative. The animals were initially put in quarantine, but were subsequently released for slaughter in the domestic market. The last brucellosis infected herd in Australia was recorded during the mid 1980s.

Hendra virus exclusion in a horse

A horse from a rural block in Katherine had a sudden onset of signs of respiratory disease. Clinically, it was dehydrated and appeared depressed with intermittent bouts of discomfort. Occasionally it would develop raspy breathing, cough a few times and when the head was dropped a straw coloured fluid ran from the nostrils and mouth. Samples were taken to exclude Hendra virus while the horse was treated for pneumonia. All tests for Hendra virus were negative and a definitive diagnosis was not reached, but the horse made an uneventful recovery.

Botulism in wild birds and poultry

Botulism is an ongoing disease in wild birds and backyard domestic poultry in the Top End of the NT, with seasonal fluctuations. In the Darwin rural area three separate incidents of botulism in poultry were diagnosed. In one case the chooks ate maggots from a dead goanna. Maggots and the associated decaying carcases seemed to be the most important source of infection.

In the Katherine region whistling ducks continued to die on a sewage pond for a three month period. *Clostridium botulinum* type C was confirmed in one sick bird. Dead ducks were removed from the ponds in an attempt to break the perpetuating cycle and deaths ceased. This situation at the sewage ponds repeats itself about every two years. The sewage water is also used to irrigate the pasture in a nearby paddock where horses are kept. The owners have been advised to remove the horses to non irrigated pastures for some time and they were made aware of the potential threat of botulism from the infected material and water.

Ophidian paramyxovirus (OPMV) in a carpet snake

A moribund carpet python was submitted for autopsy. The snake was unable to right itself and showed persistent inappropriate gaping. Another two pythons from the same facility developed the same signs subsequently and were also submitted for post mortem examination. All of these snakes originally came from the wild, but were in captivity in a registered facility for many months. Histological examination revealed marked spongiosis in the white matter of the brain. This lesion of severe leukoencephalopathy that also involved the brain stem led to suspicion of OPMV, although histology cannot provide a definitive diagnosis for this disease. There are currently no facilities in Australia for diagnosis. A differential diagnosis would be chronic organophosphate poisoning, but no convincing history of possible exposure could be established. OPMV is a chronic, neurologic disease of snakes and a recent national survey suggested that the disease can probably be regarded as endemic in Australia.

Heat stress during muster

During February a heifer in the Darwin region died suddenly after being mustered and yarded. Convulsions and bellowing were observed before death. An autopsy indicated the animal was dehydrated with sunken eyes, minimal body fluids, dry rumen contents and pale pink muscle tissue. The owner reported that a salt

lick with added phosphorus had been made available to the stock the day before. Biochemistry results revealed elevated levels of muscle enzymes and various serum electrolytes. Higher levels of chloride, sodium and albumin supported systemic dehydration and elevated potassium levels can lead to heart failure. Histopathology of the kidneys revealed acute tubular necrosis which can potentially be caused by excess phosphorus. The lungs were congested with widespread oedema and focal haemorrhages. In view of the sudden onset and circumstances it was surmised that death was due to heat stress, although access to the salt lick could have been a contributing factor.

Hepatic encephalopathy in a buffalo

A buffalo on a research farm in the Top End developed nervous signs including head pressing, ataxia and difficulty in standing. The animal was euthanized. A post mortem examination revealed congestion of all organs, copious, blood tinged peritoneal fluid and a marked discoloration of the liver. Serum chemistry results confirmed elevated levels of liver enzymes as well as higher levels of urea and creatinine. Histopathology of the liver revealed severe subacute peri-acinar necrosis. The diffuse acinar ("nutmeg") pattern in the liver with blood pooling is consistent with chronic passive congestion which is typically due to obstruction of the large hepatic vein or posterior vena cava. There was no indication of heart failure. The marked ascites is due to an inability of blood returning from the abdomen to flow easily through the liver due to scarring and venous obstruction. Neurological signs are typically attributed to an inability of the failing liver to convert ammonia to urea with the resultant build up of blood ammonia and its toxic effect on the nervous system. The resultant hepatic encephalopathy in this case was thought to be from a lesion causing mechanical obstruction to blood flow from the liver.

Suspected poisoning in poultry

A small back yard poultry flock of four died within half an hour from one another in the Katherine rural area. Various agricultural chemicals, including chlorpyriphos were seen in close proximity to where the chickens died, but no obvious leaks or spills were noticed. No significant gross findings were seen on post mortem examination, except for pulmonary congestion and oedema in one hen. Samples were sent to the Australian Animal Health Laboratory for category 2 avian influenza exclusion. Preliminary tests, including a new polymerase chain reaction test, were negative. There were no significant findings following histopathological examination of organs. The lack of lesions and sudden deaths support the submitting veterinarian's suspicion of acute pesticide poisoning.

Subcutaneous oedema and emphysema in cattle

Two cows from separate paddocks on a cattle station were reported to have swollen heads, necks and briskets. One animal died and the other was euthanized following a period of recumbency. A post mortem examination showed extensive subcutaneous emphysema over oedematous regions with no evidence of trauma to the trachea, oesophagus or lungs. The cattle were bright and alert and did not show signs of respiratory distress. A PCR test for BEF was negative. No significant changes were seen on the red or white blood cell parameters, nor were bacteria of significance cultured from the lesions. A histopathology examination is pending. The cause of the lesions is uncertain.

Pyrollizidine alkaloid toxicity

A 20-year-old horse in emaciated condition was euthanized following a period of weight loss. A post mortem examination revealed an extremely jaundiced carcass. Serum liver enzymes were elevated and histopathology results were consistent with a chronic hepatopathy as caused by pyrollizadine alkaloid toxins. The property has had cases of pyrollizidine alkaloid toxicity previously. *Crotolaria species*, known as rattle pods, are quite common in certain areas of the NT and continue to be a thread to grazing animals, particularly affecting horses. Avoidance is the only effective precautionary measure, but is difficult to accomplish under extensive grazing conditions.

Marek's disease

Deaths in point of lay pullets were investigated. Average losses of seven birds per day over a two week period culminated in losses of over 40 per day for three days. Clinically sick birds were weak, emaciated and had varying degrees of lameness with death occurring within two days of onset of illness. Avian influenza and Newcastle disease were excluded. A post mortem and subsequent histopathology examination revealed lesions of lymphoid neoplasia and Marek's disease was confirmed. Apparently a breakdown in vaccination procedures had occurred at the hatchery of the supplier.

Die off in young bats

Parks and Wildlife rangers reported weakness and death in hundreds of juvenile flying foxes in the Katherine region following the Katherine flood in April this year. The adult flying foxes made no contact with the juveniles. The affected animals were found weak and lethargic hanging in trees and lying on the ground. Five were submitted for post mortem examination. They were emaciated, but apart from liver swelling and hepatocyte vacuolation, no specific lesions were detected. Internal parasites present are most likely the ascaridoid nematode, *Toxocara pteropodis*. These worms are commonly found in flying foxes and are in general associated with suckling bats. They are expelled after about five months. Australian bat lyssavirus and Hendra virus infection was excluded. It is thought that these animals were dying of starvation after they were abandoned by the adults. The reason for this behaviour is not clear.

Project: Emergency Animal Disease Preparedness

Project Officers: P. Saville and Livestock Biosecurity and Product Integrity Staff

Location: Territory wide

Objectives:

To participate in contingency planning and training for emergency animal disease preparedness.
To ensure that DPIFM staff, relevant organisations and pastoralists have a continuing high level of awareness in relation to emergency diseases and their role in a response.

The main focus of emergency animal disease preparedness in 2005 was on highly pathogenic avian influenza. The NT participated in exercise Eleusis with the establishment of an SDCHQ in Darwin. The next national preparedness exercise to involve the NT is scheduled for 2007.

Departmental officers continued to contribute to the technical and policy management of the national emergency animal disease program at several levels. The AUSVETPLAN manual revision is a major project by Animal Health Australia. There are 33 manuals available at http://www.animalhealthaustralia.com.au/. The NT also participated in the development of a business plan to address a possible invasion by screw worm flies.

The emergency animal disease (EAD) response agreement continues to be reviewed particularly in respect to financial matters. Consultation was held to seek changes to reinforce the powers under the proposed new livestock legislation to deal with an EAD.

The NT operational response plan for foot-and-mouth disease (FMD) continues to be reviewed. This plan seeks to address the problems that the Territory will face in responding to a disease outbreak in the context of limited resources. It has been derived from AUSVETPLAN and contains a number of appendices with standard operating procedures including prepared documents, staffing and siting information for a response to an outbreak of FMD in the NT.

The *Protect Australian Livestock Campaign* is a nationally coordinated project that aims to raise awareness, among all sectors of the public and EAD. The EAD hotline continues to receive a small number of important calls, mostly related to problems about avian influenza as a result of greater awareness of this disease. All investigations were negative for EAD.

The Australian Veterinary Reserve aims to provide training to veterinarians from the private sector to enable them to participate in a response. A number of veterinarians with connections to the NT have been identified for training.

Inspections of garbage disposal facilities in towns by stock inspectors, remote communities and stations continue to be conducted throughout the NT to monitor the risk of inadvertent or deliberate swill feeding to pigs. Swill is garbage containing mammalian or poultry protein, which is not allowed to be fed to pigs. The level of awareness was found to be high and few significant problems were encountered. Public vigilance and reporting is appreciated.

Project: The Honeybee Industry

Project Officer: V. Simlesa

Location: Territory wide

Objective:

To provide technical advice, disease investigation and regulatory services to the honeybee industry.

There is concern about the potential introduction of exotic bees and parasitic mites after recent experiences in Australia and New Zealand. The Asian honeybee (*Apis cerana*) was detected in Darwin in 1998 and subsequently eradicated.

The national sentinel hive program (NSHP) was established in 2000 to enhance surveillance for exotic bees and bee parasites. One of these parasites is the exotic *Varro*a mite, which is a natural ectoparasite of the Asian honeybee. The *Varroa* mite has switched to the European honeybee (*Apis mellifera*) as a host, and has become a serious pest in the bee world. There are three highly specialised species of *Varroa* mite, of which *V. jacobsoni* has the widest distribution and *V. destructor* poses the greatest threat. The *Varroa* mite established in New Zealand in 2000, but Australia remains free from it.

NSHP includes both hives and log traps. The European honeybee hives are established at Darwin Port and East Arm Port. The hives are maintained by the Apiary Officer. Monitoring is conducted every three months. A commercially produced pest strip ('Bayvarol strips'), specifically designed for the detection of the *Varroa* mite is placed in the hive for 24 hours. A sticky board is placed at the bottom of the hive to capture any *Varroa* mites detected by the Bayvarol strip. Sticky boards are submitted to the Entomology Section after 24 hours for identification of possible mites.

The log traps have been established to monitor for the presence of the Asian honeybee. The trap design has been tested and it was found that the hollow palm tree trunk was the most appealing to the Asian honeybee. The traps are designed with a small access hole on the side for bee entry. Each month the log traps are checked and the presence of any honeybees is recorded. If any are present, they are sampled. There are five traps established in the Darwin region, one at Darwin Airport, two in the East Arm area and two in the Darwin Port area. Pheromone lures are used in the log traps, which are replaced every six weeks. The Asian honeybee's preference for hollow palm logs and the attraction to the pheromone facilitates its detection.

NT quarantine requirements were imposed following the discovery of the small hive beetle (*Aethina tumida*) in Queensland and New South Wales. All queen bee shipments and live hives were inspected and health certificates were issued before shipments entered the NT. Queen bees and live shipments were inspected before release.

A number of feral swarms were removed from private, public and government residences in the Darwin and rural area.

Cane toads are proving to be a continual problem for bee keepers. Pollination in the horticultural industry will be affected by the shortage of bees in the NT. One major bee keeper has left the NT while another is considering leaving soon.

Project: Livestock Identification

Project Officers: K. Small and A. Kluth

Location: Territroy wide

Objectives:

To ensure that an identification and tracing system for livestock which will satisfy nationally accepted performance standards operates in the NT.
To ensure compliance with the NT Brands Act and Regulations and the Stock Diseases Act and Regulations.

Consumer demand for food safety has highlighted the importance of a process able to trace meat products back to the property of origin. The Australian cattle industry aims to stay ahead of its competitors with this important trade issue.

The national livestock identification system (NLIS)

The NT is committed to implement the mandatory use of radio frequency identification devices (RFIDs) for property to property movements. In October 2005 the NT NLIS Advisory Committee prepared a plan for the implementation of NLIS in the NT to June 2008. The Commonwealth allocated $790 000 for implementing NLIS in the NT. The NT Government approved additional funding of $790 000 to match this allocation to achieve the milestones identified in the plan. The implementation plan was launched by the Minister for Primary Industry, Fisheries and Mines at the NTCA Annual Conference. The communication activities included displays at all regional shows, information days with commercial suppliers and NLIS workshops. NLIS demonstration sites have been set up at Kidman Springs, Douglas Daly Research Farm, Beatrice Hill, Berrimah Farm and the Arid Zone Research Institute. NLIS information packages are being supplied to all cattle owners and the NT NLIS website contains an extensive list of NLIS fact sheets. Changes to identification requirements for abattoirs, saleyards and buffalo were gazetted on 1July 2006. There are 608 cattle properties registered on the pastoral database and 97 NT account holders are listed on the NLIS database.

Waybills

About 770 000 cattle movements were recorded on the waybill database during 2005.This consisted of 245 000 cattle movements to interstate destinations and 524 000 cattle movements within the NT.

Pastoral property register

A search facility is now available on the Department's website which allows the public to check property identification codes (PICs) against property names. This information is also supplied on a regular basis to the

national NLIS database. There are 610 registered PICs in the NT: 105 in the Alice Springs region, 70 in the Tennant Creek region, 195 in the Katherine region and 240 in the Darwin region.

Brands

In 2005-06, 57 three-letter brand applications, 23 distinctive (symbol) brand applications, 35 ear mark applications and 21 transfers of brand applications were processed.

Project: Stock Movements

Project Officers: Veterinary Officers and Stock Inspectors in Each Region

Location: Territory wide

Objectives:

To provide property and animal certification for export, interstate and intrastate movements.
To facilitate interstate and intrastate movements from tick-infected and tick-protected areas by providing a service to inspect and/or treat cattle and horses for cattle ticks.
To prevent the entry of cattle ticks from interstate, particularly acaricide resistant strains from Queensland.
To prevent the entry of Johne's disease and tuberculosis from interstate.

In consultation with industry and consumers, the Government prescribes controls to prevent the spread of animal diseases. Historically, such measures were introduced in response to cattle diseases in plague proportions common in the 18th and 19th centuries. In recent years, there has been increasing industry self-regulation. While market and quality assurance programs have been developed and will continue, there are industry and consumer expectations for governments to protect consumers from health risks and animals from the spread of diseases. This applies within the NT (e.g. for cattle ticks) and for national and international markets (e.g. for bovine tuberculosis and other diseases).

A service is provided to NT producers to facilitate trade by the certification, inspection and treatment of stock, if required. Control programs (e.g. for cattle ticks) may also be implemented. Mobile spray plants and chemicals are provided for spraying horses for movement.

There is continual review of stock movement controls and area declarations in consultation with State governments and industry associations.

Animals from the tick-infected area require a clean treatment (inspection and treatment) to pass into or through the NT tick-free areas or into the tick-free areas of other States. Treatment is by plunge dipping, except for led and tractable horses and show cattle, which may be sprayed in lieu of dipping. Tick-free areas in the NT are designated as the Free Zone Protected Area, and the Central Control Zone Protected Area. Tick-infected areas are designated as the Infected Zone Protected Area, and the Northern Control Zone Protected Area. A map showing these areas can be accessed from the following DPIFM internet page: http://www.nt.gov.au/dbird/dpif/animals/cattle_ticks.shtml

Cattle moving to Western Australia also require inspection for burrs.

Cattle moving to all States except New South Wales (NSW) and South Australia require a health certificate. Cattle moving to NSW require a NSW travelling stock statement. Other stock moving interstate may also require a health certificate.

Certifications are provided to the Australian Quarantine and Inspection Service (AQIS) regarding the disease status of properties and animals to satisfy export protocols. The Animal Health Information System is an associated project for improving the reporting and retrieval of disease data. Planned active surveillance programs complement passive surveillance disease monitoring. During the year, 306 properties of origin health certificates were issued for cattle exported from NT properties.

Some protocols require treatment of animals prior to export. If authorised private veterinarians are not available, Departmental officers provide this service. No such services were provided in 2005-06.

Table 1. Summary of activities in 2005-06

Cattle inspected and treated for cattle ticks from tick areas	
Number of visits	264
Number of animals	98 600
Cattle moved interstate from tick-free areas	
Number of certificates	349
Number of animals	259 796
Cattle inspected for movement to WA	
Number of visits	116
Number of animals	24 012
Horses inspected and treated for cattle ticks from tick areas	
Number of visits	172
Number of animals	1544
Total property visits	552
Cattle inspections at sale yards	88

During 2005, 210 558 NT-bred cattle were exported from the port of Darwin. About 30 000 to 50 000 NT-bred cattle are exported annually through West Australian ports.

The number of properties visited and the number of property of origin certificates issued during the year were very similar to those in 2004-05. There was a reduction in the number of interstate health certificates issued from tick-free areas due to the high turnoff from the Alice Springs area in 2005 due to dry conditions. However, there was an increase of 100 000 animals moved to Queensland from tick-free areas due to improved seasonal conditions.

Project: Meat Industries

Project Officer: R. J. M^{c}Farlane

Location: Territory wide

Objectives:

To ensure compliance with national standards.
To foster export and domestic markets for the NT meat industry.

The Department of Primary Industry, Fisheries and Mines (DPIFM) is responsible for regulating the meat industry in the NT, from slaughter through to processing and storage for wholesale.

The Department of Health and Community Services (DHCS) regulates meat retail outlets.

DPIFM licenses and regulates:

- Abattoirs that slaughter all types of animals, including poultry and crocodiles.
- Wholesale meat processing, including the manufacture of smallgoods.
- The slaughter of game animals.
- The processing of game meat.
- The slaughter of animals for pet meat.
- The processing of pet meat.
- The slaughter and processing of animals for bait meat.
- Cold stores for the storage of domestic meat.

DPIFM's regulatory role in the meat industry in the NT is provided under the NT *Meat Industries Act 1996*, NT Meat Industries Regulations and the following national standards and codes of practice:

- The Australian Standard for Hygienic Production of Crocodile Meat for Human Consumption.
- The Australian Standard for Hygienic Production of Natural Casings Meat for Human Consumption.
- The Australian Standard for Hygienic Production of Ratite (Emus/Ostrich) Meat for Human Consumption.
- The Australian Standard for Construction of Premises and Hygienic Production of Poultry Meat for Human Consumption (Second Edition).
- The Australian Standard for Hygienic Rendering of Animal Products.
- The Australian Standard for the Hygienic Production and Transportation of Meat and Meat Products for Human Consumption.
- The Australian Standard for the Hygienic Production of Game Meat for Human Consumption.
- The Australian Standard for the Hygienic Production of Rabbit Meat for Human Consumption.
- The Australian Standard for the Hygienic Production of Pet Meat.
- The Model Code of Practice for the Welfare of Animals at Slaughtering Establishments.

Standards are non-prescriptive (outcome-based) and initiate change from the historical meat industry compliance method of online government inspection to a system of company self-regulation through government-approved and audited hazard analysis and critical control point based quality assurance programs.

Sectors of the meat industry that require meat inspectors must employ their own.

DPIFM's primary regulatory function is performed by audit, whose frequency varying according to throughput and compliance history.

Activities

Due to a lack of demand in overseas markets, no wild boar harvesting was conducted in the NT this year.

Training in auditing of the meat industry was provided to regional officers to upgrade their skills and to reduce the need for the Senior Meat Industry Officer to travel to remote abattoirs.

The Senior Meat Industry Officer was seconded for three months to develop meat industry skills in Sabah.

DPIFM issued 238 health certificates from July 2005 to June 2006 for shipments of meat and meat products to East Timor under an exemption to the *Export Control Act* issued by AQIS.

Oenpelli, Kalkaringi and Palumpa abattoirs are slaughtering small numbers of animals on a regular basis to supply meat to surrounding Aboriginal communities.

The Litchfield abattoir operates for two days a week to slaughter locally-grown pigs for the local market and it also offers slaughters other animals for a fee.

The Wamboden abattoir in Alice Springs operates fortnightly to slaughter camels and cattle.

The Barkly Meats Tennant Creek abattoir, the Teys Brothers Katherine abattoir and the Batchelor abattoir have not opened for the 2006 season.

Interested parties are trying to open the Murwangi abattoir in Arnhem Land to slaughter crocodiles.

Project: The Tuberculosis Freedom Assurance Program

Project Officers: B. Radunz, Regional Veterinary Officers and Staff

Location: Territory wide

Objectives:

To maintain Australia's internationally recognised bovine tuberculosis-free area status by continuing to implement a surveillance program that meets OIE standards and eliminating any detected tuberculosis
To identify post-2006 arrangements and manage their implementation.

The tuberculosis (TB) impending free area declaration in November 1992 was the culmination of years of work by many pastoralists, private veterinarians and departmental staff at a cost of $192 million. The NT was declared a TB-free area at the end of 1997, achieving the goals of the Brucellosis and Tuberculosis Eradication Campaign (BTEC). A further $39 million was spent between 1993 and 1997.

A five-year monitoring program - the TB freedom assurance program (TFAP) - was initiated in 1998 by State and NT governments, the cattle industry and the Commonwealth to run to 2002. The national forward estimate for TFAP was $33 million, of which $13 million was expected to be spent in the NT. The main focus was the turn-off of previously exposed cattle. Three TB cases were detected during an investigation in cattle herds in 1998 and 1999. This resulted in destocking of two small herds in the Darwin region and an eradication testing in a large herd in the Katherine region. In 2002, TB was detected in two buffalo herds, which were destocked.

TFAP 2 runs from 2003 to 2006 with the above objectives and a national budget of $20.1 million. The program has a new deed with revised standard definitions and rules. Field TB testing will take place particularly on properties with a TB case after 1988 and where there is little abattoir monitoring due to support for the live export trade. Assistance measures relate to surveillance testing and TB case eradication, which will be phased out during or at the end of the program.

Activities

Eradication

There were no ongoing eradication programs.

TB case detection

No TB cases were detected in the NT or anywhere else Australia since 2002.

The national granuloma submission program (NGSP)

TB surveillance at abattoirs has dropped to very low levels in the northern third of the NT due to the dominance of the live export market. Nationally, the program is reaching submission targets. An annual report is available at, http://www.animalhealthaustralia.com.au/.

During the period, 945 cattle and 135 buffalo were slaughtered at five NT abattoirs (similar to last year). No granulomas were detected. Most NT cattle are slaughtered and inspected interstate. A lack of monitoring at abattoirs of some feral buffalo is an emerging issue for the TB monitoring program. This has been addressed by TFAP2 by funding an additional aerial survey on the upper Katherine River, TB testing of export buffalo and monitoring by three ranger groups in a target area of north west Arnhem Land.

TB monitoring programs

Cattle previously exposed to TB infected animals remain a very low, but possible, risk of undetected TB cases despite completion of the eradication program at CF2 or CF3 status. Of the estimated 24 million cattle in Australia, about 200 000 on 70 properties were in this risk category in 1997. The national cattle industry decided that the owners of these properties should adopt risk management strategies to minimise the scope of a possible future case of TB.

Records indicated that in 1997, 50 properties in the NT may have had stock remaining that was previously exposed to TB infected animals. The owners of three properties decided not to adopt the voluntary monitor program. Four properties contained the majority of exposed cattle (34,000) in 1997 and 1998.

Category A cattle are breeders that were one year or older when exposed to TB infected stock. Category B cattle are progeny of cattle de-stocked due to TB or are progeny of category A breeders. At the end of 2005-06 no category A cattle remained. Category B cattle have declined from 25 000 at the end of June 2005 to 13 200, all on three properties. Turn-off is required at ten years of age.

Voluntary monitoring programs have been replaced by approved property TB surveillance agreements, mainly for properties with a history of TB after 1988 which are committed to the live export trade. About 60 properties have TB surveillance agreements for TFAP2. It is expected to test about 25 000 animals annually to the end of 2006.

Table 1. TB testing July 2005 to June 2006

Type	Number tested	Number of reactors	Number with confirmed TB
Cattle	23 773	17	0

Testing was done on 19 properties. Buffalo are not included.

TB monitoring after the end of TFAP 2 for 2007 to 2010 will be through a bilateral agreement between the Cattle Council of Australia and the NT. The national cattle industry will provide funding for the reimbursement of compensation for reactors or for destocking. A review will be conducted in 2010 to categorise bovine TB as an emergency animal disease.

The Berrimah Veterinary Laboratory passed the annual quality assurance test for procedures for the diagnosis TB.

Expenditure in 2005-06

Operations	$267 592*
Compensation	$14 200 (reactors)
Mustering subsidy	$167 980
Interest subsidy	$0
Freight rebate	$0
Total	$449 772

∗Estimate

Project: The Transmissible Spongiform Encephalopathy Freedom Assurance Program

Project Officers: F. Human, Regional Veterinary Officers and Staff

Location: Territory wide

Objective:

To maintain Australia's internationally recognised freedom from transmissible spongiform encephalopathy, through:

- ***The national transmissible spongiform encephalopathy surveillance program.***
- ***Restricted animal material audits.***
- ***Management of animals imported from Europe, Japan and North America.***
- ***Aggregation poin study.***

The national transmissible spongiform encephalopathy surveillance program (NTSESP)

Australia is free of the two major transmissible spongiform encephalopathies (TSEs), bovine spongiform encephalopathy (BSE), which affects cattle, and scrapie, which affects sheep. However, the Office International des Epizooties (OIE) Terrestrial Animal Health Code requires that countries claiming to be free of TSEs have a surveillance system in place to detect BSE and scrapie should they occur. It is important that Australia meets this requirement to assure continued access to export markets. NTSESP was started in 1998 to address this issue. Animal Health Australia coordinates the program, with State/NT/AQIS coordinators organising activities in their regions. There is also information about NTSESP on Animal Health Australia's website at: www.animalhealthaustralia.com.au

OIE guidelines are used to determine the necessary surveillance levels. Surveillance involves examining a large range of specimens from cattle over two years of age or sheep with signs of nervous system disease. The number of cases that each State/Territory needs to examine has been calculated according to their cattle or sheep population. The NT examines 23 cattle cases annually but no sheep.

The program operates on the calendar year. The NT made 25 submissions from cattle that were negative for BSE in 2005. Government veterinary officers, stock inspectors and a private veterinary practitioner collected samples in the NT. Some of the diagnoses for the sampled animals were septicaemias, plant poisoning, spinal cord degeneration, hepatopathy and several pneumonias.

Restricted animal material audits

No non-compliance was detected.

A random feed sample, export pellet plants, reseller audits and user audits were audited.

This exceeds the minimum number required for the NT by TSEFAP.

Imported animals

There are eleven imported animals, which are in life-long quarantine and are inspected regularly.

Aggregation point study

Twenty four samples were collected during 2005-06. Five submissions came from aggregation points such as saleyards and export yards. The rest of the samples were collected from tuberculin reactors and general disease surveillance cases. This two-year project will end by December 2006 when the national target of 2000 samples is reached.

Program: Chemical Services

Project: Control of Use of Agricultural and Veterinary Chemical Products

Project Officers: J. Alcock, D. Watson and V. Kawaljenko

Location: Berrimah Farm

Objective:

To administer the Agricultural and Veterinary Chemicals (Control of Use) Act

Background:

Control of use of agricultural and veterinary chemical products is a State/Territory responsibility. The *Agricultural and Veterinary Chemicals (Control of Use) Act* commenced on 16 May 2005

Results:

Control of use of agricultural and veterinary chemicals

The Chemical Services Section assisted to resolve issues relating to the registration and use of chemical products through direct communication with clients, NT Government agencies and non-government agencies, and through liaison with the Australian Pesticides and Veterinary Medicines Authority (APVMA) through the registration liaison committee. It also assisted Departmental personnel, government agencies and industry to develop applications to APVMA for permits for emergency, off-label and trial use

Policy

The Section contributed to the development of national policy in relation to chemical products, fertilisers and stock foods through the national product security and integrity committee.

Licences

The Section licensed 25 ground spray applicators, eight pilots and 15 businesses involved in agricultural spraying

Schedule 7 authorisations

The Section:

- Authorised 414 persons to use Schedule 7 poisons, including 273 for Mirant.
- Introduced compulsory competency training as a pre-requisite for a Schedule 7 authorisation from 1 January 2006.
- Ceased issuing authorizations on 4 January 2006 for the use of the persistent organic pollutant mirex, which is an active constituent of the registered product Mirant, which was used to control the giant termite *Mastotermes darwiniensis* on.

Complaints and inquiries about chemical use

The Chemical Adviser investigated and resolved 11 complaints about spray drift and 13 complaints about other activities, such as disposal of containers and general concerns about chemical use. Complaints were dealt with on site. Complainants received written responses and written directions were issued to persons using chemicals.

Testing horticultural produce for pesticide residues

As outlined in the 2005-06 produce residue testing project management plan, Chemical Services carried out tests on a range of NT-grown produce to determine if chemical residues were above the maximum residue limit (MRL).

The program tested 32 samples, including 13 for Asian vegetables, six for table grapes and 13 for mangoes. Samples were collected either from the farm gate or pack houses. Vegetable and mango samples were from the Darwin region while table grape samples were from Ti-Tree. The tests showed that table grape and mango growers performed well. The results were supplemented with tests on NT produce purchased from Freshtest from major interstate markets. In 2005, Freshtest tested 80 samples of fruit and vegetables grown in the NT. From the 80 samples, eight individual chemicals were detected above MRL from eight samples, indicating 10% MRL violations. There were seven MRL violations out of 24 samples (29%) in Asian vegetables. The Freshtest results generally support the findings from Chemical Services. There was only one violation of MRL from 57 samples of mangoes. Apart from the single mango violation and two violations on the sample of herbs, all violations occurred in Asian vegetables.

Table 1. Summary of chemical residue and Freshtest (FT) results 2005

Sample type	No. of samples	0-0.5 MRL	0.5 - MRL	> MRL	Chemical detected > MRL
Fruit					
Mangoes	13	2	1	0	
Dragon fruit	1	0	0	0	
Table grapes	6	3	0	0	
Mangoes FT	44	32	1	1	Bifenthrin
Limes FT	3	1	0	0	
Bananas FT	3	0	0	0	
Figs FT	1	0	0	0	
Rambutan FT	2	0	0	0	
Dragon Fruit FT	3	0	0	0	
Total fruit	76	38	2	1	
Vegetables					
Bitter melon	1	2	0	1	Chlorpyrifos
Snake bean	1	2	0	2	Chlorpyrifos, Bifenthrin
Cucumber	3	3	2	1	Chlorpyrifos
Luffah	2	2	0	4	Indoxacarb, Bifenthrin, Chlorpyrifos, Propiconazole
Long melon	1	0	1	0	
Okra	2	2	1	2	Indoxacarb, Chlorpyrifos
Kan kong	1	3	0	0	
Melon FT	6	1	0	0	
Long melon FT	2	0	0	1	Chlorpyrifos
Pumpkin FT	2	0	0	0	
Onions FT	1	0	0	0	
Cucumber FT	3	0	0	0	
Eggplant FT	1	0	0	0	
Okra FT	1	0	0	0	
Chilli FT	1	0	0	0	
Beans FT	3	0	0	3	Chlorpyrifos
Bitter melon FT	4	0	0	3	Chlorpyrifos
Total vegetables	35	15	4	17	
Other					
Sweet Basil	1	0	0	2	Chlorpyrifos, Cypermethrin
Total	112	53	6	20	

All growers sampled in the Chemical Services program received a letter of notification informing them that samples were collected. A copy of the laboratory results was provided when ready. Growers with above one half of the MRL were visited to investigate the cause(s). In collaboration with Entomology, advice was provided on pest management practices. An interpreter service was used in most cases to ensure advice was communicated effectively. Freshtest results are supplied in confidence and grower information is not revealed.

Subsequently, the Chemicals Coordinator wrote to vegetable growers (translated into Vietnamese) pointing out that label instructions must be followed when using pesticides and also reminding growers of the need to keep records required under the legislation. Chemical Services produced a brochure '*Pesticide residue monitoring program for fruit and vegetables* in English and Vietnamese. A meeting of stakeholders was arranged at which the following undertakings were made:

- The Entomology Branch (Diagnostics Division) with assistance from Chemical Services to apply for a minor use permit for management of heliothis on a range of Asian vegetables. The application is under consideration by APVMA.
- The Entomology Branch to produce a list of crop based recommendations for insect control. To be translated into Vietnamese (almost complete).
- NTHA to endeavour to employ a non-English speaking background extension officer (in progress).
- NTHA to endeavour, numbers permitting, to organise a ChemCert competency training course to be run in Vietnamese (seeking funding).
- The Crops, Forestry and Horticulture Division to provide a chemical application course for vegetable growers (planning).
- Chemical Services to introduce the infringement notice system with the assistance of the Department of Justice (in progress).
- Chemical Services to liaise with the Department of Health and Community Services (done).
- Chemical Services to continue a targeted residue monitoring program over 2006–07 (commencing when the infringement notices are in place).

CROPS, FORESTRY AND HORTICULTURE

Program: Horticulture Industry Development

Project: Industry Liaison

Project Officer: M. Connelly

Location: Territory wide

Objective:

To ensure that the targeted needs of the horticulture industry are effectively met through enhanced communication between the government and industry.

Background:

The mission of the sector liaison staff is to facilitate communication between industry stakeholders and government departments. This is achieved mainly by organising industry development plans for the different grower groups. Based on such plans, targeted research and extension activities are initiated. This year 61 activities (marked with *) were conducted covering a wide range of subjects, which attracted 623 participants (Table 1). A similar number of workshops/activities were presented to industry attracting 50 fewer participants this year. There has been a shift in the industry numbers with many small part-time growers leaving the industry for commercial reasons. Next year could see fewer workshops but greater uptake of information from a more consolidated industry base.

The annual shows in Alice Springs, Katherine, Darwin and Fred's Pass, including the Katherine Research Station's Farm and Garden Day are good venues to present valuable technical and practical information to growers and the wider public.

Results:

The nursery industry

All nurseries were surveyed for the presence of ginger ants *(Solenopsis geminate)*. A poster was prepared to describe the necessary protocols for exporting plants interstate and general control measures used in the nursery area.

Peter Shepherd presented a workshop on cost of production to enable clients to estimate profit margins and to plan for the future.

The Division hosted a nursery information and trade day at Berrimah Farm. The seminar talks were useful to the nursery industry and associated businesses.

All member nurseries in the Nursery Industry Accreditation Scheme, Australia (NIASA) retained their accreditation for 2005-06. A seedling nursery became a new member of NIASA. There are now eight accredited nursery businesses in the NT, including the Charles Darwin University and the post-entry quarantine facility.

The cut-flower industry

A survey found that locally grown flowers compared well with interstate flowers for price and vase-life but would probably never replace them.

A workshop on the cost of production was well attended. Many lessons were learnt on how to reduce costs of production. This industry works on a tight profit margin and must consider value-adding to keep up with rising costs of freight and fuel.

The Heliconia Society International's conference was attended by 45 participants in Darwin. The majority were from overseas. The participants visited several local flower farms. They also collected *Zingiber* hybrids developed by DPIFM and now grown at one of the larger properties outside Darwin.

The citrus industry

Katherine citrus growers are working together to manage irrigation to encourage increased flowering for next year's crop.

The vegetable industry

Currently there is no organized Asian vegetable grower group or association. Growers have shown no particular interest in forming such an association. Contact through individual social groups appears to be their preferred model at this stage. There are only about 55-60 growers clustered in four or five locations in the Darwin rural area.

Important developments include a move to shade-house production of cucumbers, an increase in farm size and employment of non-family labour.

Another important development has been the increase in English speaking skills among Vietnamese and Cambodian vegetable growers over the last four to five years. While there are Vietnamese and Cambodian translators for producing specific documents in those languages, there are enough bi-lingual people within the community to effectively communicate information on a one-to-one or small-group basis.

Financial returns have generally been good during this and the last season. The industry is not facing any immediate threats except from Fusarium wilt in snake beans, which is being addressed.

The Katherine horticulture advisory forum (KHAF)

KHAF was established in early 2003 to improve communication and feedback between the Katherine horticulture industry and government. The forum meets regularly and facilitates development in the region. KHAF recently expanded to include agricultural industry representatives in line with the new divisional structure of DPIFM. KHAF conveys to government the needs of industry such as extension through local best practice group activities.

The mango industry

The department recognises the NT Mango Industry Association's (NTMIA) Strategic Plan 2003-06. Although the plan was not altered in 2005-06, it is expected to be reviewed soon.

The industry is undergoing a period of structural change and adjustment. Current issues facing it will be described in a consultancy study commissioned by the department in March 2006. The study will provide the NT Government and industry information on how to enhance decision-making on appropriate ways to deal with industry adjustment issues. The findings of the study should help the department to define more clearly its role in future on how to assist the industry.

The NT Horticulture Association (NTHA) continues to act as the main administrative and communication contact point for NTMIA. The department participated in several activities hosted by both industry associations, such as post-season supply chain forums, and pre-season transport and labour forums.

The department continues to maintain strong links with the Australian Mango Industry Association (AMIA), the peak national body, which supports industry-wide R&D activities through levy-generated funding. In May 2006, AMIA held its regional forums for NT growers at the Katherine Research Station and the Coastal Plains Horticulture Research Station, near Darwin.

The horticulture partnership group (HPG)

HPG held its inaugural meeting on 9 June 2004. During 2004-05, the group met four times: 23 August 2004, 21 February 2005, 7 March 2005, and 16 May 2005. Three vacant positions were filled during the year, including business and marketing.

Planning workshops were held during the year where the group identified priorities for sustainable and profitable industry growth in order to achieve its vision of doubling the value of the NT's horticulture industry in five years.

HPG considered mechanisms to enable the NT horticulture industry to work cooperatively on packaging, marketing and supply. A pre-feasibility assessment was completed analysing various horticultural marketing organisational models and practices from around Australia and their suitability for improving marketing of N T produce.

The rambutan industry

NTHA plays a leading role in the national tropical fruit partnership program e-supply chain and the coordinated supply chain marketing project. Horticulture staff have supported the introduction of the project by working with the IT provider to populate data fields on the electronic proformas and are helping growers to implement the scheme.

The melon industry

Divisional staff in Katherine were involved in a melon supply chain project in conjunction with QDPI&F for the Australian Melon Association. Melon handling and cool chain processes were assessed from picking through to retailing. NT melon growers have to contend with the extra challenge of distance to market. The project officers presented results in each growing region, published melon assessment guides and information on improving melon supply chain handling systems.

Workshops/field days/shows/displays - conducted/participated in by Crops, Forestry and Horticulture 2005-06

Subject	Organised by	Participant	Venue	Date	Industry participants
Asian vegetables					**45**
Presentation on the product description language project at RIRDC and meeting researchers	RIRDC	G. Walduck	Sydney	28-29/03/06	45
Bananas					**340**
Presentation on FOC at Padang University	ACIAR	G. Walduck	Padang, Indonesia	26/07/05	30
Workshop on FOC control measures in Indonesia	ACIAR	G. Walduck	Solok , Indonesia	28/07/05	30
Workshop and presentation on FOC/BDD identification and variety trials	ACIAR	G. Walduck	Padang, Indonesia	15/02/06	20
Presentation on FOC at the Australian Banana Conference	ABGC	G. Walduck	Cairns	11/08/05	60
Poster display on Formosana Australian at the Banana Conference	ABGC	G. Walduck	Cairns	11/08/05	200
Citrus					**60**
Bio-security and levies for citrus	Cittgroup	M. Connelly/M Hoult	Darwin	9/08/05	12*
Citrus flowering practices	DPIFM	M. Connelly/M. Hoult/G. Azam/R. Renfree	Katherine	9/07/05	6*
Mandarin walk through	Cittgroup	M. Connelly/M. Hoult	Darwin	5/11/05	13*
Soil health and exotic diseases	Cittgroup	M. Connelly	Darwin	13/12/05	7*
Soil health and exotic diseases	Cittgroup	M. Connelly/R. Renfree	Katherine	15/02/06	8*
Common sense growing practices for citrus	Cittgroup	M. Connelly	Darwin	10/04/06	8*
A hands on pruning day	Cittgroup	M. Connelly	Katherine	14/04/06	6*
Cotton					**45**
Genetically modified crops	DPIFM/KRS Seminar	R. Eastick/A. Davies	Katherine	2/06/06	20
Potential for weediness of Bt cotton	DPIFM/BARC Seminar	R. Eastick	Darwin	16/06/06	25
Cut-flowers					**109**
Heliconia nutrition	DPIFM	M. Connelly/D. Marcsik/M. Hoult	Darwin	13/12/05	10*
Curcuma walk	DPIFM	M. Connelly/A. Wilson/M. Hoult	Darwin	17/02/06	6*
Cut-flower growers meeting	NTHA	D. Marcsik	Darwin	27/09/05	18*
Spiralling white fly talk	DPIFM	S. Smith/D. Marcsik	Darwin	28/03/06	10*
Cut-flower water use study	NTHA	C. Wicks/M. Connelly	Darwin	May-06	15*
Heliconia Society Conference	Heliconia Society	M. Connelly/D. Marcsik/M. Hoult	Mirambeena, Darwin	26-28/6/06	50
Forestry					**50**
Workshop on African mahogany		D. Reilly/B. Robertson	Townsville, Qld	10-12/5/06	50*
Fruit fly					**20**
Fruit fly meeting with growers	DPIFM	G. Kenna/A. Nesbitt/D King/D. Salter	TTRF	Mar-06	20*
Katherine industry meetings					**11**
Water use review presentation	D Jaeschke	KRS staff	KRS	15/09/05	11*

Katherine local best practice groups					**136**
Soft option pest control	DPIFM/LBPG	KRS staff	Katherine	5-7/7/05	25*
Bore reports	DPIFM/LBPG	KRS staff	Katherine	17/08/05	6*
Mango fruit handling	DPIFM/LBPG	G. Owens/D. Hamilton	Katherine	21/09/05	21*
Mango sunburn trial orchard walk	DPIFM/LBPG	G. Azam	Katherine	19/10/05	12*
Soil health workshop	DPIFM/LBPG	KRS staff	Katherine	11/03/06	11*
Mango flush management using Ethrel®	DPIFM/LBPG	KRS staff	Katherine	22/03/06	17*
On farm irrigation	DPIFM/LBPG	C. Wicks	Katherine	10/05/06	22*
Plant nutrition	DPIFM/LBPG	G. Owens	Katherine	21/06/06	22*
Mangoes					**103**
Mango mangers' workshop - Darwin	DPIFM	G. Walduck/D. Hamilton	Darwin	5/09/05	6*
Mango managers' workshop - Katherine	DPIFM	G. Walduck/D. Hamilton	Katherine	15/09/05	6*
WEPack effective spraying and canopy management	WEPack	G. Owens/D. Hamilton	WEPack, Darwin	7/05/06	22*
WEPack mango nutrition and quality out-turns	WEPack	G. Owens/D. Hamilton	WEPack, Darwin	10/06/06	18*
National mango crop forecasting growers' meeting	DPIFM	G. Owens	Dimbulah	14/06/06	7
NTMIA post-season seminar	NTHA	G. Owens	Howard Springs	25/03/06	9*
AMIA forum	AMIA	G. Owens/D Hamilton	CPHRF	30/05/06	15
AMIA forum	AMIA	G. Owens	KRS	29/05/06	20
Nursery					**98**
Protocols for ginger ants in NT nurseries	DPIFM	M. Connelly/B. Thistleton/D. Chin/H. Brown	Darwin	29/08/05	20*
Environmental stewardship	DPIFM	M. Connelly	Darwin	14/10/05	22*
Spiralling white fly talk	DPIFM	M. Connelly	Darwin	2/05/06	6*
Nursery & trade information day	NGINT	M. Connelly	Darwin	23/05/06	50*
Rambutan					**50**
Rambutan growers' meeting	DPIFM	C. Wicks/G. McMahon	Grower property	24/11/05	20*
Rambutan growers' meeting	DPIFM	C. Wicks/G. McMahon	Grower prop/NTHA	13/05/06	10*
Visit by Alan Zappala and Ian Kikkertt and meeting with growers	DPIFM	G. McMahon	Grower property	8/08/05	10*
Meeting with rambutan growers' & NTHA : IPP project	NTHA	G. McMahon	Grower property	13/05/06	10*
Show circuit/displays					**45**
Alice Springs Show	DPIFM/M&C	CFH staff	Alice Springs	1-2/7/05	
Katherine Show	DPIFM/M&C	CFH staff	Katherine	15-16/7/05	
Royal Darwin Show	DPIFM/M&C	CFH staff	Darwin	21-23/7/05	
NT Tropical Garden Spectacular	NGINT	CFH staff	Darwin	6-7/8/05	
Horticulture seminar	CSIRO	CFH staff	CSIRO	21/10/05	
APEN/CVCB extension workshop	G Owens	CFH staff	TDZ Darwin	14/11/05	45*
Katherine Farm & Garden Day	DPIFM/KRS	CFH staff	KRS	1/04/06	1900
Fred's Pass Show	DPIFM/M&C	CFH staff	Coolalinga	20-21/5/06	

Table grapes					**23**
Table grape R&D workshop	DPIFM/AZRI	G. Kenna/A. Nesbitt/D. King/D. Salter	TTRF	Jul-05	8*
Table grape growers' discussion group	DPIFM/AZRI	G. Kenna/A. Nesbitt/D. King/D. Salter	TTRF/growers prop	Jul-05	5*
Table grape growers' discussion group	DPIFM/AZRI	G. Kenna/A. Nesbitt/D. King/D. Salter	TTRF/growers prop	Sep-05	5*
Table grape growers discussion group	DPIFM/AZRI	G. Kenna/A. Nesbitt/D. King/D. Salter	TTRF/growers prop	Mar-06	5*
Weeds					**67**
Weed risk assessment technical group meeting	DPIFM	R. Eastick	Darwin	3-4/4/06	12
Weed risk assessment stakeholder & tech working group meeting	DPIFM	R. Eastick	Darwin	12/04/06	55
Indigenous economic development					**Total visits 156**

Project: Cittgroup Activities for 2005-06

Project Officer: M. Connelly

Location: Territory wide

Objective:

To provide Northern Territory citrus growers relevant workshops, seminars and field days to improve their knowledge.

Background:

The role of the Cittgroup coordinator is to organise technical workshops/field days in the Katherine and Darwin regions, including Kununurra when possible.

Activities

- Field walk of the mandarin rootstock trial 5/12/05.
- Identifying exotic pests and soil health - Darwin 13/2/06 and Katherine 15/2/06.
- Common sense growing practices for citrus 10/3/06.
- 'Hands on' pruning day 13/4/06.
- Darwin lime producers are working towards best practice management strategies for quality fruit.
- Katherine citrus growers are working together to manage irrigation deficit to induce a concentrated flowering in red flesh grapefruit and lemons.

Project: Implementing a Top End Better Mangoes Project - MG05005

Project Officer: G. Owens

Location: Berrimah Farm

Objective:

To implement a Top End better mangoes project.

Background:

The mango industry in the Top End has looked at Queensland for viable fruit transport and ripening systems to ensure consumers receive the best produce possible. The Queensland better mangoes project showed that fruit quality depended on the way the fruit was treated in the cool chain. The project also developed the concept of the saleable life index (SLI) which allowed the fruit to be objectively benchmarked in the market.

Mango producing areas such as the Top End and Kununurra in WA are many thousands of kilometres away from major markets. Fruit takes on average six to 10 days and in some cases two weeks, to reach such markets. Top End supply chains usually send mature unripe mangoes to markets. The mangoes are then ripened using gas or naturally.

Method:

The Top End better mangoes project aims to use some of the techniques developed in Queensland to map the performance of current supply chains. It also aims to establish the SLI for Top End fruit and use this as the benchmark to evaluate other systems.

In the second and third years of the project, other systems could be trialled, such as in-transit ripening, or staged ripening at some point along the supply chain.

Although just commenced, the project already involves several growers/packers, including two growers from Darwin rural, three from Katherine and one from Kununurra. This group will specify the treatment of whole containers or trucks of mangoes and will share its findings with the Top End industry.

Project: Improving Market Outcomes for NT Mangoes

Project Officers: G. Owens, D. Hamilton and P. Subedi (CQU)

Location: Berrimah Farm and WEPack Mango Packing Shed

Objective:

To improve the quality of fruit received in the packing facility so as to maximize its attractiveness in southern markets.

WEPack is a mango packing facility and a mango freight consolidation business on Cox Peninsular Road, Berry Springs. It does not own mango trees but packs fruit for between 70 to 80 small and medium sized mango growers each year.

Since its inception five years ago, it has established a reputation for high quality, consistent outcomes for its clients. The owner selected more than 25 of the better performing growers to join the WEPack group. The group uses best practice in the field, attends training and field events and has been identified as a premium brand. As other growers improve their performance, they could join the group.

A colour branding system is used to differentiate fruit in the market. Last year this group received a premium price over and above the high prices paid for first grade fruit in a low supply season.

DPIFM is currently conducting three best practice WEPack projects/activities for the 2006 mango season:

- Staff conducted a series of workshops and field activities for WEPack growers to improve orchard management practices to ensure high quality fruit is supplied to southern markets. This year the activities were open to all mango growers and were advertised through NTHA.

- Between 15 and 20 WEPack growers attend these activities regularly. Activities this year included canopy management, effective spraying techniques, nutrition for a quality product and interpretation of market outturn reports. Planned activities include harvest procedures for quality, pest control and cincturing techniques for flowering.

- Follow up assistance to growers who have undertaken training is a critical part of the success of the workshops. Often, such assistance makes the difference between success and failure.

WEPack is not a closed group. However, it has a limited packing capacity based on the size of its shed and cooling capacity. New growers can join and most importantly, fruit from non-performing growers can be packed at other packing facilities.

Near infra-red (NIR) maturity index trials

DPIFM, WEPack and Central Queensland University (CQU) are developing a non-destructive maturity test for Kensington Pride and Calypso mangoes using NIR. Last season, a researcher from CQU showed that it was possible to predict the maturity of harvested mangoes using a desk-top NIR unit.

This season CQU will introduce a hand-held field NIR unit that promises to assess fruit maturity in the orchard, before the fruit is harvested and without destroying the fruit. WEPack will focus on maturity in Kensington Pride mangoes. Current results will be submitted for publication in the journal *Post-Harvest Biology.*

Top End better mangoes

The three year Top End better mangoes project begins this season. WEPack is one of six participants in Darwin, Katherine and Kununurra. The project is funded by the national mango levy through Horticulture Australia. DPIFM contributes through its technical and extension staff.

The Top End better mangoes project is a continuation of the very successful Queensland better mangoes project. The Top End project will study the longer supply chains of more than four days and will use the 'saleable life index' developed by QDPI&F as the quantitative benchmark.

The project will map and benchmark the performance of selected supply chains in the first season. Participating growers will visit the markets during the fruit evaluation period.

Project: Improving the Sustainability of Katherine Crops, Forestry and Horticultural Industries through Local Best Practice Groups

Project Officer: D. Rock

Location: Katherine Region

Objectives:

To facilitate the improvement of crop management practices in the Katherine region.
To promote the local best management practice group's activities in the Katherine region.

Introduction:

Local best practice group extension activities are determined by the Katherine Horticulture Advisory Forum (KHAF). These activities promote and support a holistic approach to farming in the Katherine region.

Activities

Soft option pest control
A series of on-farm discussion groups were held in Katherine and Mataranka from 5-7July 2005, which were attended by 24 growers. A discussion group format was used with growers learning from each other as well as from DPIFM Entomology, Plant Pathology and Horticulture staff. Each session was held on a farm, beginning with an orchard walk, and finishing with a BBQ. The subject was quite topical as there had been a recent small outbreak of mango leaf hoppers in the Katherine region.

Understanding your bore report
A local expert from the Department of Natural Resources, Environment and the Arts led an informal discussion at Katherine Research Station (KRS) with six growers on 17 August 2005. Topics included how to

look after your bore, how to read bore reports, water quality, what the analysis means to your crops, irrigation and spraying.

Mango fruit handling
A practical on-farm session was held on 21 September 2005 at one of the corporate farms in Katherine. It was conducted by a DPIFM Senior Extension Officer and was attended by 21 growers. Topics included how to treat fruit with care, how to manage sap-burn, skin browning and bruising, and how to use harvest aids.

Mango sunburn trial
A field walk was held on 19 October 2005 at a grower's property to show the results of the sunburn trial conducted by DPIFM staff. Seven growers attended the walk.

Soil health workshop
In cooperation with Charles Darwin University, a one-day soil health workshop was held at the Rural College on 11 March 2006, attended by 11 growers. The aim of the workshop was to provide growers greater understanding of soils and microbes, and how to manage and maintain appropriate soil conditions conducive to sustainable farm management and land use.

Mango flush management with Ethrel
A practical and theory session was held at KRS on 22 March 2006, which was attended by 12 interested growers. Ping Lu from CSIRO showcased his research on the use of Ethrel to manage flush in mango trees.

Irrigation discussion group
An on-farm discussion group attended by 18 growers was led by a DPIFM Senior Horticulturist on 10 May 2006. The session started with an orchard walk to observe a micro-jet sprinkler system in use. Topics included sprinkler testing, increasing the efficiency of irrigation units and watering times. The discussion related back to crop nutrition including pastures, mangoes, melons and vegetables.

Plant nutrition
The Senior Extension Officer and Industry Development Officer from DPIFM conducted a session on general plant nutrition at KRS on 21 June 2006, which was attended by 18 interested growers. The discussion covered crop nutrition including pastures, mangoes, melons and vegetables.

Results:

The local best practice group activities have been successful in several ways. There is evidence that the major objective of improving crop management practices in the region has been achieved. A decline in the use of chemicals, for example, has been reported by a number of growers who are now using softer options.

Local best practice group activities have gained popularity among growers with numbers steadily increasing throughout the year. The Katherine horticultural industry shows signs of unity among growers, with many happy to hold DPIFM-facilitated sessions on their own farms. The sessions now cater for agricultural growers as well as forestry and horticultural growers in line with the new structure of the Crops, Forestry and Horticulture Division.

Program: Indigenous Horticulture Development

Project: Community Gardens

Project Officer: C. Kelly

Location: Berrimah Farm

Objective:

To encourage horticulture development in indigenous communities by facilitating the establishment of community/market gardens.

Background:

In 2005 the NT Government launched the indigenous economic development (IED) strategy. As a part of the strategy, the Crops Forestry and Horticulture Division of DPIFM developed a program to increase the indigenous community's and the individual's involvement and participation in plant-based enterprises. The community gardens project is part of this program, which is the first step towards plant-based economic development of indigenous communities, run by indigenous people.

It is envisaged that the establishment of small gardens managed by community participation, will encourage an understanding of plant industry practices and the potential for plant-based enterprises.

Activities

In 2005-2006 the project continued to demonstrate a cooperative working relationship between the NT and Commonwealth Governments under the umbrella of the new arrangements in indigenous affairs. Advice has been provided to communities considering entering into shared responsibility agreements with the Commonwealth Government on establishing community market gardens.

A program of visits continued to communities and outstations which are considering establishing plant-based enterprises. Over 30 communities were visited to discuss with relevant stakeholders community aspirations regarding the establishment of community market gardens. Resource assessments were undertaken and reports were prepared for a number of communities who, through preliminary discussions, have demonstrated a commitment to address all the issues affecting the establishment and sustainable management of market gardens. Three communities have taken the steps towards establishing community market gardens which, subject to funding from other government agencies, should begin activities early next year.

The project has continued to support the establishment of a pilot community garden at the Emu Point community, 320 km south-west of Darwin. Progress has been slower than anticipated due to restricted access during the wet season and cultural activities during the planting season. So far, the community has participated in all activities from ground preparation to installation of drip irrigation, providing a good grounding in plant establishment requirements. The participants are now capable of utilising the same methods and machinery to develop larger areas. The challenges faced in establishing and managing gardens in this community are documented and provide knowledge and experience beneficial to other remote communities.

A booklet containing basic information on simple production systems is being developed to assist communities in project feasibility, planning and establishment. The need for this came from feedback on information presented in the form of leaflets earlier in the project. It was noted that the leaflets were not

descriptive enough and that the majority of clients wanted information on “how to complete tasks”, rather than what to do.

Project: Development of Skills for Indigenous Employment in Commercial Horticulture

Project Officer: G. Kenna

Location: Ti Tree Research Farm (TTRF)

Objective:

To facilitate employment opportunities for indigenous people in the commercial horticulture industry in the Ti Tree region by training local people in skills required to gain employment.

Background:

The table grape industry is centred on the Ti Tree area in the southern NT. The industry is currently valued at around $5.8 million. However, plantings are increasing and the industry is expected to reach around $20 million in the next five years with around 400 hectares planted.

The availability of skilled and semi-skilled labour to meet the industry’s requirements is limited. At this time virtually all of the workforce comes from southern states and is employed on a contract basis. The industry wants to employ local labour. However, there are no skills in the potential labour force that resides in the area.

As a result, a partnership has been formed between industry, the Anmatjere Community Council (ACC) and DPIFM to address the issue of skills training leading to employment.

Activities

Necessary skills required to gain employment in the table grape industry have been identified with industry. These include vine pruning, vine planting, bunch trimming and thinning, and erection of trellises.

A program has commenced to train in these and other skills required to gain employment. One stage of the training is to train a group of Anmatjere men using facilities at TTRF. Activities include irrigation maintenance, pest and disease control, fencing and the establishment and management of various crops.

The second stage of the project involves training and contracting for vine pruning and planting on commercial properties in the area. A group of local Anmatjere men have been trained in spur and cane pruning vines. ACC has then contracted its labour to a commercial property to prune a substantial part of the planting. Training was also provided in vine planting. This has resulted in a contract to plant 4 hectares on a commercial property after agreeing on a contract rate for the work. In both instances the work was carried out at a high standard.

The high standard of work and the productivity of the workers are being recognised by the industry, resulting in higher employment opportunities. In the mean time, trainees are given more opportunities to improve their skills to gain full-time contract employment in future.

The aim is to continue to expand the project to build a substantial number of skilled and semi-skilled workers in the community that are capable of taking on substantial contracts on properties in the area. As well as the skills issues, there are a range of other supporting activities that need to be addressed in order to achieve this core group of trained workers. Among them are work ethics and life skills needed to hold a job and

improve living standards. Mentoring of Anmatjere people by Anmatjere people is an important part of the program.

Among the benefits envisaged with the success of this program is a higher standard of living for the families involved, with flow-on effects of better health, nutrition and improved school attendance.

This project is used as a model for skills training by Centrefarm Corporation. In cooperation with the IED officer, Centrefarm is playing a leading role to identify and develop aboriginal land for commercial horticulture in the NT.

A local Anmatjere person has been offered an apprenticeship in commercial horticulture production in the Ti Tree area, based at TTRF. He will assist in supervising other trainees and will transfer the skills that he has learned to them. Training opportunities are also available on local properties as part of the ongoing cooperation between industry, the community and DPIFM.

Program: New and Improved Products

Project: Improvement of Productivity of Tree Crops

Project Officers: C. Wicks, G. Azam, M. Connelly, R. Renfree and M. Hoult

Location: Darwin and Katherine

Objectives:

To identify and understand critical factors affecting tree crop productivity and fruit quality in the Darwin and Katherine regions.
To develop and deliver suitable solutions to the industry to address them.

Activities

In 2005-06 the following activities were planned:

- Assess the importance to industry of further mango rootstock trials.
- Maintain and assess mango rootstock material at the Katherine Research Station (KRS).
- Manage citrus trees in the NT.
- Assess alternative strategies to manage nitrogen fertiliser in mangoes.
- Conduct the national mango benchmarking project.
- Evaluate the effect of various tree and fruit management factors on mango fruit quality.
- Conduct field trials to measure the response of tree crops to various biological methods of managing soil health.

Mango rootstocks

The first two activities involve ongoing assessment of alternative rootstocks for Kensington Pride mangoes. While there is industry interest in this project, no funding has been offered yet. Once a full dataset becomes available, a report will be published.

Mango flowering and bearing were highly variable in the 2005 season. At the Eumeralla site, for example, only about 25% of the trees flowered. Yield ranged between seven and 200 mangoes per tree. This makes analysis very difficult.

However, some trees that had been poor in good-bearing years at the original site on Zimmin Drive performed well this season. As a result, unlike in the past, full data will be recorded in the 2006 season.

In 2005 it was decided to make available all the “best” rootstocks for a third assessment phase elsewhere in Australia or for commercialisation in the Katherine region. This involves utilising various techniques to recover/multiply selected rootstocks by a commercial mango nursery.

Citrus tree management

Two activities were initiated after discussions with the NT citrus industry. One was a demonstration plot at KRS to stress lemon trees for various periods of time and then supplying nitrogen fertiliser and water to encourage flowering in good numbers at a desired time.

This part of the project also includes soil water monitoring at two commercial properties on the Venn. Water monitoring depth is 2 m at one site and 1 m at the other. This is to determine to what depth root activity occurs, as physical inspection at various sites on the Venn has shown that citrus roots reach that depth and beyond. Preliminary data has shown that some root activity does occur at 2 m but that most of it occurs above 1.2 m.

The second part of this project involves monitoring soil water and crop phenology at a mandarin rootstock plot in the Darwin rural area. This part will take a few years to show clear outcomes. However, the grower has already changed irrigation and tree management as early findings indicated over-irrigation, under-fertilising and inappropriate canopy management.

The national mango benchmarking project

This activity is reported elsewhere in the better mangoes project that was initiated by the AMIA in response to the findings of the national benchmarking project. The project involved a survey of growers and discussion of the findings with focus groups before reporting to Industry.

Soil health

This activity has been expanded into a project looking at soil health and soil biology. It was commenced in the wet season of 2005-06. However, little data has been collected to date as methodologies and techniques are refined.

Project: The Australian National Mango Breeding Project

Project Officers: C. Wicks, L. Chidwick and G. McMahon

Location: CPHRF

Objectives:

To develop improved mango cultivars for the domestic and export markets through a hand-pollinated hybridisation program.
To develop hybrid cultivars with superior fruit quality and suitable production characteristics for the various mango growing regions in Australia.
To generate a minimum of 50 individual hybrids for each parental combination over three years.
To generate some quantifiable data on the inheritance of characters and the combining ability of specific mango cultivars.

Selection and culling of hybrids was conducted at both locations, Mareeba and Darwin, where they are planted. The most promising selections have been propagated for testing in each of the various agro-climatic regions.

Method:

The project activities can be grouped into the following four phases in chronological order:

Phase 1, Hybridisation

This phase was completed in 1997.

Phase 2, Initial selection and characterisation

The second phase of the program involves the initial screening of hybrids for desirable types and collecting data on the specific characteristics for inheritance analysis. Detailed evaluation commenced in the 1999-00 season and was completed with the 2004 harvest.

Phase 3, Detailed regional testing

The third phase of the program involves the planting of replicated trials in nine agro-climatic regions to compare and evaluate the most desirable selections from the initial screening (phase 2) of the program. Data gained from these trials will be used to evaluate the commercial suitability of selections for the different growing regions in Australia and to prepare applications for Plant Breeders' Rights. The nine regions are Carnavan, Kununurra, GinGin WA, Darwin, Katherine, Mareeba, Burdekin, Bundaberg and northern NSW. This phase has yet to be commenced due to delays in both the adminstrative process and the payment of commercialisation fees by the commercial participants.

Phase 4, Market testing

The fourth phase of the program covers market testing and full commercialisation of potential hybrids. This phase (which overlaps the other three phases) will involve market testing in the domestic and export markets of commercial quantities of fruit grown in grower-cooperator orchards.

Work done this year

A block of A and B selections plus a number of the parent trees have been planted at CPHRF. These trees are performing well. A number of re-plants are required due to plant death, missed planting and incorrect supply of some budwood.

The small number of selected trees planted a few years ago were assessed for flowering and yield. Flowering in 2005 was very poor. This was common across the entire north Australian mango industry that season. Of the 10 lines in the block, three did not flower at all and another six had very light flowering. One line did flower and bear very well, with an average of 94 mangoes per tree.

Other activities

It was planned to remove the large blocks of old hybrid trees at CPHRF this year. However, the industry requested that the trees be retained until commercialisation and other issues have been fully assessed. Given that there was no need for information on fruit from those trees, they were mechanically pruned in June, after flowering.

Project: Mango Rootstock and Parent Tree Assessment in the Northern Territory

Project Officers: G. Azam, C. Wicks, R. Renfree and C. Newbould

Location: Katherine Research Station (KRS)

Objective:

To test various rootstocks and parent trees for total yield, marketable, unmarketable and fallen fruit.

Introduction:

This trial is investigating several rootstocks and parent trees under Katherine environmental conditions for their suitability to supply both domestic and international markets.

Method:

The mango rootstock and parent tree planting at KRS consisted of two to six trees of 18 cultivars randomly distributed in the block (Table 1). Trees were spaced 8 m x 6.5 m. In 2005 flowering was erratic. Harvest data was collected on 14 October and 17 November 2005. On 14 October 2005 Joa, N8E54 and one of the trees of N10E10 mangoes were harvested. The weight of “ground” fruit (over-mature and fallen), marketable fruit and unmarketable fruit was recorded and combined to derive the total yield for each cultivar. Mean weights per tree of the fallen fruit, marketable fruit, unmarketable fruit and total fruit are presented in Table 2.

Table 1. Mango trees under evaluation

Tree type	Planting date	No. of established trees
A. Rootstock cultivars		
Palmer 1/2	24 May 2001	6
Palmer 1/3	24 May 2001	3
Palmer 2/15	24 May 2001	6
1/2 Willard 1	25 September 2002	2
1/2 Willard 2	25 September 2002	2
1/2 Willard 3	25 September 2002	2
B. Parent trees		
N10E10	24 May 2001	4
E10-5/3	24 May 2001	4
N8E54	24 May 2001	2
N10E56	24 May 2001	4
N6E35	24 May 2001	2
R2E2	5 June 2001	4
Celebration	5 June 2001	4
Neldica	24 May 2001	4
Kensington Pride (KP)	5 June 2001	4
Chene	24 May 2001	4
Joa	24 May 2001	4
Heidi	24 May 2001	4

Table 2. Mango cultivar yield data, KRS 2005

Tree type	Cultivar	No. of productive fruiting trees	Total trees	Av. fallen fruit wt/tree[b] (kg)	Av. marketable fruit wt/tree[b] (kg)	Av. unmarketable fruit wt/tree[b] (kg)	Av. total fruit wt/tree[b] (kg)
A. Rootstock cultivars	Palmer 1/2	1	6	4.70 (.087)	3.70 (.074)	0	8.40 (.042)
	Palmer 1/3	0	3	0	0	0	0
	Palmer 2/15	0	6	0	0	0	0
	1/2 Willard 1	0	2	0	0	0	0
	1/2 Willard 2	0	2	0	0	0	0
	1/2 Willard 3	0	2	0	0	0	0
B. Parent trees	N10E10	3	4	3.93 (.061)	9.30 (.062)	0	13.23 (.021)
	E10-5/3	3	4	0.42 (.035)	2.77 (.071)	1.10 (.032)	4.29 (.060)
	N8E54	1	2	2.57 (.094)	9.26 (.096)	0	11.83 (.023)
	N10E56	1	4	0	0.68 (.254)	0	0.68 (.254)
	N6E35	0	2	0	0	0	0
	R2E2	2	4	0	3.38 (.113)	0	3.38 (.113)
	Celebration	4	4	4.63 (.029)	19.38 (.041)	3.00 (.018)	27.01 (.021)
	Neldica	1	4	0	1.30 (.087)	0	1.30 (.087)
	Kensington	2	4	0.61 (.011)	22.26 (.026)	0.66 (.011)	23.53 (.017)
	Chene	1	4	0	4.08 (.059)	0	4.08 (.059)
	Joa	1	4	0.42 (.005)	14.62 (.013)	0	15.04 (.011)
	Heidi	1	4	0	8.68 (.031)	0	8.68 (.031)

[b] Means (± 95% confidence intervals)

Results:

The cultivars that produced the best average marketable fruit were Kensington Pride, Celebration, Joa, N10E10 and N8E54. The cultivars that produced the highest average total yield were Celebration, Kensington Pride, Joa, N10E10 and N8E54. Joa, N8E54 and N10E10 cultivar mangoes matured earlier than other cultivars. The flowering intensity of all cultivars was assessed. However, fruit retention and harvest intensity were not assessed. As limited and highly variable (between and within varieties) flowering occurred during this season, no data is reported.

Conclusion

This was the second harvest year and a further two to three harvest years will be observed. The cultivars with the highest combined average marketable fruit weight and total yield were Celebration, Kensington Pride, Joa and N10E10. In future seasons we plan to quantify fruit maturity over time with dry matter testing and continue yield and quality assessments.

Acknowledgements

We would like to acknowledge the contribution of Jeremy Bright, former Research Horticulturist who established the planting; Birdwood Nursery, Nambour, Queensland and Ken Raynor, Nurseryman, Katherine, for supplying the trees.

Project: Northern Australia Cocoa Development (RIRDC Project DAQ-256A)

Project Officers: C. Wicks, R. Connolly and L. Chidwick

Location: CPHRF

Objectives:

To generate in-depth knowledge of cocoa production in northern Australia.
To refine a model that can determine the economic viability of cocoa production in northern Australia.

Background:

Cadbury Schweppes Australia approached DPIFM, Agriculture WA and QDPI&F in late 1997 with a proposal to conduct a collaborative feasibility study to develop cocoa production in northern Australia. Cadbury Schweppes was concerned that the increasing demand from Eastern Europe and China, combined with the continuing problems with supply from traditional cocoa growing areas, may lead to a shortfall in production. Currently, cocoa prices are rising as forecast.

Method:

After various study tours and an economic analysis by an independent consultant, representatives from DPIFM, Cadbury Schweppes, the Rural Industries Research and Development Corporation (RIRDC), QDPI&F and Agriculture WA met a number of times. It was agreed to form the “North Australia Cocoa Development Alliance”, which would coordinate all activities, including future commercial development, subject to feasibility of the crop. It was agreed that DPIFM would be directly involved in cocoa yield evaluation and clonal introduction projects.

Results:

A clear seasonal trend emerged in hybrid cocoa pod production. Data from over three years of production indicated that pod yield was generally associated with the build-up, reaching a peak between December and January and declining very sharply between April and May. Under experimental conditions in the NT, there were no differences in pod yield between hybrids.

Pod and bean size is a matter of concern in the NT, as pods tend to be small which means pod indexes (the number of pods required to produce 1 kg of dry bean) are too high for commercial production. A seasonal trend in pod size indicated that smaller pods were produced during the months when yield was highest. There were no apparent differences in pod size among the four hybrids under evaluation.

The funding for the north Queensland portion of the project was extended for two years in conjunction with the start of a commercial cocoa industry in the area. However, the NT project was not extended as yields did not increase to commercial levels. Savings in project funds allowed some selected harvests and the removal of hybrid trees in June 2006. The clonal trees will be retained until the national program is satisfied that all the material is duplicated elsewhere. A final report will submitted in late 2006.

Project: Tropical Germ Plasm Assessment

Project Officer: G. McMahon

Location: CPHRF

Objectives:

To research and identify suitable fruit crops for Top End production.
To evaluate the phenology and yield of selected lowland longan varieties.
To multiply and release to industry those that are suitable.

Background:

Overall, the season was very poor with little flowering and poor yields in most tropical fruit crops. Durian produced few flowers and no fruit and longan produced poor yields. No work was done on rambutan, carambola or pitaya this season. Durian flowering will be assessed again next season.

Longan

The Vietnamese low-land longan (*Dimocarpus longan*), continues to grow and is being assessed. The trial trees were planted in 1999 with a subsequent planting in January 2003. The five varieties planted are Mata Kuching, Xuong com vang, an unnamed variety called ex Vietnam, Long and Tieu la bau.

Flowering
Flowering this season was late, mostly occurring in October, while some trees were still flowering in December and January. Some fruit was harvested in February. Yield was very poor and many fruit dropped. Flowering in August and February, the variety ‘Tieu’ produced two crops, in November and May.

Pruning
The late crop may have been due to late pruning, which was done in July. Trees were pruned in March this year using two different methods to maintain tree shape and to determine the effect on yield. Half of the trees were pruned into an upright shape removing several major stems. The other half were pruned leaving the main stems to grow in a lateral direction which would encourage new growth upwards from lateral branches. This method is used in Thailand good results.

Figure 1. Lateral pruning

Figure 2. Upright pruning

Irrigation

Reduced irrigation before flowering last season caused late and more sporadic flowering. This season a trial was commenced to look at the effect of water stress on flowering using the two different methods of pruning. Tensiometers and diviners were installed to measure soil moisture. Watering was reduced after pruning to 8 litres per day. Five weeks later water was turned off on one row. Soil moisutre levels and phenology are being recorded. Flowering is expected in September.

Project: Subtropical Germ Plasm Assessment - Evaluation of Stone and Pome Fruit in Central Australia

Project Officers: D. King and I. Broad

Location: Arid Zone Research Institute (AZRI) and Ti Tree Research Farm (TTRF)

Objective:

To research, identify and evaluate suitable subtropical crops for production in Central Australia

Introduction:

Although there is potential local and interstate demand for Central Australian stone fruit, currently there are no commercial plantings in the Alice Springs region. Research plantings of stone fruit were established at AZRI in the past. Initially, the plants grew well and produced satisfactory crops. However, they eventually became unthrifty and were short-lived. Nemaguard was used as the rootstock for these earlier plantings. The rootstock was unable to adapt to the high pH and high temperature of the soil during summer.

There is a need to identify, research, and evaluate subtropical crops that are suitable for production in Central Australian.

Method:

New plantings of peaches, nectarines, apricots and plums were established at AZRI in 1996, 1997, 1998 and 1999. Several high and medium chill varieties were removed in 2002 and 2005. There are presently seven varieties of apricots.

Nine varieties of peaches, four of nectarines and two of apricots were established at TTRF in 1998. These plantings produced their first crop in 2002. Several varieties were removed in 2004 due to varying weather conditions and poor performance. The remaining were also removed subsequently.

Bright's hybrid, a peach/almond hybrid, is the main rootstock used in low chill peaches and nectarines. It is resistant to nematodes and tolerates high soil temperature and pH. Apricot varieties are grown on plum rootstocks Microbalan 29C and Marianna.

The aim is to evaluate a range of stone fruit types and varieties with varying chill requirements on a range of rootstocks for commercial production in Central Australia.

Sugar content of fruit juice was measured with a refractometer. The readings, in degrees brix, also indicated the relative maturity of the fruit.

Results:

The removal of some 70 high and medium chill varieties, heavier pruning, more intense thinning, later than normal frosts and varying weather conditions contributed significantly to changes in data for the 2005 season compared with the previous season.

Apricots

In 2005, Trevatt and Moorpark Early varieties were the only producers. Apricots need a longer period of time to establish. Four other varieties, Castlebrite, Taminick Gold, Goldrich and Rival, which were planted in late 1999, are expected to produce a light crop next season.

Tree management

Nutrition
Leaf nutrient analysis indicated zinc deficiency throughout the planting in 2005. A zinc spray at the appropriate time will rectify the problem. Copper and calcium levels were marginal. Copper oxy-chloride sprays have been used to overcome copper deficiency. A light side-dressing of ammonium sulphate or ammonium nitrate will help keep nitrogen at acceptable levels. Sodium and chloride levels were also very high in some varieties. Uptake of salt varies between rootstocks. A regular leaching program is addressing the problem

Birds
The use of a gas powered 'scare' gun has reduced the amount of damage caused by birds as the fruit ripens, which used to be a major problem at AZRI in the past. Early-maturing crops however, still incurred heavy losses. There was no apparent fruit fly damage.

Summary
Overall, yields of medium and low chill nectarines and peaches were much lower than in previous years. One of the four varieties of apricots planted in 1998 produced a small crop. Fruit fly infestation was negligible. Birds severely damaged marketable fruit.

Future work
Evaluation for another 12 months of apricot varieties planted at AZRI in 1998/99.

Preparation of a technical report on the viability of stone fruit production in Central Australia.

Pome fruit

Summary
Two new varieties, Pink Lady / M9 and Galaxy / MM106 were sourced from orchards in South Australia. They were planted at 1 row x 20 trees of Pink Lady and 3 rows x 20 trees of Galaxy, in September 2004.

TTRF varieties were removed due to poor growth resulting from poor nutrition and heat stress.

Future work
In conjunction with a supplier, a nutrition and management program has been set in place for the new varieties for the next 12 months.

Project: New and Improved Ornamental Crops

Project Officers: **D. Marcsik, M. Hoult, A. Wilson (Horticulture Apprentice), L. Chidwick, D. Cumberland and M. Hearnden**

Location: Berrimah Farm, commercial nurseries and a cut-flower farm

Objective:

To enhance market opportunities for the ornamental industry by providing new and unique cut-flowers over the next three years.

CURCUMA

Introduction:

The *Curcuma* breeding work is in the final stages of the hybrid evaluation process to select for promising cut-flower and potted colour commercial varieties. An intensive evaluation was conducted of all the hybrids in the field trial and of the hybrids being evaluated by the two commercial nurseries during the 2005-06 flowering season.

Method:

The hybrids in the field trial were evaluated based on the *Curcuma* cut-flower selection criteria in Table 1. During the flowering period between December 2005 and March 2006, yield and observational assessments were conducted of all flowering hybrids in the field. In addition, vase-life studies were conducted where a minimum of five inflorescences were harvested from each hybrid during the flowering period.

Table 1. Selection criteria for *Curcuma* cut-flowers

Characteristics	Minimum standard	Priority
Vase-life	10 days from pick to first sign of ageing	Essential
Yield	>10 stems/plant	Essential
Stem length	30 cm	Important
Number of colourful floral bracts per spike	Numerous	Important
Response or tolerance to Phomas fungus	Good	Important
Response to bacterial wilt	Good	Important
Adaptability	Full sun	Beneficial

Feedback on the evaluation of hybrids for potted colour from the two commercial nurseries was recorded during the flowering period. Also, some observational assessments were conducted of the hybrids at the local commercial nursery during the flowering period. These observational assessments were based on some of the standard criteria used for screening new ornamental plants for potted colour.

The selection criteria identified for *Curcuma* potted colour were:

- Compact growth suitable for 6 inch pots.
- Many inflorescences to a pot displayed above the foliage.
- Range of floral colour and forms.
- Colourful foliage.

Results:

Field trial assessments

Vase-life

In general, preliminary results from the vase-life studies found hybrids that were derived from *C.petiolata* crosses had poor to satisfactory vase-life (see Figure 1). However, hybrids derived from 'Voodoo Magic' crosses and even those hybrids crossed with *C. petiolata* had a vase-life of 10 days and longer. Similarly, hybrids crossed with unknown *Curcuma* species identified as CU56, had excellent vase-life.

Stem length

Crossing long-stemmed inflorescence *Curcuma* species with shorter-stemmed species resulted in hybrids with increased stem length. Hybrids that resulted in longer stems were those crossed with parents such as *C. petiolata*, *C. alismatifolia* and *Curcuma* species CU56 (see Figures 2 and 3).

Figure 1

Figure 2

Figure 3

Figure 1. *C. petiolata* hybrids with visible bract drying and senescence after seven days.
Figure 2. *C. petiolata* hybrid with stem length >30 cm
Figure 3. *C. alismatifolia* hybrid with stem length >30 cm

Yield

Preliminary findings indicated a significant increase in yield when low-yielding species were crossed with high-yielding species. Furthermore, the crossing of different *C. alismatifolia* forms resulted in some of these hybrids exhibiting good productivity (see Figure 4).

Phoma fungus (spotting)

The incidence of spotting was only observed on those hybrids crossed with *C. alismatifolia* and *C. thorelli* that are prone to this disorder. The degree of spotting ranged from excellent tolerance to very poor tolerance in hybrids derived from crosses between the different *C. alismatifolia* forms. Similarly, the incidence of spotting ranged from good to poor tolerance to spotting in some of the *C. thorelli* x *C. alismatifolia* crosses. Figures 5 and 6 show the degree of spotting observed in the field trial.

Figure 4

Figure 5

Figure 6

Figure 4. High yielding *C. alismatifolia* hybrid form
Figure 5. Severe spotting on *C. alismatifolia* hybrid form
Figure 6. Low spotting incidence on *C. alismatifolia* hybrid form

There were also other attractive features observed in the field trial such as hybrids with attractive coloured foliage, interesting plant habit, and ones with interesting inflorescence forms (see Figures 7 to 10).

Figure 7

Figure 8

Figure 9

Figure 10

Figure 7. Attractive coloured foliage
Figure 8. Interesting foliage pattern
Figure 9. Strong bicolour form
Figure 10. Interesting inflorescence bicolour form

Nursery evaluation and feedback

Positive feedback was received from the two commercial nurseries that were selected to evaluate a selection of *Curcuma* hybrids for the nursery potted colour component of the project. Due to the confidentiality of information between the Department and the two commercial nurseries, only a few of the comments can be mentioned in this report.

Feedback received from commercial nurseries:

- "These are a better and newer generation of *Curcuma* hybrids to what is around."
- "Better improved potted colour *Curcumas* to what is in the market."
- "These plants have the WOW factor."

Conclusion:

The preliminary findings indicate that there are good prospects for the selection of promising varieties that meet the selection criteria for *Curcuma* cut-flowers. Furthermore, the positive feedback from the two commercial nurseries also indicates that these hybrids have good prospects for potted colour production. Selection and finalising of the promising cut-flower types from the *Curcuma* hybrid block is expected to be completed in early 2007. Those hybrids that will go on to be commercialised will be registered with the International Registration Authority for Cultivated Curcumas (http://www.curcuma.sbg.org.sg). Similarly, promising varieties selected for potted colour by the commercial nurseries will be registered.

ZINGIBERALE (HELICONIA AND GINGER)

Introduction:

In the 2004-05 Technical Annual Report a number of new accessions of Zingiberaceae and Heliconia were introduced into the ornamentals project. This report discusses the progress of four accessions that have been established in the field. These are the open-pollinated (OP) seedlings of *Heliconia chartacea* 'sexy pink', OP seedlings of *H. colgantea*, OP seedlings of *Etlingera elatior* var. 'Alba' and, 'Singapore Gold' x 'Apricot' and 'Apricot' x 'Singapore Gold' *Zingiber* hybrids.

Method:

In November 2005, 61 OP *H. chartacea* 'Sexy Pink' seedlings and nine plants of *H. colgantea* propagated from rhizomes taken from the original nine OP seedling plants were planted in a field trial at Berrimah Farm in deep ripped rows 2.5 m apart and 2 m within the row. Fertiliser was applied pre-planting at 500 kg/ha NPK Blue, 500 kg/ha single super phosphate, 1000 kg/ha gypsum and 1000 kg/ha lime. Irrigation was applied by upright sprinklers at 240 L/hr, once a day for an hour. Plants were fertilised every four to six weeks with a handful of approximately 70 g NPK Blue and 70 g Dynamic lifter. A broad spectrum fungicide, Banrot 400WP®, was applied at 0.6 g/L as a soil drench at four-week intervals to all *Heliconia* plants during the establishment and initial growing phase to control soft rots in the rhizomes.

In March 2006, OP *E. elatior* var. 'Alba' seedlings were planted in the field trial at Berrimah Farm. Before planting, a handful of approximately 70 g of NPK Blue and 70 g of Dynamic lifter were applied to each hole. Seedlings were planted 1.5 m apart within the row. Plants were maintained under similar management practices as for the *Heliconia* plants, except that no Banrot® was applied.

Sixteen plants of 'Singapore Gold' x 'Apricot' hybrids and two plants of 'Apricot' x 'Singapore Gold' *Zingiber* hybrids were planted at a commercial cut-flower farm in June 2004. Seedlings were planted in the field under 80% shade cloth and maintained under the grower's management practices for *Zingibers*. Observational assessments and post-harvest studies were conducted on the hybrids over one flowering season.

Results:

About 20% of the OP 'Sexy Pink' seedlings in the trial failed to establish due to poor vigour and problems with rhizome soft rots. *H. colgantea* plants performed poorly under the full sun and most died. However, the OP *E. elatior* var. 'Alba' seedlings performed well in the full sun and are yet to start flowering, which will probably occur in April next year.

From observational assessments of the *Zingiber* hybrids in the trial there was a good contrast between hybrids from within the two families to the degree of susceptibility to rhizome rots (see Figure 11). Only one of the two 'Apricot' x 'Singapore Gold' hybrids survived and less than 50% of the 'Singapore Gold' x 'Apricot' hybrids are still alive in the trial. These hybrids struggled or failed to establish due to poor vigour and problems with rhizome rots and shoot collapse. Similarly, the 'Singapore Gold' plants in the trial did not survive due to problems with rhizome rots and stem collapse. Those hybrids that did successfully survive had strong hybrid vigour and showed some degree of resistance to the rhizome rots.

The first visible flowering shoots were observed at the beginning of July on hybrids 009 and 013. This was followed by flowering in hybrids 003, 017, 011 and 001. Three hybrids 009, 013 and 017 were found to be very vigorous and productive with multiple shoots, and more than 50 inflorescences to a bush.

Table 2 details the preliminary vase-life studies of four of the six hybrids that flowered in the trial. Hybrids 009, 013 and 017 were found to have a vase-life of up to three weeks from time of harvest to the rating 5 'not suitable to vase' stage. Hybrid 003 had a vase-life of over two weeks for the same period. Interestingly, from the post-harvest assessments of all four hybrids it was found that not all of the day flowers readily fell out of the bracts straight after senescence, particularly in hybrid 017 where some of the old day flowers stayed attached to the bracts over a few days (see Figure 12).

Table 2. Preliminary post-harvest assessment of the new *Zingiber* hybrids

Hybrid number	Average days to rating 3 'not saleable'	Average days to rating 5 'not suitable to vase'	Average stem length (mm)	Average inflores. head length (mm)
003	14	17	323	95
	Bracts are rounded and closed. Some bract splitting as the inflorescence ages with the emerging day flowers. Day flowers do not readily fall out. Inflorescence has a strong orange colour.			
009	15	21	409	144
	Bracts more rounded and open for mature inflorescences. Inflorescence a paler yellow/orange colour compared to the other hybrids. A red tinge develops quite early on the bottom bracts of the inflorescence. Day flowers do not readily fall out.			
013	16	20	433	137
	Bracts are rounded and open. Inflorescence is a more yellow golden colour. Day flowers readily come out when removed. Larger and mature inflorescences develop a red tinge at the base.			
017	15	20	479	130
	Bracts rounded and very open compared to the other hybrids. Inflorescence is a strong orange/golden colour. Day flowers do not readily fall out like the other hybrids and stay in the bracts.			

Figure 11. Differences in hybrid vigour between eight-month-old *Zingiber* plants

Figure 12. Hybrid 017 inflorescence and retention of old day flowers

Shown in Figure 13 are pictures of the six hybrids that flowered in the trial during 2005-06 at the grower's property. There was only one hybrid that looked distinctly different to the others when compared to the parents, which was 001 that looked like a fat round 'Singapore Gold'. In general, the inflorescence form of the other hybrids was intermediate between their parental plants. Longer stems were evident for most of the hybrids, except for 003 that had a similar stem length to 'Apricot'.

Figure 13. The six *Zingiber* hybrids that flowered during 2005-06

Conclusion

The poor tolerance of 'Singapore Gold' to rhizome rots in the soil is a major problem with growing this variety commercially. Another is the retention of old day flowers that can sometimes detract the inflorescence quality of this variety. The findings from the *Zingiber* hybrid trial showed a clear contrast between those hybrids with poor vigour and tolerance to rhizome rots that failed to establish, compared with the other hybrids that exhibited strong hybrid vigour and tolerance to rhizome rots and survived. With regards to the retention of old dayflowers in these *Zingiber* hybrids, it was still strongly influenced by 'Singapore Gold'. The degree of retention was found to be relatively low for most of the hybrids, except for one hybrid where the old day flowers stayed on the inflorescence over a few days.

OP seeds of both *Heliconia* and gingers are still good sources for providing new and improved varieties. The overall plant performance and health of the OP *H. chartacea* 'Sexy Pink' seedlings and *Etlingera elatior* var. 'Alba' seedlings in the trial indicate that they can tolerate the full sun. Screening and selection work will be conducted on these seedlings when they start to flower, to identify potential new and improved varieties. All

the *H. colgantea* plants, except one survived in the trial. The status of the original plant material will be assessed when grown on a commercial cut-flower farm this wet season.

TOP END WILD FLOWERS

Introduction:

In January 2004, RIRDC announced funding offers for projects to address a need in export markets for a feature or feature filler, red coloured flower that would be available from November to March. The Ornamental Crops Program obtained funding for from RIRDC for project DNT – 34A: "Identifying export potential for north Australian wild flowers", which is briefly discussed below.

Method:

A desktop scan was conducted of all genera of wild flowers in the NT to identify those with some scope for amenity horticulture, and then select those with specific potential for cut-flower development. Then a simple matrix was established using the key criteria identified by the RIRDC wild flower committee to cross reference with genera that had shown specific potential for cut-flower development. Certain criteria, such as flowering during November to March and preference for red flowers, were given priority over others as required by RIRDC. Other important criteria included nomination in the best bet program for export markets and a basis of current knowledge on cultivation and marketing.

A short list of potential genera and/or species was prepared and was then verified with botanical experts in the NT Herbarium, the Darwin Botanic Gardens and local native plant enthusiasts from such groups as the Top End native plant society.

Another part of the project involved an evaluation of the scope to cultivate "traditional" wild flowers in northern Australia out of season to traditional southern production. Using the top 20% of products identified in the best bet program by Slater and Carson (2003), the scope for "out of season" production of popular flowers was assessed.

Results:

Only four genera and/or species were identified from the Top End potentially capable to meet export market criteria set by RIRDC. They were *Corymbia* (Northern bloodwoods), *Grevillea*, *Haemodorum* and *Petraeomyrtus punicea* (Figure 14). All have been little developed, apart from *Haemodorum*. No potential feature flower was identified. Most species would be considered feature fillers rather than individual feature flowers.

Corymbia

There are several species of *Corymbia* that meet the very specific criteria, such as *Corymbia setosa, Corymbia dunlopiana* and *Corymbia ptychocarpa*. All species have buds which are produced terminally and flower through the designated months of November to March. Flower colour varies from white through light pinks to dark pink and red. There is scope to select better forms in a range of colours as cut-flowers but limited scope for foliage with buds.

Grevillea

The north-west of Australia is endowed with a good range of endemic *Grevillea* species, several of which produce spectacular inflorescences between November and March. The following species have inflorescences in the broad "red" colour group: *Grevillea aurea*, *benthamiana*, *byrnesi*, *dryandri* ssp. *dryandri*, *dryandri* ssp. *dasycarpa*, *goodii*, *heliosperma*, *pungens*, *refracta* and *wickhamii*. Not all of these are terminal producing and among them there is more scope for feature filler types and less as feature flowers.

Petraeomyrtus

Previously classified as a *Regelia* as well as a *Melalueca* species, *Petraeomyrtus* is endemic to the NT and has good scope for development as long as some fundamental issues are quantified. It has red terminal flowers which are produced during the target market months and has scope as focal filler. The unknowns include vase-life, potential stem length, response to heavy "cutting" pressure and market acceptability. A lack of readily available product would hinder quantifying a number of these issues. As for *Corymbia* species, some preliminary vase-life determinations and market evaluations need to be done before conducting breeding or development work.

Haemodorum

The northern species within the genera that have inflorescences in the broad "red" colour group are:

- *Haemodorum coccineum*
- *Haemodorum ensifolium*
- *Haemodorum* species A14021 "red flower".

Many different forms also exist within these species that offer great scope for selecting unique types that would enhance any breeding effort. The key points in favour of further development of *Haemodorum* are a ready market for the product for its red colour, excellent stem length, good vase-life, potential as a focal or feature filler and production from November to March.

An analysis of the top 20% of the Australian best bet program for export cut-flowers revealed that there were very poor opportunities for "out of season" production of existing commercial crops in the tropical lowlands of the NT. Of the few crops that may warrant some evaluation, such as *Alloxylon*, *Actinotus* and *Banksia*, none would meet both the key market criteria designated for this project - a red "feature" or "feature filler" - and flower production in summer.

Haemeodorum coccineum

Corymbia dunlopiana

Corymbia phytcocarpa

Figure 14. Some Top End wild flowers identified to have potential to meet RIRDC export market criteria

Program: Production Systems

Project: Evaluating the Use of the SPAD-502 Meter to Measure Nitrogen Levels in Mango Trees

Project Officers: G. Azam, R. Renfree and C. Newbould

Location: Katherine Region

Objectives:

To calibrate the relationship between leaf nitrogen (N) content and SPAD values.
To observe leaf N content trends during the growing season.
To develop a sampling guideline/protocol using chlorophyll level as an indicator of leaf N status in mango trees.
To provide growers with a tool to monitor leaf N levels to assist in adequate fertiliser application, optimise overall tree health and increase long-term cumulative fruit yield.

Introduction:

An effective management of fertiliser N is a major challenge for mango growers. Growers are inclined to minimize the risk of deficiency by excessive fertiliser applications. A sufficient supply of N is essential throughout the growing season for a high yield of quality mangoes. However, an incorrect supply of N can adversely affect a mango crop (Samra and Arora 1998).

Monitoring of tree N levels is very important in improving crop productivity. Leaf N is directly involved in the process of photosynthesis. Monitoring indicates the dynamic changes in need for N by the tree during the growing season. The soil plant analysis diagnostic (SPAD) chlorophyll meter provides a quick and non-destructive method for estimating the leaf N level.

SPAD readings offer an opportunity to evaluate crop N status and potentially determine the need for N fertiliser in horticultural crops. Currently, there are no clear sampling guidelines using chlorophyll levels as indicators of leaf N status in mango trees. This project attempts to determine the relationship between leaf N content and SPAD values.

Method:

Leaf N monitoring was conducted in mango trees at four commercial orchards in the Katherine region in the 2005 season. At each site 18 trees were randomly selected from six blocks. Eight terminals per tree were tagged. Four terminals were selected from the sunny side and four from the dark side. A SPAD meter was used to measure the chlorophyll level in leaves in SPAD units. Three readings were taken from each leaf and the average reading was recorded analysis. The variance in individual recordings could not be established due to data recording methods. The study commenced on 15 June 2005 and finished on 6 December 2005. At site 3 the study finished on 3 November 2005. Initially data was collected weekly from 15 June to 11 August and then fortnightly, from 24 August to 6 December 2005. There were no control trees. Grower practices including fertiliser application were monitored.

Calibration of SPAD readings and LN were done in 2004. The calibrated data was used to interpret the 2005 SPAD values in mango trees. Mature leaf samples were collected on 12 July and 1 October 2004. On each sampling date 120 leaves were collected from each side of the northwest (sunny side) and southeast (shaded/dark side) of trees and kept in separate groups. Each leaf was individually numbered and SPAD

readings were taken along the midrib. The leaves that had SPAD values within 1 unit were treated as a single sample for tissue analysis. SPAD readings and tissue analysis data was used for regression analysis. The following equations were obtained for each of the location/time combinations for leaf nitrogen (LN):

Dark July	LN=0.4154 + 0.0095*SPAD
Sunny July	LN =0.6068 + 0.0045*SPAD
Dark October	LN=0.3741 + 0.0111*SPAD
Sunny October	LN=0.3775 + 0.0118*SPAD

All of the above equations were used except sunny July because it was not significantly different from the null model (i.e. predicted LN = intercept or Y = a) in which ‘a’ was simply the mean of SPAD values. There was very little difference between the model fits for the other equations.

The dark July equation was used for conversion of dark side SPAD values to leaf N content. This equation was used for the June, July and August 2005 data.

The sunny October equation was used for conversion of sunny side SPAD values to LN content. This equation was used for June to December 2005 data.

The dark October equation was used for conversion of dark side SPAD values to LN content. This equation was used for September, October, November and December 2005 data.

Leaf samples were collected in July-August, October and December 2005 from the mango trees. On each sampling date and at each location, leaves were collected from the northwest (sunny side) and southeast (shaded/dark side) side of the trees for the tissue analysis. The tissue analyses were done from the bulked samples.

Fertilisers applied to the mango trees during the N monitoring period at different sites were as follows:

Site 1

A range of fertilisers including micro gypsum, Solubor®, potassium, ferrous, manganese, copper, zinc and magnesium sulphate were applied over a period of nine weeks (Table 1). Trees were spaced at 10 m x 8 m and were irrigated by under tree sprinklers. The trees were 10 years old and were pruned to about 3.8 m in height and 4.6 m in canopy width.

Table 1. Fertilisers applied to the trees during the N monitoring period at site 1

Date	Fertiliser	Rate (g/tree)
01/08/05	Micro gypsum	200
15/08/2005	Micro gypsum and	200
	Solubor®	10
28/08/05	Potassium sulphate	200
	Manganese sulphate	5
	Ferrous sulphate	5
	Copper sulphate	6
	Zinc sulphate	4
	Magnesium sulphate	50
05/09/05	Micro gypsum	250
	Solubor®	10
12 and 19/09/05	Potassium sulphate	200
	Manganese sulphate	20
	Ferrous sulphate	20
	Copper sulphate	24
	Zinc sulphate	16
	Magnesium sulphate	50
24/09/05	Micro gypsum	265
	Solubor®	10
30/09/05	Potassium sulphate	200
	Manganese sulphate	20
	Ferrous sulphate	20
	Copper sulphate	24
	Magnesium sulphate	50
03/10/05	Micro gypsum	200
	Solubor®	10

Site 2

A range of fertilisers including magnesium, potassium and zinc sulphate, potassium nitrate, Solubor®, Spraygro-Calcium®, Hydro-Complex® (12:5:15, NPK), Biobrew-Harvest®, Upstart® (8:4:8, NPK) and molasses were applied to the trees over a period of 12 weeks (Table 2). Trees were spaced at 10 m x 8 m and were irrigated by under tree sprinklers. The trees were 11 years old and were pruned to about 4.0 m in height and 4.7 m in canopy width.

Table 2. Fertilisers applied to the trees during the N monitoring period at site 2

Date	Fertiliser	Rate
14/06/05	Upstart®	900 g/tree
26/06/05	Magnesium sulphate	11 g/tree
	Zinc sulphate	5.5 g/tree
30/06/05	Magnesium sulphate	7.3 g/tree
	Zinc sulphate	7.3 g/tree
14/07/05	Magnesium sulphate	3.6 g/tree
	Solubor®	3.6 g/tree
	Molasses	3.6 mL/tree
10/08/05	Spraygro-Calcium®	6.8 mL/tree
12/08/05	Hydro-complex®	250 g/tree
30/08/05	Solubor®	2.7 g/tree
	Potassium sulphate	2.7 g/tree
	Spraygro-Calcium®	8.2 mL/tree
05/09/05	Zinc sulphate	2.7 g/tree
	Solubor®	2.7 g/tree
	Potassium nitrate	5.5 g/tree
	Spraygro-Calcium®	8.2 mL/tree
	Biobrew-Harvest®	2.7 mL/tree

Site 3

A range of fertilisers including Solubor®, potassium sulphate, micro gypsum and molasses were applied to the trees over a period of nine weeks (Table 3). Trees were spaced at 10 m x 10 m and were irrigated by under tree sprinklers. The trees were eight years old and were pruned to about 4.0 m in height and 4.6 m in canopy width.

Table 3. Fertilisers applied to the trees during the N monitoring period at site 3

Date	Fertiliser	Rate (g/tree)
07/07/05	Solubor®	20
22/07/05	Molasses	100
04/08/05	Potassium sulphate	200
12, 19 and 26/08/05 and	Potassium sulphate	70
02 and 07/09/05	Micro gypsum	60
	Molasses	16

Site 4

A couple of fertilisers such as potassium nitrate and mono potassium phosphate were applied to the trees over a period of four weeks (Table 4). Trees were spaced at 10 m x 5 m and were irrigated by under tree sprinklers. The trees were eight years old and were pruned to about 3.5 m in height and 3.5 m in canopy width.

Table 4. Fertilisers applied to the trees during the N monitoring period at site 4

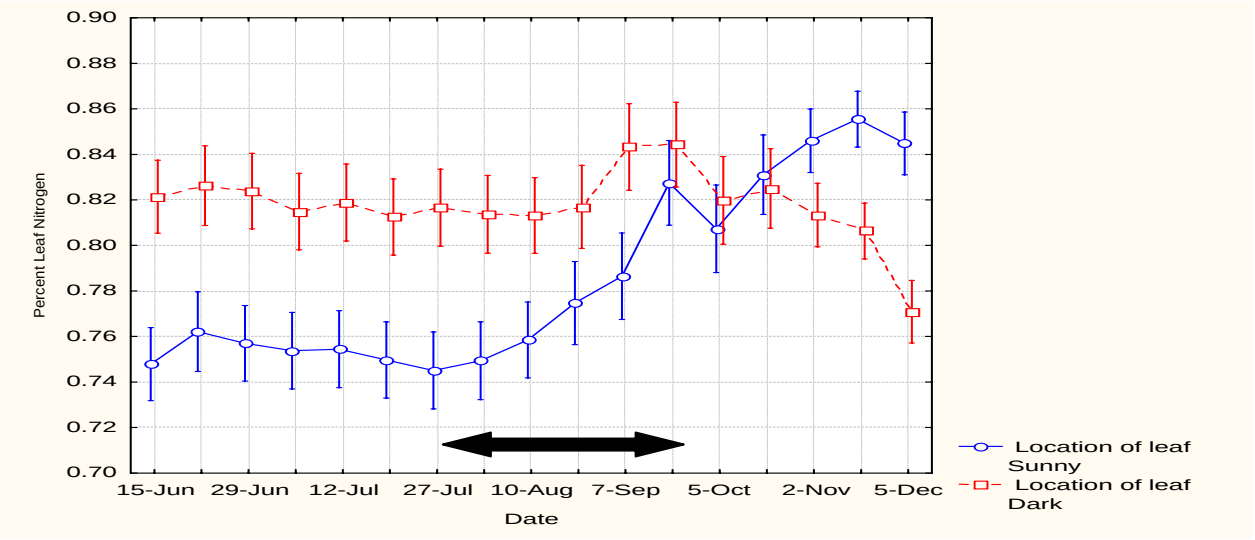
Date	Fertiliser	Rate
14/06/05	Potassium nitrate	2%
22/06/05	Potassium nitrate	2%
13/07/05	Mono potassium phosphate	600 g/tree

Results:

Site 1

From 15 June to 3 August, LN contents were 0.74% to 0.78% and 0.80% to 0.84% in the sunny side and dark side, respectively. From 10 August to 20 September, LN content in both sides increased. In the sunny side, LN content increased from 0.76% to 0.83% during this period (Figure 1). Average maximum temperatures were about 3^0C higher than in June - July (Figure 2) and irrigation was on during this period. Soil moisture, day length and temperature may have caused the increase in LN content. Various types of non-N-based fertiliser were applied to the trees. That could be one of the reasons for the high levels of LN during this period. Some non-N-based fertilisers may increase N levels in leaves if the element is low in leaves. No N-based fertiliser was applied during the crop-monitoring period at site 1.

From 20 September to 5 October LN content in both sides decreased, due probably to crop load. LN contents in both sides started to diverge on 18 October and then a few weeks later declined in the sunny side (Figure 1). One reason for this could be fruit load.



= Fertiliser applications

Figure 1. Overall trends in nitrogen content in mango leaves at site 1

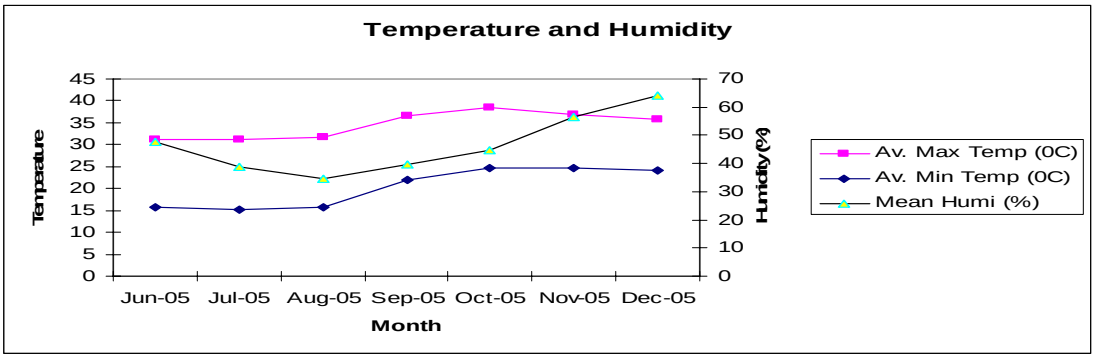
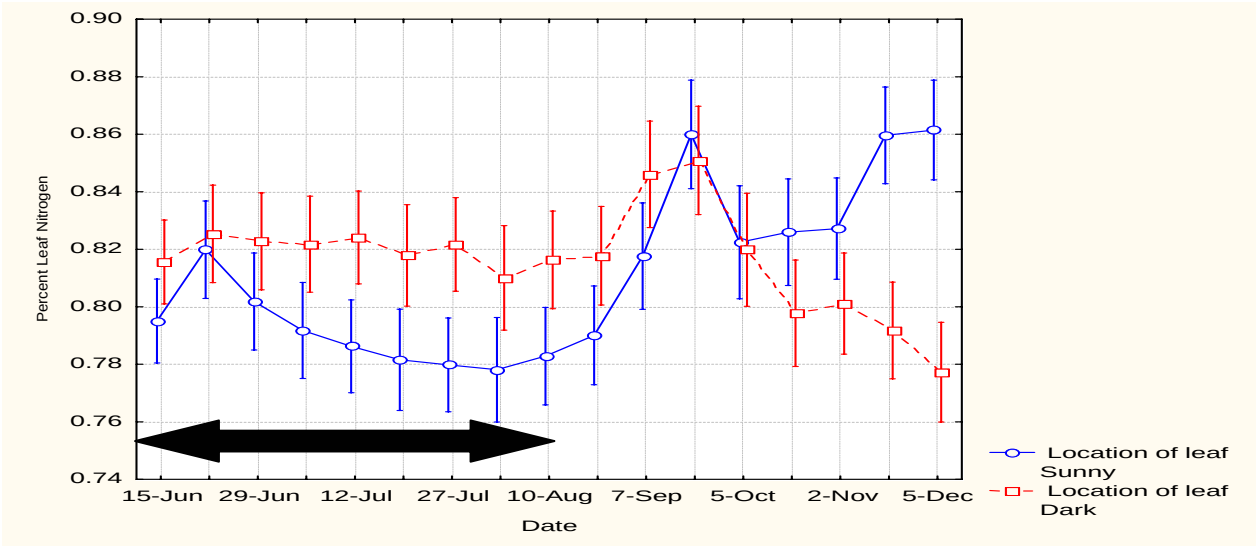


Figure 2. Katherine average temperatures and humidity from June 2005 to December 2005

Site 2

On 14 June Upstart® (8% N) was applied to the trees. From 15 June to 22 June LN content increased in both the sunny and dark side of the trees (Figure 3). One of the reasons could be Upstart®. From 22 June to 3 August LN content in the sunny side decreased in spite of the application of molasses and some non-N-based fertilisers during this period. Molasses had only 1.01% N. The main reason for the decline in LN content in the sunny side may be due to insufficient water because irrigation was not fully on until the mid of July when trees were at the flowering stage.

On 12 August Hydro-complex®, a N-based fertiliser, was applied to the trees. From 3 August to 20 September LN content increased on both tree sides. The main reasons for the increase in LN content were irrigation, fertilizers and high temperatures. From 20 September to 5 October LN content in both sides declined due probably to crop loads. LN content in both sides started to diverge on 2 November (Figure 3).



= Fertiliser applications

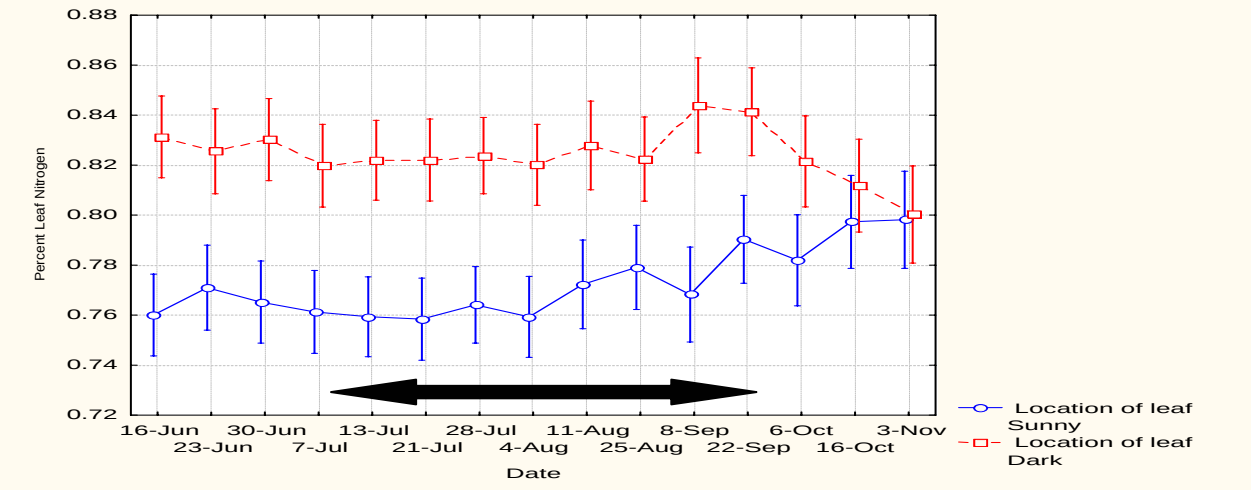
Figure 3. Overall trends of nitrogen content in mango leaves at site 2

Site 3

From 16 June to 4 August, LN content was 0.74% to 0.78% and 0.80% to 0.84% in the sunny side and dark side, respectively. On 4 August, potassium sulphate was applied to the trees. From 4 August to 25 August, LN content in the sunny side increased (Figure 4). A few factors could be responsible for this such as

temperatures, soil moisture and fertiliser. From 4 August to 8 September LN content in the dark side increased as well except on 25 August.

From 22 September to 6 October LN content in both sides decreased. One reason could be fruit load. From 6 October to 3 November LN content in the dark side decreased due to fruit load. The overall nutrition level in the leaves could have influenced LN content at site 3. The required levels for copper and boron in mango leaves are 10-20 mg/kg and 50-100 mg/kg, respectively (Poffley and Owens 2005). At site 3, leaf samples analysis results indicated that copper and boron levels in the leaves were 6-8 mg/kg and 22-43 mg/kg, respectively during the trial period. Therefore, the levels of copper and boron were low.



= Fertiliser applications

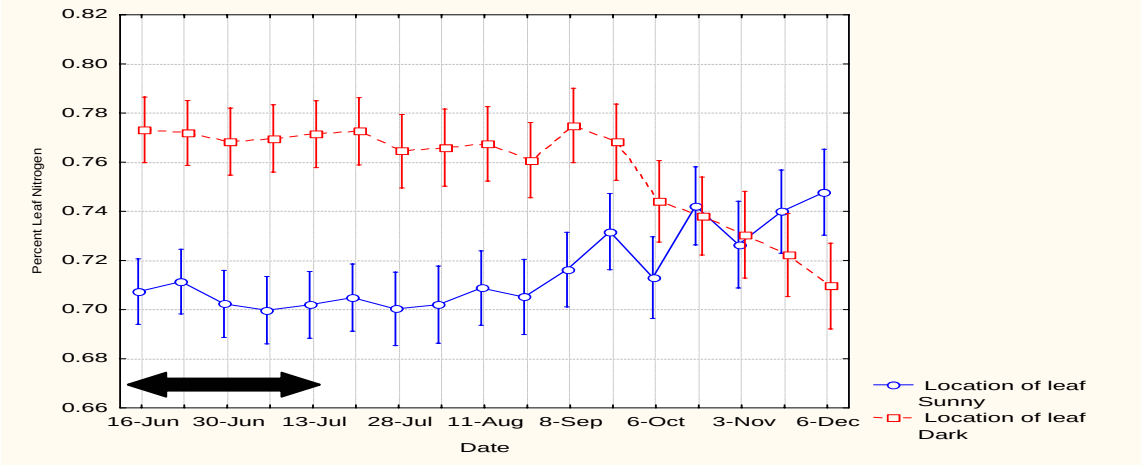
Figure 4. Overall trends in nitrogen content in mango leaves at site 3

Site 4

On 14 June potassium nitrate was applied to the trees. From 16 June to 23 June LN content in the sunny side increased marginally (Figure 5). In the dark side LN content decreased during this period, due to such factors as the flowering stage, no irrigation and low levels of elements such as manganese. The required nutrient level for manganese in mango leaves is 100-500 mg/kg (Poffley and Owens 2005). At site 4, leaf samples analysis results indicated that manganese in leaves was 74-130 mg/kg during the trial period.

Potassium nitrate, a N-based fertiliser, was applied to the trees on 14 and 22 June. From 13 July to 21 July LN content slightly increased in both sides (Figure 5) due to irrigation and a non-N-based fertiliser, mono potassium phosphate.

From 22 September to 6 October, LN content decreased in both sides, due probably to fruit load. LN content in both sides started to diverge on 3 November.



= Fertiliser applications

Figure 5. Overall trends in nitrogen content in mango leaves at site 4

There was only little similarity in LN content trends in both sides, the sunny side and dark side at both sites 1 and 2 (Figures 1 and 3). The required nutrient levels for calcium and zinc in mango leaves are 1.5-2.8% and 25-60 mg/kg respectively (Poffley and Owens 2005). At site 2, calcium and zinc nutrient levels in leaves were 2.21-2.83% and 80-141 mg/kg, respectively during the trial period. At site 1, calcium and zinc nutrient levels were 1.65-1.87% and 20-22 mg/kg, respectively. At site 2 these nutrient levels were higher than at site 1. Trees at site 2 were older than at site 1. The size of the canopy at site 2 was bigger than at site 1.

The required nutrient level for N in mango leaves is 0.8-1.2% (Poffley and Owens 2005). Leaf sample analysis indicated that LN content in the sunny side was 1.02, 0.98 and 1.03% in August, October and December, respectively at site 1. At the same site, LN content in the dark side was 1.02, 1.01 and 1.02% in August, October and December, respectively.

Leaf samples analysis indicated that LN content in the sunny side was 1.00, 0.87 and 0.88% in August, October and December, respectively at site 2. At the same site, LN content in the dark side was 0.92%, 0.91% and 0.83% in August, October and December, respectively.

At site 3 leaf samples analysis indicated that LN content in the sunny side was 1.02% and 0.89% in August and October, respectively. At the same site, LN content in the dark side was 0.93% and 0.88% in August and October, respectively.

From leaf samples analysis it was found that LN content in the sunny side was 0.92%, 0.84% and 0.85% in August, October and December, respectively at site 4. At the same site, LN content in the dark side was 0.72%, 0.79% and 0.74% in August, October and December, respectively.

From 10 August to 20 September, LN content in the sunny side increased impressively at sites 1 and 2. During this period the average maximum temperatures were about 3^0C higher than in June - July and irrigation was on. Fertilisers, soil moisture, temperature, day length and overhead sun may have been responsible for the increases in nitrogen content in leaves.

It was clearly shown that nitrogen content was higher at site 3 than at site 4 in both sides, the sunny side and dark side, during the nitrogen monitoring period (Figures 4 and 5). The size of the canopy at site 3 was bigger than at site 4.

From 5 October to 16 November, LN content in the sunny side increased at all sites except site 4 on 3 November and 16 November. Temperature, soil moisture and day length may have contributed to more photosynthesis occurring during this period in the sunny side.

From 20 September to early December, LN content in the dark side declined at all sites except on 18 October at site 1 and on 2 November at site 2. One of the reasons for the declining LN content could be fruit load. Mangoes were harvested in late October to mid November. Yield differences between the sides of the tree were not recorded.

Acknowledgements:

We are grateful to David Higgins, Bob Dodd, Bernie Tomlin and Bill Davey of Eumaralla Plantation for the use of their mango orchards.

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Project: Evaluating the Use of the SPAD-502 Meter to Monitor Nitrogen Levels in Various Horticultural Crops

Project Officers: G. Azam, M. Traynor, R. Renfree, C. Wicks and C. Newbould

Location: Katherine and Darwin

Objective:

To provide growers with a field-based tool to monitor leaf nitrogen levels to assist with adequate fertiliser application, optimise overall plant health and increase long-term cumulative crop yield.

Introduction:

An effective management of fertiliser nitrogen (N) is a major challenge for horticultural growers. Growers are inclined to use N fertiliser liberally to minimise the risk of deficiency. However, that may lead to excessive use of fertiliser which can be especially damaging in such crops as citrus where N levels should be monitored to prevent excessive leaf flushing at the wrong time (Vock et al. 1997). It is known that a high application of N causes melon plants to become very bushy, which ultimately decreases the quality of melons (Wright et al. 1997).

It is very important to monitor plant N levels in order to improve crop productivity. Leaf nitrogen (LN) is directly involved in photosynthesis. It is an indicator of the dynamic changes in the need for N by plants in a growing season. The soil plant analysis diagnostic (SPAD) chlorophyll meter provides a quick and non-destructive method for estimating the level of N in leaves.

SPAD readings may assist in evaluating the status of N in crops and could potentially define N fertiliser needs in horticultural crops. Currently, there are no clear sampling guidelines for using chlorophyll N levels

as an indicator of leaf N status in a range of crops grown in the NT. The SPAD meter may help growers to optimise N fertiliser applications to improve tree health and long-term cumulative fruit yield.

The usefulness of the SPAD meter was assessed in citrus, melons and Taro at commercial orchards in Katherine and Darwin.

Citrus

Method:

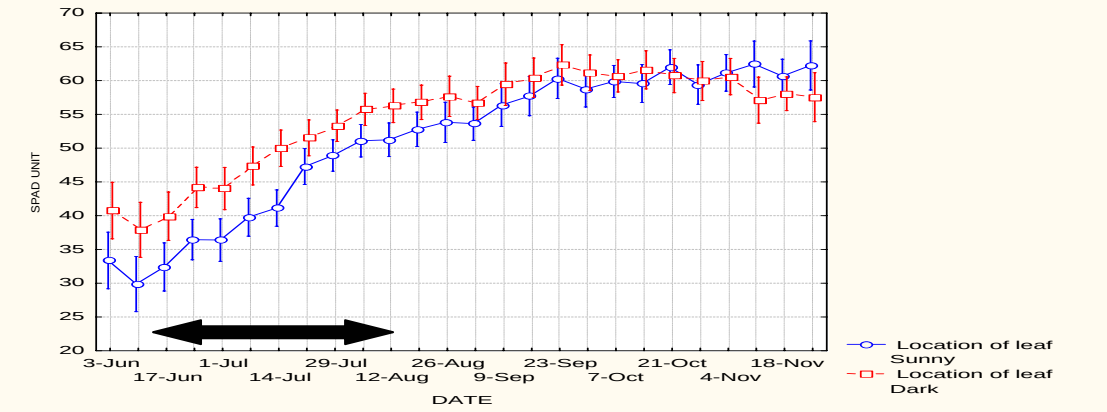
Two sites were used on one property. At each site nine citrus trees were randomly selected and six terminals were tagged per tree. Three terminals were selected on the sunny side (North) and three on the dark side (South). The average of three readings from each terminal was recorded. The trees were eight years old and were planted at a spacing of 8 m x 4 m with irrigation from under tree sprinklers. In line with standard citrus tree management in Katherine, fertilisers such as urea and calcium nitrate were applied at both sites over a period of eight weeks starting around 18 June when irrigation rates were markedly increased.

Leaf samples were collected in August, October and December 2005. On each sampling date and at each location, leaves were collected for tissue analysis from the sunny side and the dark side of trees. Tissue analyses were done on bulked samples from each side of each tree.

Results:

At both sites initial readings were down and declining. However, as can be seen in Figure 1, a dramatic increase in SPAD readings occurred following the application of extra fertiliser and water. As SPAD readings match plant N and health, this result was expected. The low SPAD readings up to the time when additional fertiliser was applied were not expected but could be a useful indicator of stress under common citrus management in Katherine.

The difference between the sunny and dark sides of trees was significant but not consistent between sites (site 1 $p<0.001$; site 2 ns). The decline in SPAD readings on the dark side that started in October was seen at both sites though it was more marked at site 2. This could be due to variations in leaf temperature or to the sun moving south and thus exposing the leaves from the dark side to longer periods of full sun or it could just be due to differences in crop load.



= Fertiliser applications

Figure 1. SPAD meter readings in citrus over a season at a property in Katherine

Leaf samples were analysed three times during the season. The leaf N content was higher at site 1 than at site 2 during most analysis dates. As can be seen in Figure 2, there was no clear relationship between citrus LN and SPAD readings in this trial.

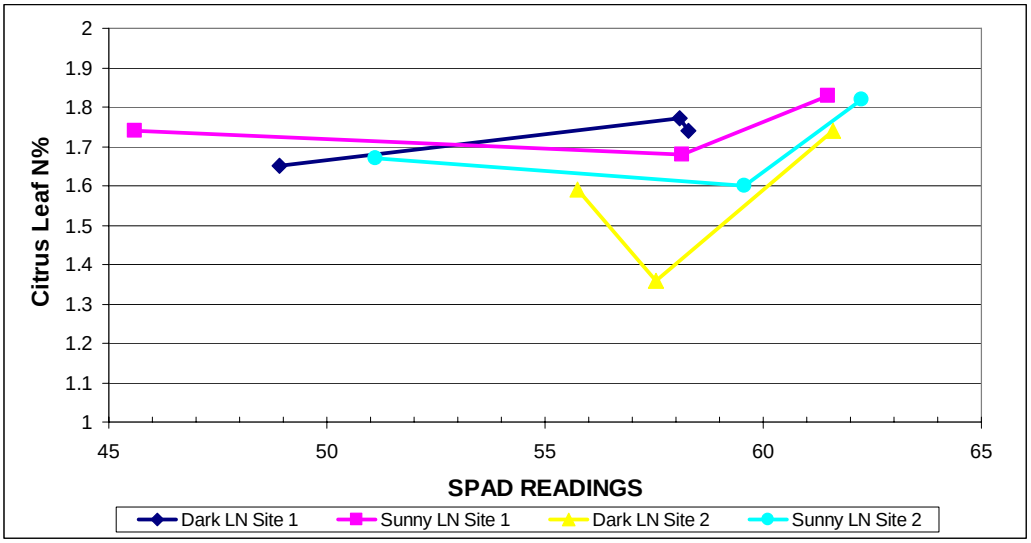


Figure 2. SPAD meter readings and citrus LN from the Sunny and Dark sides of trees at two sites in Katherine

Taro

Method:

Fertiliser rates recommended from results of a trial on taro in 2004 were applied to a commercial planting in the Darwin area in 2005. The nutritional status of this planting was monitored weekly by petiole sap analyses throughout dry season growth period. The SPAD-502 meter was used to compare readings with petiole sap analyses results to determine if there was a correlation.

The youngest fully expanded leaf was collected from each of five random plants each week. Six SPAD readings equally spaced around the margin of each leaf were recorded. The petioles were then removed from the leaves and the combined sample was submitted to the DPIFM chemistry laboratory for sap analysis. This was repeated weekly for 15 weeks.

Results:

Figure 3 shows the fairly poor relationship between the average SPAD readings and the petiole nitrate levels for those leaves.

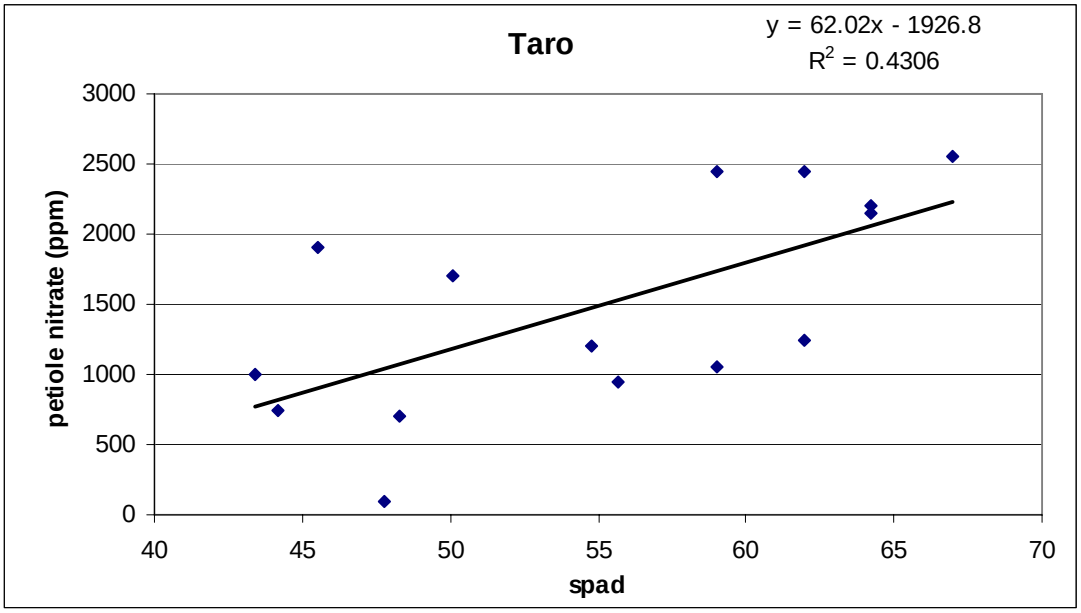


Figure 3. SPAD readings and petiole nitrate levels in taro grown in the Darwin region

Table 1 shows the typical range of SPAD readings recorded from a taro leaf. The variation in readings from a single leaf is evident and indicates that chlorophyll levels may fluctuate within individual leaves especially in crops with large leaves, such as taro. The average of a large number of readings would be required for a more accurate indication of chlorophyll levels.

Table 1. SPAD readings within and between taro leaves during one sampling

leaf 1	leaf 2	leaf 3	leaf 4	leaf 5
52.7	51.9	60.6	62.1	58.9
45.4	51.0	56.6	55.2	57.7
50.0	54.2	50.1	49.4	53.2
55.1	53.4	56.2	49.4	55.3
56.1	55.7	62.1	63.0	53.5
58.6	55.2	47.3	63.0	50.7

Melons

Method:

Over the 2005 season, LN levels were monitored weekly at a commercial melon farm in Katherine using a SPAD meter.

Also during the season, from 24 June to 27 July, a leaf was selected at each site from 20 different randomly-selected plants and sampled for N. Three SPAD readings were taken from each leaf and the average reading was recorded. The uppermost fully expanded leaf in the main stem was chosen. Tissue analyses were done on bulked samples for each site.

A number of fertilisers including ammonium sulphate, Diamond-19®, manganese, magnesium, potassium sulphate, fulvic acid, boric acid, Sprayfos-400® and molasses were applied to the plants during the crop growing season. Watermelon sites had common irrigation schedules and compost tea applied twice a week.

Results:

As can be seen in Figure 4, from 24 June to 8 July, SPAD meter readings increased at site 1 (Block 4, watermelons). During this period the plants were at the fruit-set and fruit development stage. From 8 July to 29 July, SPAD readings decreased at site 1 except on 22 July. Site 2 (Block 7, watermelons) gave different results both early and late in the sampling period. The different results could be due to differences in crop load and crop age or different crop nutrient uptake between plantings.

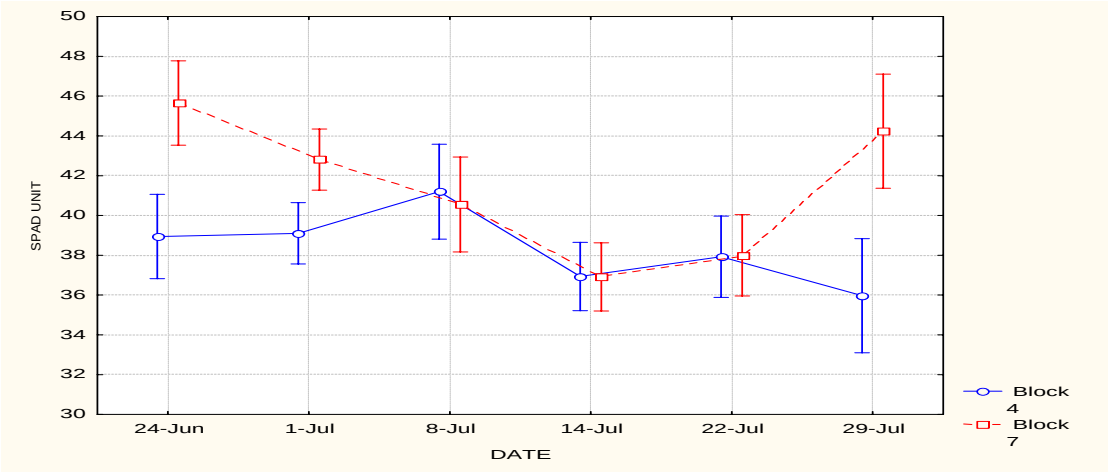


Figure 4. SPAD meter readings in watermelon leaves at two sites

Rockmelon N trends were quite different from those in watermelons. In this study it was not easy to compare N trends in watermelons and rockmelons. This could be due to rockmelons having a different physiology, leaf surface area, production and uptake and utilization of N and other nutrients.

The correlation between SPAD and LN showed very little relationship. This can be seen in Figure 5, which shows the relationship between average SPAD readings and bulked LN for two crops of watermelon and one crop of rockmelon. It may be useful to correlate SPAD readings with petiole sap N. However, such data is not available.

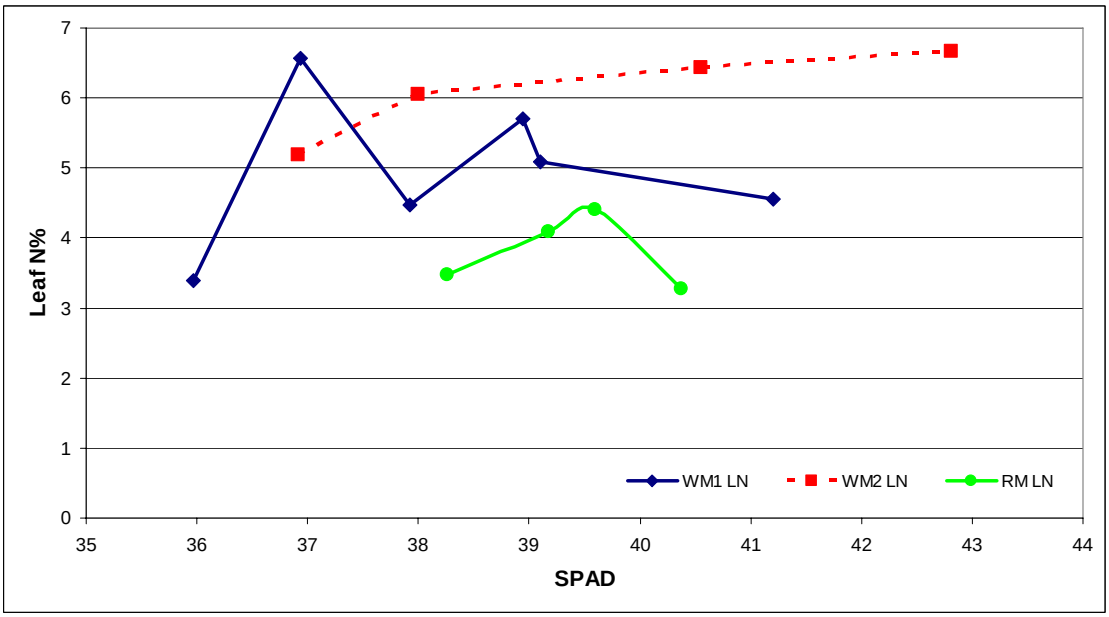


Figure 5. SPAD readings and LN for two crops of watermelon (WM1 & WM2) and one crop of rockmelon (RM) grown in Katherine in 2005

Conclusion

The SPAD-502 chlorophyll meter did not demonstrate its usefulness as a tool for rapid field estimation of LN levels in citrus trees, taro or melon crops.

There were some problems with methodology. However, the nature of this preliminary study precluded in-depth analysis needed for clear recommendations. It is also clear that the usefulness of the SPAD meter may be restricted to perennial crops or to crops grown under very homogeneous conditions.

The ability of the SPAD meter to indicate citrus tree health could be very useful to measure the level of stress applied to citrus trees to encourage flowering. It is recommended that this potential be examined in-depth in 2006 using improved calibrations.

Acknowledgements

We are grateful to Eumaralla Plantation for the use of the citrus orchards, Graham and Anne Beech for the use of their melon crops and Phaly Soc for the use of his taro planting.

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Project: Asian Vegetables – Best Practice

Project Officers: G. Walduck, M. Traynor, J. Thomas, G. Owens, and B. Thistleton

Location: Darwin Region

Objective:

To support the Asian vegetable industry and its organisation.

Introduction:

The industry is centred near Darwin with over 50 small growers producing a range of Asian and traditional vegetables for local and capital city markets. A major new development has been the emergence of large shade house operations growing Lebanese and green slicer type cucumbers to supply high-priced demand in winter.

The main effort this year has been to develop capacity in the industry and promote some past trial results through direct contact, tapping into industry social and commercial groups.

Figure 1

Figure 2

Figure 1. Lebanese cucumber growing in a shade house in the Darwin area
Figure 2. Returnable crates for local vegetables in the Perth market

Perth has a well established local returnable crate system based on low transport distances from farm to market and closed loops.

Activities

1. Distributed more copies of the English/Vietnamese publications of current DPIFM printed information on Asian vegetables including the two-poster set on pests and diseases of Asian vegetables.

2. Further developed working version of a PC-based 'tool box' for agricultural pesticides for use in Asian vegetables in cooperation with Biosecurity and Product Integrity, which is currently producing recommendations on pesticides.

3. Collaborating in a RIRDC-funded project to map the supply chain for winter Asian vegetables to capital city markets and to develop support materials. This has involved surveys of local producers in the NT and WA, transport operators and consolidators and surveys of wholesale and retail markets in Sydney, Melbourne and Perth. The Perth market is unique in that much of the local Asian vegetables are handled in a returnable-crate closed loop system.

   A draft report is being prepared which will be available during the second half of 2006.

4. Geoff Walduck organised a meeting in Sydney in June as part of the activities for the final year of a RIRDC-funded project to improve interaction between Asian vegetable researchers. Prepared a CD of the proceedings for distribution to participants and RIRDC.

5. Produced a number of draft product description language [PDL] documents as part of a RIRDC funded project to produce PDL for tropical fruits and vegetables.

Project: Banana Tropical Race 4 Panama Disease Management

Project Officers: G. Walduck, D. Cumberland, L. Chidwick A. Daly and S. Smith

Location: Coastal Plains Banana Quarantine Station (CPBQS) and local banana plantations

Objectives:

To find and develop a commercially acceptable banana variety resistant or tolerant to Panama tropical race 4 for the NT banana industry.
To develop field management methods to reduce the spread of the disease and to extend the commercial life of existing plantations in the NT.

Specifically to:

1. Commission and operate CPBQS to conduct secure research on Fusarium oxysporum cubense - tropical race 4 (FOCTR4).
2. Locate and source banana varieties with likely or reputed resistance to FOCTR4 and screen them for resistance or tolerance to FOCTR4 within the CPBQS secure facility.
3. Test the commercial acceptability of any variety found resistant or tolerant to FOCTR4.
4. Develop and commercialise any resistant or tolerant variety found to be commercially acceptable.
5. Develop field management techniques to reduce the spread of the disease and extend the commercial life of existing plantations in the NT.
6. Develop field techniques to disinfest currently infested areas.
7. Assist other research organisations to conduct research on FOCTR4 which may benefit the NT and Australian banana industries.
8. Assist with and facilitate appropriate legislation in the NT relating to bananas.

Results:

Variety testing

CPBQS has been successfully operating since 2001 and has passed external audits every year.

Thirty six banana varieties were tested or are in the process of being tested at this time and a summary of the resistance status and certain agronomic characters is attached as Annex1.

No new resistant types have been identified this year and a number of recent Cavendish types from overseas with reputed resistance are at various stages of testing. Formosana has unfortunately proved susceptible in testing.

The resistant varieties identified so far are:

- **FHIA 25:** It is a high-yielding tetraploid cooking banana with a finger shape and size similar to Cavendish. It is resistant to yellow Sigatoka and was obtained from a breeding program in Central America. Initial taste trials indicated it was unacceptable as a dessert banana. Some recent taste trials of fruit grown slowly and tested during a period of high banana prices indicated it was a little bland but acceptable in a narrow range of stages of maturity to the test group. It was still not as good as Cavendish.
- **Malaccensis:** Three selections of seeded diploids were obtained from Indonesia. They have no commercial value. However, seeds and genetic material are useful for breeding and genetic improvement work. Apart from the three resistant lines still held at CPBQA, some 50 hand crosses of resistant and non resistant malaccensis conducted by CSIRO were planted in the CPBQS area this year for FOCTR4 resistance assessment.
- **GCTV119:** It is a soma-clonal variant Cavendish which was obtained from a Taiwanese breeding program. It is a very weak plant, prone to breaking and with no resistance to leaf spot. It produces small bunches of acceptable fruit but is not of any commercial value.
- **FHIA 18:** It is a sweet acid dessert type banana which was obtained from a breeding program in Central America. Losses to FOCTR4 were observed in the plant crop but there were few losses in subsequent ratoons and test plants are still producing satisfactory bunches. It has some commercial potential as a sweet acid type similar to lady finger and gold finger but has ripening problems. It is a tall growing type and is resistant to yellow Sigatoka .It is currently marketed in very small quantities in NSW as bananza.
- **FHIA 01:** Gold finger is a sweet acid banana which was obtained from a breeding program in Central America. It has commercial potential and was released in Queensland 10 years ago but has struggled commercially and has shelf-life and taste problems when grown in the tropics.

Some 20 plants of both FHIA01 and FHIA18 have been planted in a new Cavendish planting on a private property. This area has a high risk of FOCTR4 infection. Their performance will be observed under these commercial conditions.

Varieties FHIA25 and Formosana were planted in an area that was fallowed for two years after FOCTR4 infection. FHIA25 is healthy and disease-free but Formosana suffered 100% infected stools and produced no commercial bunches after two and a half years and three crop cycles.

All other varieties tested so far are susceptible to FOCTR4 to varying degrees.

Currently undergoing testing is the last batch to be tested in this project. It includes a Cavendish selection of Formosana from Indonesia which is reputed to have better resistance than standard Cavendish. Preliminary results from testing of this last batch should be available early next year.

As part of an ACIAR-funded project in Indonesia in which DPIFM is participating, further testing of FOCTR4 resistant varieties will be conducted in Indonesia once testing has ceased in this project next year. As a result of our involvement in this project we will have access to the data and eventually any varieties that prove to be useful.

Table 1. Summary of characteristics of varieties being tested for resistance against FOCTR4 at CPBQA (HAL Proj.FR00043)

Varieties being tested	Type	FOCTR4 plant cycle	Susceptible ratoon cycles	Agronomic yield	Production attributes	Market acceptance	Leaf spot resistance
Cavendish [Williams]	AAA	VS	VS	High	Good	Good	No
Cavendish[GCTV-119] ex Taiwan	AAA	SS	SS-R	Low	Poor	Good	No
FHIA-01[Gold finger]	AAAAB	S	RR	High	Very good	Variable	Yes
FHIA-17	AAAA	VS	VS	Variable	Good	Good	Yes
FHIA-18	AAAB	S	RR	Medium	Poor	Good	Yes
FHIA-25	Cooking type	R	R	High	Very good	Poor	Yes
SH-3640 [High Noon]	AAAB	VS	VS	Good	Good	Good	Some
Malaccensis [FOC susceptible]	AA	S	S	Very low	Good	Seeded	Yes
Malaccensis [FOC susceptible]	AA	S	S	Very low	Good	Seeded	Yes
Malaccensis [FOC susceptible]	AA	S	S	Very low	Good	Seeded	Yes
Malaccensis [FOC resistant]	AA	R	R	Very low	Good	Seeded	Yes
Malaccensis [FOC resistant]	AA	R	R	Very low	Good	Seeded	Yes
Malaccensis [FOC resistant]	AA	R	R	Very low	Good	Seeded	Yes
FHIA-23	AAAA	VS	VS	High	Poor	Average	Yes
Pissang berungan [Lakatan]	AAA	EX	EX	High	Good	Good	No
Mutiaria E	AAB	VS	VS	Low	Good	Good	Some
Novaria D	AAA	VS	VS	High	Good	Good	No
Novaria G	AAA	VS	VS	High	Good	Good	No
Pissang embung	AA	S	VS	Low	Good	Good	No
Pissang jari buya	AA	SS	SS	Medium	Good	Smell	Some
Ducasse	AAB	VS	VS	Medium	Good	Good	Some
Cavendish[Grande nain]	AAA	VS	VS	High	Good	Good	No
Improved ladies finger	AAB	VS	VS	Low	Good	Good	No
Pacific plantain	AAB	VS	ES	High	Good	Cooking	No
Pissang Celan [Mysore]	AAB	S	VS	Medium	Good	Good	No
Cavendish [GCTV-Formosana]	AAA	VS	VS	High	Good	Good	No
D5 [ex. South Africa]	AAA	VS	VS	n/a	n/a	n/a	n/a
DPM25[ex South .Africa]	AAA	VS	VS	n/a	n/a	n/a	n/a
PKZ [ex South Africa]	AAAB?	VS	VS	n/a	n/a	n/a	n/a
RSS3 [ex South Africa]	AAA	VS	VS	n/a	n/a	n/a	n/a
Cavendish[CJ19 ex Indonesia]	AAA	n/a	n/a				
Dwarf Parfitt ex QDPI&F	AAA	n/a	n/a				
Blue Java	ABB	n/a	n/a	High-medium-commercially acceptable			
Dwarf red dacca	AAA	n/a	n/a	Good-very good - commercially acceptable			
Williams	AAA	n/a	n/a				

EX-Extremely susceptible [dies before emergence]

VS- Very susceptible [most develop symptoms and die before harvest]

S- Susceptible [few show symptoms at bunch emergence but most by harvest and many die]

SS- Slowly susceptible [few plants show symptoms at harvest and only occasionally die]

R- Resistant [no or very rare plant symptoms at harvest]

RR - Resistance in ratoon crop but losses in the plant crop.

Figure 1. Latest batch of banana selections undergoing screening for FOCTR4 resistance at CPBQF area

The previous batch to be tested is in the background and is showing symptoms.

Disease management

Research conducted in the past developed field management techniques to prevent and to slow the spread of disease between properties and within infected properties.

Work was undertaken this year to confirm the feasibility of using heat treatment of the soil to kill all the FOCTR4 in small isolated sites. This would be useful in eradicating first isolated outbreaks and could potentially be used to decontaminate sites.

Trials were conducted on an infected site at CPBHF using various fuel loads of bales of grass hay with and without heat shields to heat the soil. Thermocouples connected to a data logger were used to record soil temperatures over time and samples of infected corm material were buried at known depths to record survival of FOCTR4. Previous work indicated that treatment of fresh infected banana butt material in hot water at 60ºC or above for over 20 minutes killed all FOCTR4 in the sample.

Figure 2

Figure 3

Figure 2. Field heat test site at CPHRF with burning grass bales, heat shield and data logger buried in the foreground

Figure 3. Heat treatment site immediately before placing bales of grass and installing the heat shield

Figure 3 shows the sites where pieces of FOCTR4-infected banana corm samples were buried prior to burning.

The results are shown in Tables 3 to 5 and indicate that soil heating is variable and that temperatures of over 60ºC below 30 cm cannot be reliably achieved. The treatments did show that killing FOC TR4 in fresh material to 30 cm was feasible.

This supports the currently recommended treatment of burning infected plants when they are at an early stage of infection. This confirms the negative results obtained for FOC from the butts of burned infected plants in commercial plantations.

Table 2. FOC field heat treatment details

Burn No.	Date of burn	Fire load	Shielding	Burn frequency	Burn duration
1	06-Oct-05	15 square std. bales	Yes + bottom vents	1	4-5 hours
2	07-Oct-05	15 square std. bales	Yes, no vents	1	8-9 hours
3	11-Oct-05	15 square std. bales	Yes, no vents	2	12-15+ hours
4	20-Oct-05	7 large round bales	No	1	48 hours
5	28-Oct-05	30 square std. bales	Yes, no vents	3	24+ hours
6	01-Nov-05	4 large round bales	Yes, no vents	1	3+ days
7	11-Nov-05	21 square std. bales	Yes, no vents	2	24 hours

Data from burn 1 is presented in Figures 4a, 4b, 4c, 4d and 4e, only as an example. Graph sets for all the seven burns are available but have been excluded due to space restrictions.

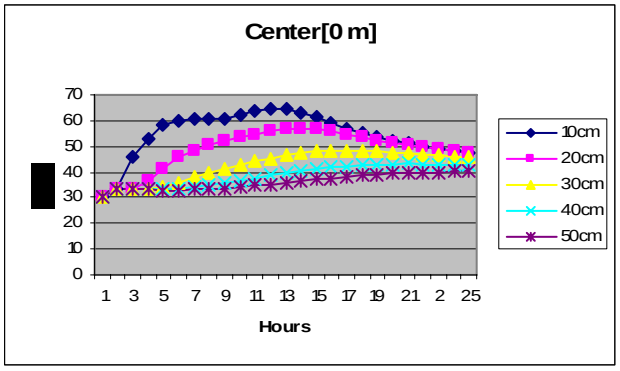


Figure 4a.

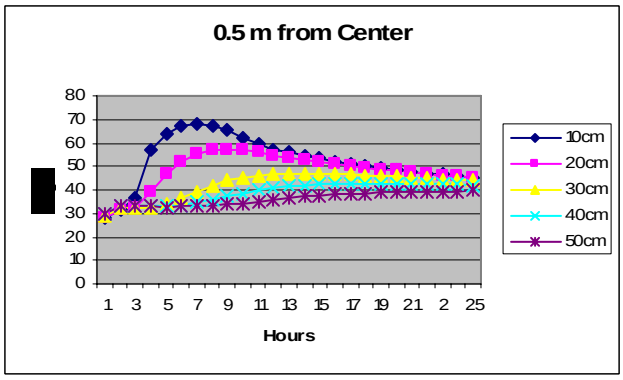


Figure 4b.

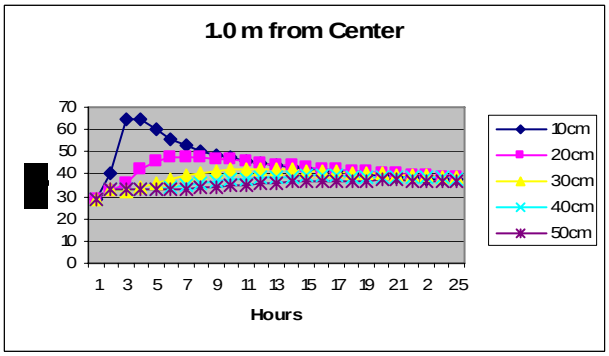


Figure 4c.

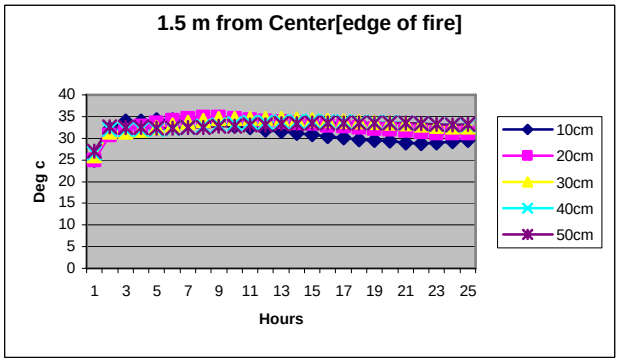


Figure 4d.

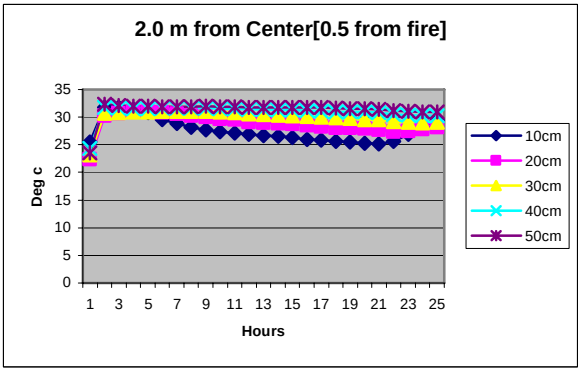


Figure 4e.

Figures 4a, 4b, 4c, 4d and 4e. Data for burn 1

Foc infested soil treatment (consolidated data 2005)

Treated areas (3 m diameter) were “spiked” with *Foc* infected banana material at measured distances from the centre and depths in the soil profile. The material was recovered post treatment and analysed to see if the recorded heat had sterilised it. Results are presented in Tables 3 to 5.

Table 3. Burn 3 rectangle bale, double burn (15 bales per burn, 30 bales in total)

Distance from centre (m)	Depth below surface (cm)	Max temp achieved (°C)	Duration at max temp (h)	Samples sterilised
Centre	10	>=65 (72)	31	Yes
	20	>=65 (67)	14	Yes
	30	>=60	12	Yes
	40	>=55	12	Yes
0.5	10	>=65 (78)	26	Yes
	20	>=65 (71)	20	Yes
	30	>=60	10	Yes
	40	>=55	10	No
1.0	10	>=65 (70)	14	Yes
	20	>=60 (63)	11	Yes
	30	>=55	8	No
	40	>=50	12	No

Table 4. Burn 5 rectangle bale, triple burn (15 bales per burn, 45 bales in total)

Distance from centre (m)	Depth below surface (cm)	Max temp achieved (°C)	Duration at max temp (h)	Samples sterilised
Centre	10	>=65 (71)	26	Yes
	20	>=60 (63)	37	Yes
	30	>=55 (60)	51	Yes
	40	>=55	32	Yes
0.5	10	>=65 (69)	12	Yes
	20	>=55 (59)	38	Yes
	30	>=50 (55)	48	Yes
	40	>=50 (52)	40	Yes
1.0	10	>=65 (73)	12	Yes
	20	>=55 (59)	15	Yes
	30	>=50 (52)	19	Yes
	40	>=45 (48)	35	Yes

*Y = Yes

Table 5. Burn 6 round bale burn

Distance from centre(m)	Depth below surface (cm)	Max temp achieved (°C)	Duration at max temp (h)	Samples sterilised
0	10	>=60 (62)	53	Yes
	20	>=55 (59)	55	Yes
	30	>=55 (58)	39	Yes
	40	>=55	22	Yes
0.5	10	>=65 (89)	57	Yes
	20	>=65 (80)	48	Yes
	30	>=65 (69)	34	Yes
	40	>=60 (63)	31	Yes
1.0	10	>=65 (136)	59	Yes
	20	>=65 (82)	51	Yes
	30	>=65 (71)	40	Yes
	40	>=60 (63)	31	No

*Y = Yes *N = No

Prospecting for antagonistic or suppressive organisms from existing FOCTR4 infected sites

This is a small joint project between DPIFM and CDU. Currently three Trichoderma isolates capable of parasitising FOCTR4 in laboratory plates have been identified. Samples from existing FOCTR4-infected sites are currently being assessed in the laboratory. As no isolates with FOCTR4 suppressive activity were isolated, this project has been concluded.

Use of commercially available Trichoderma preparation

A large field trial was established in a commercial plantation at very high risk of FOCTR4 infection. Preliminary results after two years indicate that the number of plants infected with FOCTR4 and the rate of spread of infection is roughly the same for treated and untreated areas. The area is currently in commercial production but losses have reduced production close to the economic threshold and the plantation will cease production in a year.

The results are summarised in Figure 5.

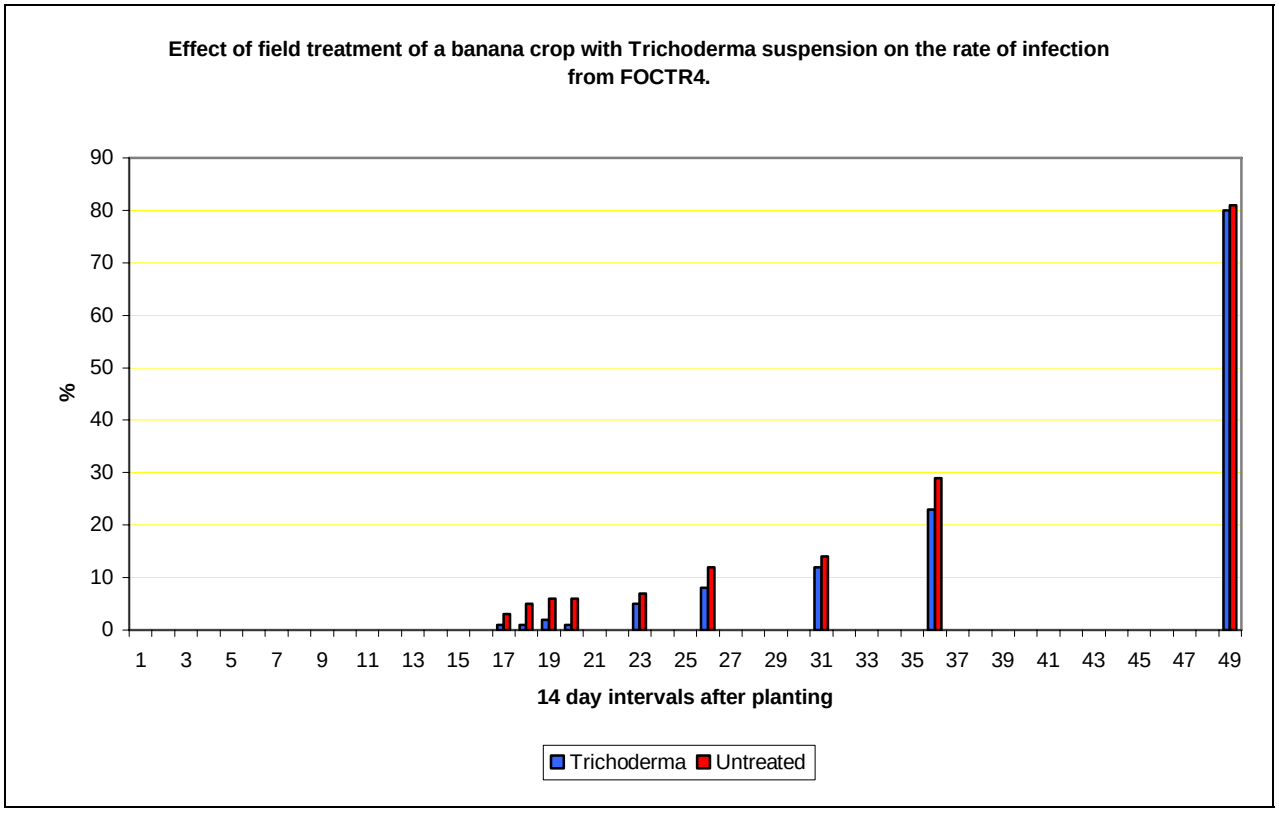


Figure 5. Effect of Trichodermas on infection

Legislative changes

Assistance was provided to the Chief Inspector of Plants regarding recent legislative changes and negotiation with growers over upgraded FOCTR4 management plans. There were no new recorded outbreaks of FOCTR4 in the NT during the year.

ACIAR project in Indonesia

The project is attempting to identify and develop control strategies for Fusarium wilt and bacterial wilt disease (BWD) in bananas in Indonesia.

DPIFM is a member of the project team and has gained a lot of information on the distribution of both of these diseases and has made valuable contacts.

As a result of this project we have received detailed maps of Indonesia showing the distribution of FOC and BWD in Indonesia. DPIFM is receiving information on the pathogens from collaborators in two universities. This will be useful for further developing biosecurity plans should BWD enter Australia.

Project: Biological Farming Systems for the Top End

Project Officers: M. Bennett, D. Owens and M Kahl

Location: Katherine Research Station

Objective:

To develop practical methods based on a sound scientific understanding of crop-biological interactions which will significantly improve crop performance and profit margins.

Background:

Biological farming systems cover all projects that investigate soft/biological options to enhance agricultural production. Good soil health is the foundation of all sustainable agricultural production. Healthy soils function optimally through balanced interactions between their biological, physio-chemical, and mineral components. Farmers are well aware that many agricultural practices reduce the functional capacity of their soil. Local horticultural and agricultural industries want to know how to reduce soil degradation and enhance soil health. Research in biological farming systems has been expanded in the NT to include soft/biological solutions to problems of insects, weeds and diseases.

Method:

In the first year of this project, four action plans will be conducted:

- Consult with horticultural and broad-acre farmers to determine industry priorities.
- Contact Australian scientists who are researching biological farming systems to discuss current research techniques and to assemble relevant literature.
- Collect baseline soil health data from five wet season companion/cover crops, a mango orchard and a sabi grass pasture. The crops will include sorghum, sunflower, millet, lablab and cowpea. Compare the results from the three commercial laboratories. Soil health data will be collected from farms for dry season irrigated melon crops grown on sandy soils of the Venn in Katherine.
- Collect baseline entomology data for a range of wet season companion/cover crops. Prepare a dataset of insect pests and predators that are present on sesame, sorghum, millet, lablab and cowpeas, including the time in which they are present and their numbers.

Progress

Meetings will be conducted soon with interested farmers and those who have adopted biological practices. Contact has been established with some interstate research groups and biological/analytical laboratories. An on-going soil biology and integrated pest management literature search will be established.

Experimental areas will be sown in January 2007.

Project: **The Effect of Calcium Hydroxide, Surround®, Mangocote® and Envy® on the Incidence and Severity of Sunburn in Kensington Pride Mangoes in Katherine**

Project Officers: **G. Azam, R. Renfree and C. Newbould**

Location: Katherine Region

Objective:

To evaluate the effectiveness of sprayed films of calcium hydroxide, Surround®, Mangocote® and Envy® to protect mangoes from sunburn.

Introduction:

Kensington Pride (KP) mangoes are the main commercial variety grown in the NT. Diurnal fluctuations in temperature and high ultra-violet radiation during fruit development are mainly responsible for sunburn in mangoes. Sunburned fruit has a dry and slightly sunken but firm surface. The injury can be caused by heat when water or sprayed material concentrates sunlight on the surface of fruit, or simply when fruit is exposed to direct constant sunlight.

A variety of commercial products are available to control sunburn, including calcium hydroxide (Ca (OH)2), Surround®, Mangocote® and Envy®. These products provide a dry white film on fruit and foliage, which reflects light and reduces the temperature of the fruit. It is therefore expected that the use of such products would reduce the problems associated with high environmental temperatures, including sunburn, resulting in better quality and higher yield. This trial was conducted to determine if this assumption was true.

Method:

Trial site

A trial was conducted at a commercial property on 40 KP trees with four treatments during the 2005 mango-growing season to examine the extent of spray coverage, the subsequent control of sunburn and the quality of fruit. A non-sprayed group of trees was used as control.

Treatments

Immediately prior to initial spraying, mangoes were inspected for sunburn. All were found to be free of sunburn. Ca (OH)2, Surround®, Mangocote® and Envy® were applied to 10 trees each on 21 and 28 September and on 12 October 2005, prior to harvest. The interval between the first two applications was seven days and between the second and third application it was 14 days. All chemicals were sprayed on the sunny side of the trees. Sprays were applied to the point of run-off using a motorised knapsack sprayer. The application rates were in compliance with manufacturers' recommendations and are shown in Table 1. The total quantity of each chemical sprayed on each tree over the three application periods is shown in Table 2.

Table 1. Treatments

Treatment number	Treatment	Rate/100 L water
1	Control (no spray)	
2	Ca(OH)2	5.0 kg
3	Surround®	Initial application 5.0 kg - Subsequent applications 2.5 kg
4	Mangocote®	3.0 kg
5	Envy®	5.0 L

Table 2. The total quantity of each product sprayed on each tree during the three applications

Treatment	Quantity/tree
Surround®	105 g
Ca(OH)2	153 g
Mangocote®	88 g
Envy®	146 mL

Assessments

Spray coverage and fruit sunburn

Within one day of the first application, and a day before and after each subsequent application, the proportion of the surface area covered by each chemical was estimated on each of five representative fruits per tree. A linear scale was used for spray coverage and fruit sunburn assessment. The linear scale, based on visual assessment, had a 1 to 5 range, where 1 = 0–20%, 2 = 20-40%, 3 = 40-60%, 4 = 60–80% and 5 = 80-100% spray cover or fruit sunburn. A total of 200 mangoes from 40 trees were assessed for spray coverage and fruit sunburn on 22, 27, and 28 September and on 11, 13 and 25 October 2005. Mangoes were harvested on 25 October 2005.

Fruit quality

Fruit was weighed and categorised into three grades: A (1st grade), B (2nd grade) and C (reject), using the grading specifications produced by the Queensland mango sub-committee and HAL.

Results:

Spray coverage

The fruit on the Mangocote® and Surround® treated trees had a better coverage than the Ca $(OH)_2$ or Envy® treated trees. The increased coverage by Mangocote® and Surround® may be due to a wetting agent in the products.

Fruit sunburn

Surround® and Mangocote® treated trees had a better white film on foliage and fruit than the Ca $(OH)_2$ and Envy® treated trees. The incidence and severity of fruit sunburn was lower in the Surround® and Mangocote® treated mangoes compared with mangoes treated with the other products. A wetter or sticker may help to keep the products on the fruit.

Fruit quality

Coverage and sunburn

By providing a higher coverage, Surround® or Mangocote® may reduce the proportion of rejected fruit and increase the proportion of grade 'A' fruit. Although Envy® and Ca $(OH)_2$ provided some protection, they did not improve the yield or quality of fruit.

Conclusion

Foliar applications of Mangocote® and Surround® could reduce the incidence and severity of mango sunburn. Anti-sunburn products were applied only three times during the mango growing season due to the lack of consistency of flowering. More sprays and the use of wetters or stickers may be necessary to manage sunburn. The application of Envy® and Ca $(OH)_2$ did not produce noticeable improvements in quality or yield. This may need to be investigated further with the addition of wetting agents. Surround® and Mangocote® appear to be effective and inexpensive treatments for sunburn in mangoes.

Acknowledgements

We are grateful to Ian and Heather Curtis for the use of their mango orchards.

Program: Supply Chain Development

Project: Developing a Crop Forecasting System for the Australian Mango Industry - MG05004

Project Officer: G. Owens

Location: Berrimah Farm

Objective:

To develop a crop forecasting system for the Australian mango industry

Background:

Mangoes are a highly seasonal fruit with a fluctuating supply from one year to another. This forecasting system will identify peaks in supply which will assist the mango industry to better plan harvesting and marketing to prevent immature fruit flooding the market and reduce returns to those in the supply chain.

The crop forecasting system was designed by DPIFM in conjunction with the local mango industry association in the NT. The system uses predictions based on flowering surveys and the application of heat sum calculations to convert flowering data to a harvest pattern.

An NT mango seasonal forecast for the last four seasons has been published. It shows the predicted time for harvest peaks in the two main production regions of Darwin rural and Katherine.

Each year the forecast is compared with the actual production pattern for the season by collecting weekly dispatch information from the major packing sheds and consolidators.

As part of the project to develop a national crop forecasting system, a small group of growers has been formed in the Mutchilba/Dimbulah area to ground-proof the heat sums technology on the Atherton Tablelands on varieties like Keitt, which are not grown in the NT. Temperature data loggers have been installed and flowering trees have been tagged for fruit maturity assessments later.

Flowering surveys will be used as a method of collecting data to compile an Australian mango season forecast. Surveys have been already distributed to growers in the Mutchilba/Dimbulah group and in Burdekin. The growers groups will benefit from an in-house forecast and the process will be checked before it is released to the public next season.

As the forecast system does not predict the volume of mangoes likely to be produced each season, a reliable method is being investigated for such a prediction in each production region.

Program: Crops, Forestry and Horticulture Information Service

Project: Crops, Forestry and Horticulture Information Service

Project Officers: **G. Owens, A. Black, J. Thomas, G. McMahon, J. Bird and A. Nesbitt**

Location: Berrimah Farm, KRS and AZRI

Objective:

To continue to develop, package and efficiently deliver information for industry development.

Background:

The Crops, Forestry and Horticulture Information Service has been successfully established for 18 months and is providing up-to-date, consistent, locally-relevant and accountable information to a variety of client groups.

Activities

The service updated displays and information products on crops, forestry and horticulture for NT Information Centres in Darwin, Katherine, Tennant Creek and Alice Springs, the NTAgA and NTHA shopfronts and DPIFM offices.

The farms database has been utilised by several Divisions at Berrimah farm. However, with Connect:NT under review, administration and management of the database may need some changes in 2006-07.

The service was enhanced with the publication of five new Fact Sheets seven Growing Notes, four Information Packages, one Information Booklet, 26 Information Sheets and two miscellaneous publications. The total number of publications available from the service is 167. The service was represented at the Alice Springs, Tennant Creek, Katherine, Darwin and Fred's Pass shows

Gaps in knowledge are being progressively identified and addressed. Formatting and presentation of publications is becoming more tailored and user-friendly, such as the grafting tomatoes Information Sheet.

Client feedback is generally very positive and it appears that more clients are using the website to access information rather than requesting hard copies. This is indicated by the lower number of requests for general plant growing information.

The Crops, Forestry and Horticulture component of the DPIFM website was recently updated and put in an easier format. It was developed so the information on each crop is grouped together, thereby reducing the time for clients to access all the information available on a specific crop. Direct access to past and present research projects and seasonal information for growers, including mango crop forecasts and market prices, is also available. A crop specific catalogue has also been developed which relates to the website. Please visit www.horticulture.nt.gov.au.

The Connect:NT client management system, which is run by the extension officer, information has been under-utilised and is under review as part of the Connect:NT/DPIFM information technology review.

Program: Irrigation Production

Project: The Role of IPM in Sustainable Cotton Farming Systems in the NT

Project Officers: A. Davies and C. Martin

Location: Katherine Research Station

Objectives:

To monitor key lepidopteran pests weekly using pheromone traps at seven sites.
To test resistance and develop resistance management strategies for Helicoverpa armigera and Aphis gossypii.
To monitor H. armigera for Bt resistance.
To develop companion cropping protocols for sucking insects and Helicoverpa in the NT and monitor their impact in field-scale trials.
To assess the impact of sucking insects on cotton grown in the NT including the continued development of thresholds.
To monitor and model the impact of Trichogramma pretiosum on H. armigera.

The following is an abstract from the final report:

Critical components of proposed integrated pest management (IPM) systems designed to promote the sustainability of the cotton (*Gossypium hirsutum L.)* industry based on transgenic cultivars that express *Bt* toxins (Bollgard II®, Monsanto) in the NT, were investigated from 2000 to 2005. The noctuid pest, *Helicoverpa armigera* (Hübner) attacks cotton (and possibly *Bt* cotton) in NT and has a demonstrable ability to develop resistance to conventional control methods. An IPM system was devised to minimize the risk of developing resistance. Strategies that were employed during IPM trials in Katherine included winter cropping to avoid high pest densities in summer, reliance on natural enemies for biological control of pests, provision of unsprayed refuges for natural enemy proliferation, trap crops to attract insect pests away from cotton plants, incorporation of cotton's inherent ability to compensate for damage caused by sucking mirids (*Creontiades diltus* (Stål) and *Creontiades pacificus* (Stål)) and utilisation of target selective insecticides at lowest effective concentration, only when absolutely necessary. The aim was to design a local cotton IPM system that avoids insecticidal control of pests where possible without loss of lint yield and quality. IPM

strategies suggested by research in previous years were implemented as a system in 2005 contributing to record yields and minimal (average 2.8 per field) insecticide applications.

Irrigated lablab (*Lablab purpureus* (L.)) produced relatively large numbers of *H. armigera* compared with other local crops during the winter growing season. It was therefore tested as a possible companion crop in a Bollgard II® production system. Although lablab effectively maintains large numbers of *H. armigera* over the season, insect pest and natural enemy densities and lint yield and quality from cotton crops grown with and without lablab companions were not different. Companion crops with more a discernible advantage to cotton production should be trialled in the future.

Insecticide reliance steadily decreased as the IPM system was refined from 2000 to 2005. The majority of *Helicoverpa* suppression was achieved through Bollgard II®'s inherent control potential, which did not wane for the life of the project, and biological control with natural enemies. Coccinellids (lady beetles) and syrphid (hover fly) larvae effectively maintain aphid (*Aphis gossypii* Glover) and white fly (*Bemisia tabaci* (Gennadius)) densities below control thresholds in local cotton when not disrupted by insecticides. Spiders are more robust and persist in Katherine cotton regardless of insecticide use, but are highly polyphagous, consuming insect pests and natural enemies alike, so their benefit in biological control is marginalized. *Trichogramma* (*Trichogramma pretiosum* Riley) parasitise a high percentage (c.a. 50 to 80%) of *H. armigera* eggs early in the season in local Bollard II® crops. *Trichogramma* contribute to the management of possible resistance in *H. armigera* populations as they consume the developing embryo in parasitised host eggs minimizing larval hatch and exposure to *Bt* proteins. Natural enemies are critical to the local cotton IPM system and their pest control efficacy governs the need for judicious insecticide selection and application.

Insecticides that target sucking insects with minimal disruption to natural enemies were examined. Preliminary trials suggest mirids require control at a threshold of 0.5 per metre in local cotton to maintain yield. To the detriment of experimental consistency, trials incorporated other sucking insects (red-banded shield bugs (RBSB, *Piezodorus grossi* (Staddon)) and green vegetable bugs (GVB, *Nezara viridula* (L.)), in threshold calculations despite their relative damage potentials being not quantified. Further, the seasonal relative abundance of different mirid species (green, *C. dilutus*, and brown, *C. pacificus*) and their pest status in local cotton has not been clarified. Consequently, large scale trials attempting to clarify control thresholds for this suite of sucking insects collectively were largely unsuccessful. The pest status and damage potential of RBSBs and another sucking pest, *Austroasca alfalfae* (Evans) (leafhoppers) were examined in late season cotton in 2005 only.

Local populations of the noctuid pests *H. armigera*, *Helicoverpa punctigera* (Wallengren), *Pectinophora gossypiella* (Saunders) and *Spodoptera litura* (Fabricius) were monitored temporally and spatially for the life of the project with pheromone traps. Local *H. armigera* populations persist year round with population peaks in both the wet and dry seasons. *Helicoverpa punctigera* migrate into crops early in dry season with the ability to persist throughout the season. *Pectinophora gossypiella* populations develop during the wet season only so are avoided by cropping through cool and dry winter. *Spodoptera litura* are prevalent in the wet season and persist into cotton crops through the dry so. Although less damaging to cotton, their pest status and possible control measures require examination. To date, *H. armigera* resistance to *Bt* proteins has not caused problems in Katherine, although resistance to conventional insecticides is of concern and has been detected, often to products not utilised during local cotton production. Continued monitoring of *H. armigera*, *H. punctigera* and *S. litura* populations would be required should cotton production trials proceed.

All cotton IPM trials conducted in the NT during this project were compromised by continual staff turnover, inadequate cotton production expertise and farming infrastructure, and a lack of priority at the management level. It is recommended future trials be scrutinised more closely by external stakeholders should cotton production proceed. This project has laid the foundation for environmentally sound pest management in future local transgenic cotton production systems despite difficult circumstances. Methods to further refine the local cotton IPM system are suggested.

Project: Peanut Varieties for Northern Australia

Project Officers: P. Shotton, C. Collins, S. Bhuiyan, M.Boyd and F. O'Gara

Location: Douglas Daly Research Farm (DDRF)

Objective:

To evaluate and identify suitable peanut varieties for production in the NT.

Introduction:

This trial follows a three year collaborative project between DPIFM, QDPI&F, the Grains Research and Development Corporation (GRDC) and the Peanut Company of Australia (PCA). Each year new peanut lines are evaluated for yield, disease tolerance, kernel grades and shell proportion. The research is focused on identifying high yielding, disease-resistant, high oleic oil varieties suitable for production in the NT. The market now demands high oleic varieties due to their longer shelf-life and health properties. PCA is currently phasing out low oleic oil varieties.

In 2005 PCA selected four high oleic oil varieties which were assessed under irrigation during the 2005 dry season.

Method:

The varieties were hand-planted within a bulk peanut crop under centre pivot irrigation at DDRF. The trial was a randomized block design with four replicates. The trial was repeated with Flame® herbicide as a treatment. Plots were 5 m long and two rows wide, each row width being 0.9 m. The crop was planted on 16 March. Once established, the crop was hand thinned to a population of 120 000 plants per hectare. Plots were harvested between 8 September and 22 September 2005, based on maturity.

About 7.4 mega litres of water per hectare was used to grow the crop. Fertilisers were applied both pre and post-emergent. Pre and post-emergent herbicides were applied for weed control as follows: pre-emergent 2.5 L/ha of Triflurlin and post-emergent Flame® at 0.4 L/ha in trial 1. A fungicide schedule of Elect®and Folicur® was applied during the season to control leaf disease.

Results:

Varieties were analysed separately for Flame® and non Flame®.

The performance of each variety was rated on kernel yield per hectare and the proportions of different grades.

Disease assessment

Overall disease incidence was fairly low. Most of the diseased plants in Menzies, Deakin and Barton varieties were affected by aspergillus crown rots caused by *Aspergillus niger.* The number of affected plants was low. There were no significant differences (Table 1) in disease incidence among the three varieties. Although the variety Holt was not affected by crown rot, about 12 plants per plot had ‘leaf spot symptoms’. The spots were small, irregular and grey-brown in colour on both sides of the leaf. Affected leaves were inspected at Katherine Research Station and no pathogenic organisms were isolated, indicating a possible abiotic cause such as herbicide or fungicide damage.

Table 1. Disease incidence on four peanut varieties grown at DDRF

Rep	MZ[1]	DEAKIN[1]	BARTON[1]	HOLT[2]
1	1	1	0	15
2	0	0	0	15
3	3	1	2	8
4	1	1	1	8
5	3	2	0	12
6	1	0	0	13

[1] Mostly affected by crown rots, [2] Affected by leaf spot only

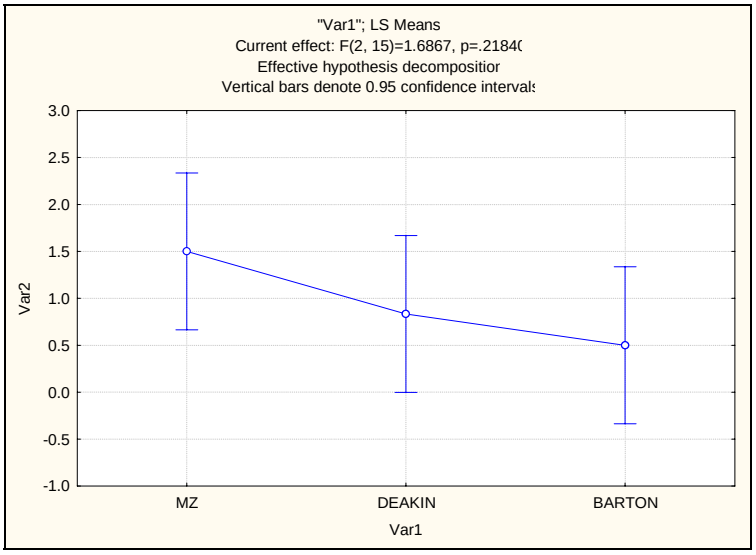


Figure 1. Crown rot incidence in the peanut variety trial at DDRF

Figure 1 shows the incidence of crown rot in varieties Menzies, Deakin and Barton, however no crown rot was found in the variety Holt. Symptoms of leaf spot were recorded in Holt only (Table 1).

Statistical analyses

Statistical analyses were carried out to determine significant differences in kernel yield, proportions of kernel grades and shell in each variety. The treatments Flame® and no Flame® were analysed separately.

Table 2. Mean yield and grading of varieties

Variety	Deakin	Holt	Barton	Menzies
Treatment	**Flame**	**Flame**	**Flame**	**Flame**
NIS* (kg/ha)	5725.7	7017.4	6392.4	6159.8
Jumbo (%)	40.3	55.4	42.5	49.6
Grade 1 (%)	8.2	5.0	9.3	5.9
Grade 2 (%)	5.9	3.9	4.9	4.5
Combined grades	54.4	64.3	56.7	60.0
Mfg (%)	0.6	0.6	0.6	0.7
Splits (%)	13.4	10.4	18.7	12.8
Ts oil (%)	3.8	2.2	2.1	3.0
Hp oil (%)	7.0	2.4	3.5	3.9
Shell (%)	20.9	20.2	18.4	19.8
Treatment	**No Flame**	**No Flame**	**No Flame**	**No Flame**
NIS (kg/ha)	6833	7930	6420	6851
Jumbo (%)	38.2	53.6	46.4	46.2
Grade 1 (%)	7.4	6.0	8.0	6.9
Grade 2 (%)	5.7	4.7	3.8	5.5
Combined grades	51.3	64.2	58.05	58.52
Mfg (%)	0.6	0.9	0.5	0.6
Splits (%)	14.8	8.8	17.8	12.4
Ts oil (%)	4.8	3.2	2.2	3.5
Hp oil (%)	8.2	2.8	3.3	5.7
Shell (%)	20.9	20.2	18.2	19.3

Mfg = Manufacturing kernel. Ts oil = Through sieve grade. Hp oil = Hand picked kernel * Nut in shell

The highest return per hectare, average grade prices, kernel yields and theoretical gross returns for trial varieties PCA 2005 was Holt at $743.68 (no Flame® treatment) and $759.00 (Flame® treatment). Deakin gave the least return of $656.50 (Flame® treatment) and $639.68 (no Flame® treatment).

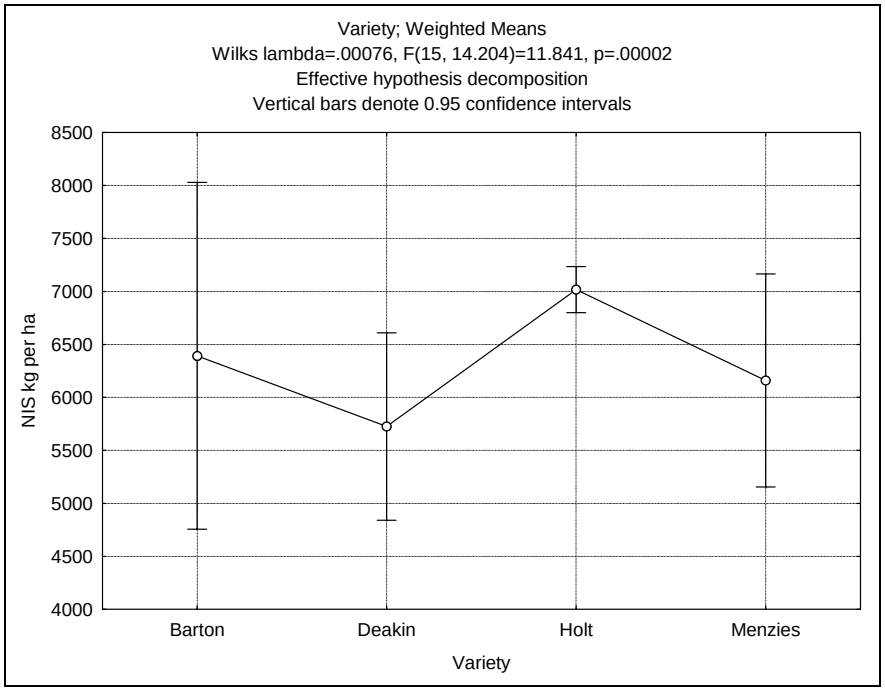


Figure 2. Weighted means for nut in shell yields (Flame® treatment)

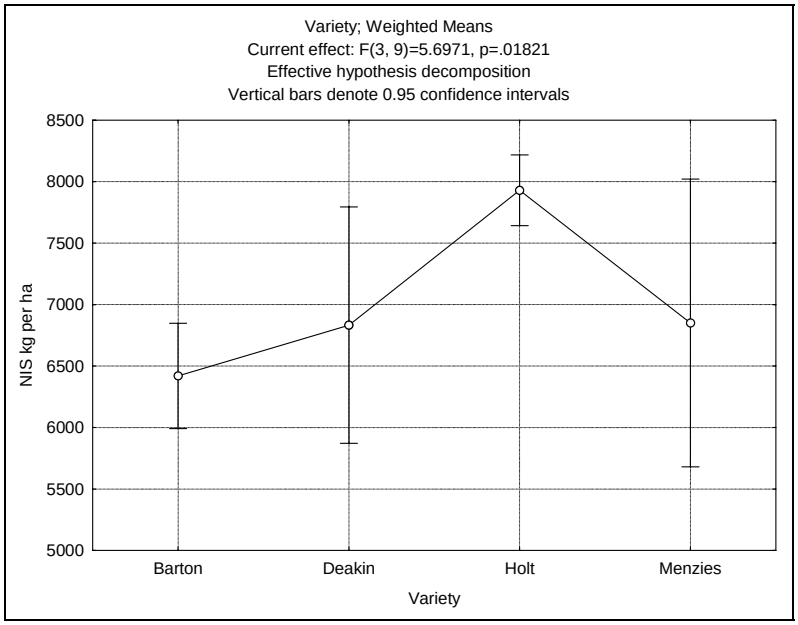


Figure 3. Weighted means for NIS yields (no-Flame® treatment)

NIS yields were higher in all varieties in the no-Flame® plots compared with the Flame® treatment, although the no-Flame® treatment crop was visibly weedier. Flame® effectively controlled most broadleaf and grass weeds. Flame® suppressed nutgrass; however, it eventually recovered.

Barton was late in germinating and emerging - some seven days after the other varieties.

When hand harvesting Menzies plots, five to 10 nuts per plot were sprouted indicating harvest was a few days late. Several loose nuts were found on the ground indicating weak pegs.

Holt produced the highest NIS yield (Table 2), the highest proportion of Jumbo and combined kernels in both the Flame® and no-Flame® treatments and produced the highest theoretical gross returns for trial varieties. Deakin had the lowest proportion of Jumbo and combined grades.

There was a significant difference in the proportion of shell, with Deakin having the highest and Barton the lowest. Varieties with a high shell proportion are more expensive to freight and usually return less per tonne. This is an important consideration for Territory growers.

No statistical analysis was carried out on the splits; however, the highest were in Barton and the lowest in Holt.

Project: Evaluation of Irrigated Fodders at Douglas Daly Research Farm

Project Officers: **F. O'Gara, C. Collins, S. Reed, P. Shotton and DDRF Farm Staff**

Location: Douglas Daly Research Farm (DDRF)

Objective:

To determine the yield potential, agronomic requirements and viability of forage crops under centre pivot irrigation in the Daly Basin.

Background:

There is a need to evaluate a range of field crops and identify suitable varieties for irrigated production in the Katherine Daly Basin. Some of the limitations for irrigated field crops include the lack of crop options and markets and the relatively high cost of production compared with other farming areas.

Although peanuts and maize have been successfully produced using centre pivot irrigation, there is a need for a viable rotation in the farming system. Irrigated cropping has declined recently due to production costs and the lack of markets. However, there is growing interest in the production of high quality hay for export and for the live cattle trade.

In 2005 the NT Agricultural Association, local producers and processors sent a trial shipment of Jarra grass (*Digitaria milangiana*), Tully (*Bracharia humidicola*), Cavalcade (*Centrosema pascourum*) and irrigated Rhodes grass hay to Korea. Reports indicate the Koreans were impressed with Rhodes grass and Cavalcade but did not consider the Jarra or Tully to be of high quality. In general, wet season produced grass hay is of poor quality and relatively low in nutritional value and unlikely to meet export standards.

Dry season irrigation offers the opportunity to produce high quality hay suitable for the export trade. This project is evaluating different fodder species and varieties to determine agronomic requirements, production costs and quality traits. Non-replicated evaluations have been conducted to assess maize silage, forage sorghum, Rhodes grass, lucerne and forage oats for yield and commercial potential under irrigation at DDRF. In 2005 fine-cut Rhodes grass was evaluated for the third successive season and two lucerne varieties were evaluated for the second season.

Rhodes grass

Rhodes grass planted in March 2003. The stand has persisted well and continued to produce good yields of high quality grass. In 2005 it was harvested eight times, the first in February and the last in December.

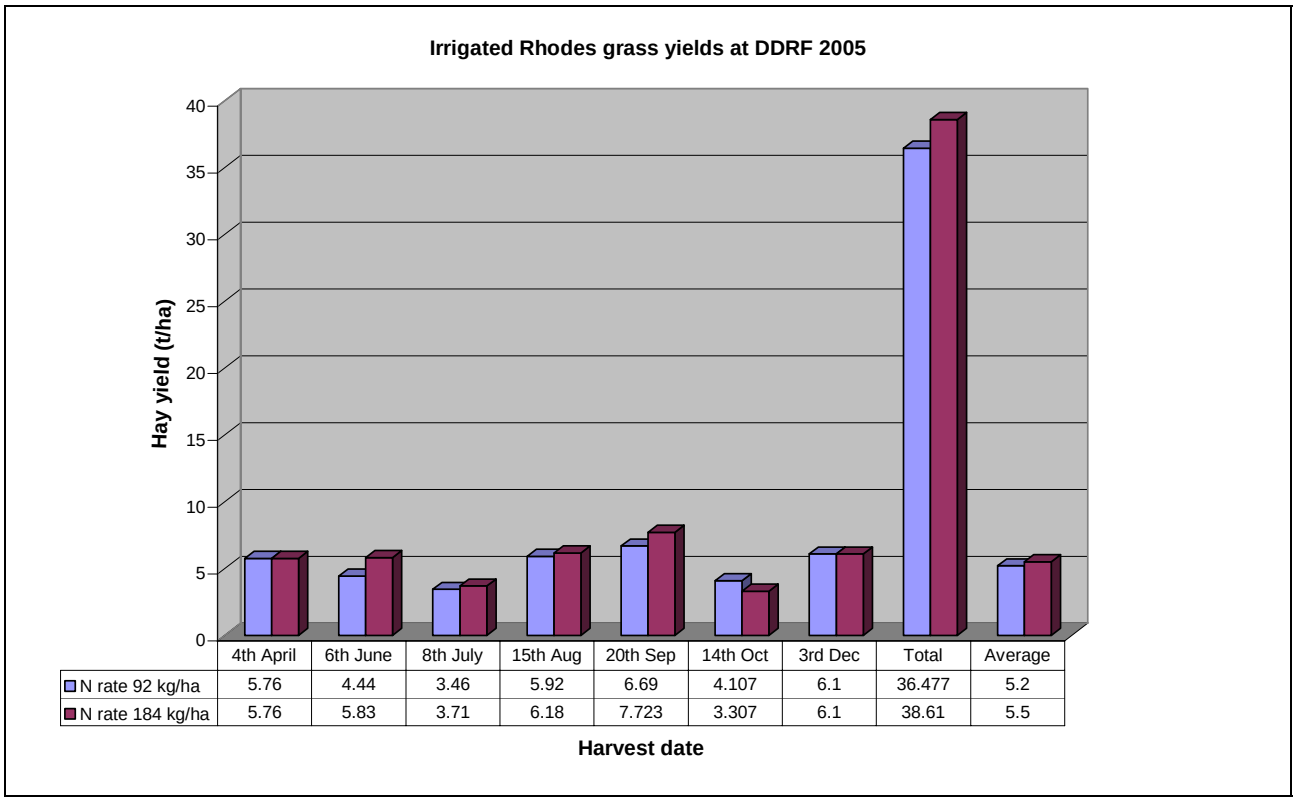
The initial growth of Rhodes grass after the wet season is slow due to a run-down in nutrients, in particular nitrogen (N). Cool temperatures in the middle of the dry season also reduce production. Considerable nitrogen is required to stimulate production early in the dry season. Rates of up to 250 kg/ha N may be required to stimulate growth after the wet season.

After the April harvest, two different rates of N (92 kg/ha and 184 kg/ha) were assessed to determine whether production and quality are influenced by N application. N was applied as granulated urea after each harvest and was watered in. The crop also received phosphorus, potassium, sulphur, magnesium and zinc to ensure these elements were adequate.

Yield was between 36 and 38 t/ha of hay over seven harvests, with an average yield of around 5.5 t/ha per harvest. There was no significant yield difference between N treatments. The high N treatment produced only 2.0 t/ha more than the lower N treatment over the season. The quality of the hay in terms of crude

protein, digestibility and energy was consistently higher in the higher N treatment. As yield and quality is highly influenced by the duration of growth at cutting time and nutrient status, hay quality varied at each harvest. Feedtest® analysis showed that the high N treatment gave crude protein, digestibility and energy levels up to 18.7%, 65% and 10.4 MJ/kg dry matter, respectively. The average crude protein over five harvests was 13.8%, while the lower N treatment had a maximum crude protein of 14.6% and an average 11.9%.

While the additional N resulted in marginally higher hay yields and better quality on average, the differences were smaller than expected. It is unlikely that the additional N would be economical unless a premium is paid for higher quality hay.



	4th April	6th June	8th July	15th Aug	20th Sep	14th Oct	3rd Dec	Total	Average
N rate 92 kg/ha	5.76	4.44	3.46	5.92	6.69	4.107	6.1	36.477	5.2
N rate 184 kg/ha	5.76	5.83	3.71	6.18	7.723	3.307	6.1	38.61	5.5

Figure 1. Irrigated Rhodes grass yields at DDRF in 2005

As there was little difference in yield between the high and low N treatments, this may indicate that 90 to 100 kg/ha of N per harvest is close to the optimum economic rate of N for Rhodes grass under irrigated conditions at DDRF.

Lucerne

The two varieties of lucerne, Hunterfield and Faulkner, which were established in April 2004, persisted and grew well in the 2005 season. Nine harvests were undertaken through the dry season and the average yield per harvest was 2.5 t/ha. Yields fluctuated considerably from 1.5 t/ha to over 3.0 t/ha. Cold weather in the middle of the dry season may account for some reduction in growth as seen in the July harvest (Figure 2). A similar reduction in yield was seen in the Rhodes grass in July.

As there were no observable differences between Hunterfield and Faulkner, both varieties were harvested together. Hunterfield did appear slightly more vigorous than Faulkner but no conclusion can be drawn on whether one variety was better than another.

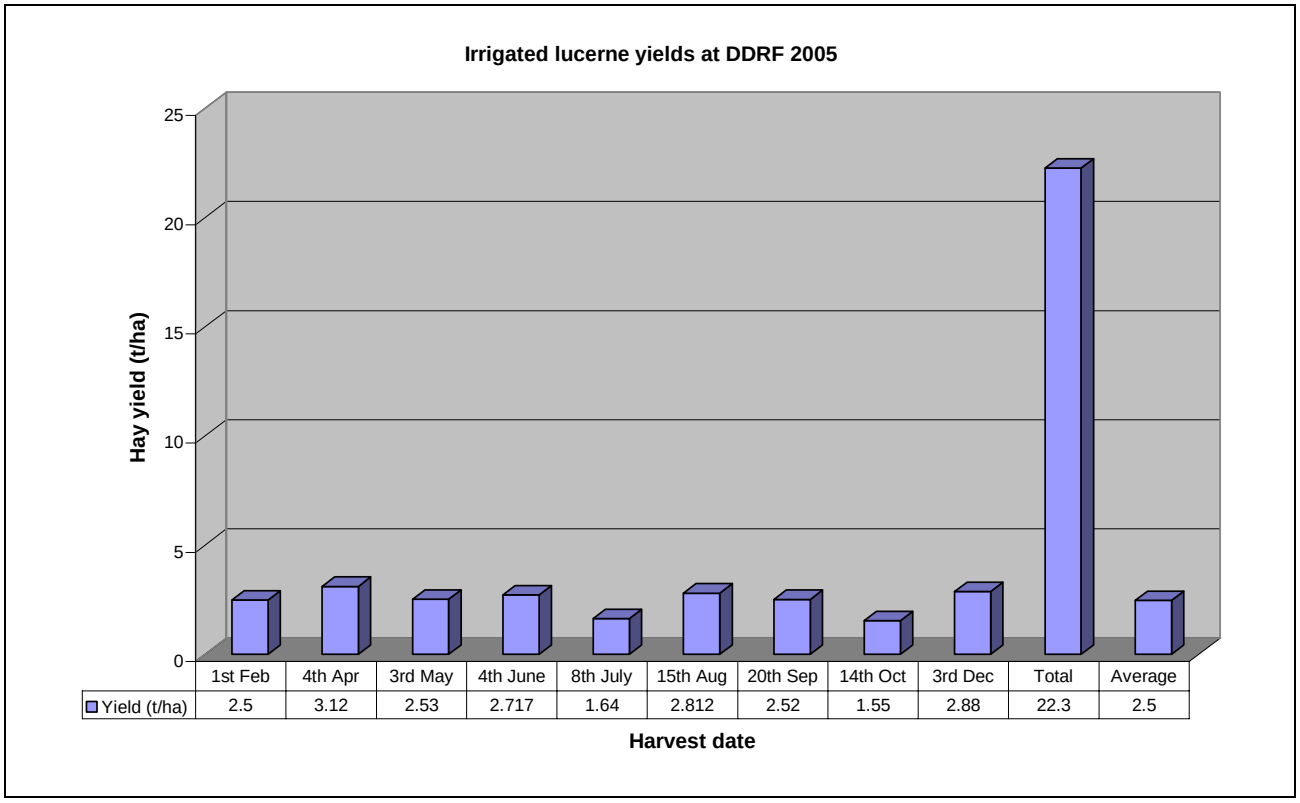


Figure 2. Irrigated lucerne yields at DDRF in 2005

Two major constraints reduced lucerne's persistence and productivity. The first was weed competition from nutgrass (*Cyperus rotundus*) and summer grasses such as crows-foot grass (*Elusine indica*).

While many grasses can be controlled with selective grass herbicides, crows-foot grass is more vigorous and difficult to control. Nutgrass is practically impossible to control with existing herbicide options. Flame (imazapic 240 g/L a.i.) was trialled on the lucerne at 300 and 400 mL/ha to determine efficacy and its effect on lucerne. Flame has been effective in suppressing nutgrass in peanut crops at DDRF. A slight discoloration and temporary suppression of lucerne plants were observed but there was no measurable difference between treated and un-treated areas. Flame was applied to the entire crop in October to suppress nutgrass.

In November 2005 magpie geese invaded the trial area. They dug up the ground chasing nutgrass tubers. As a result, they killed or damaged 70% to 80% of lucerne plants in the process. Unfortunately, the area had to be ploughed out, with only one small observation plot kept.

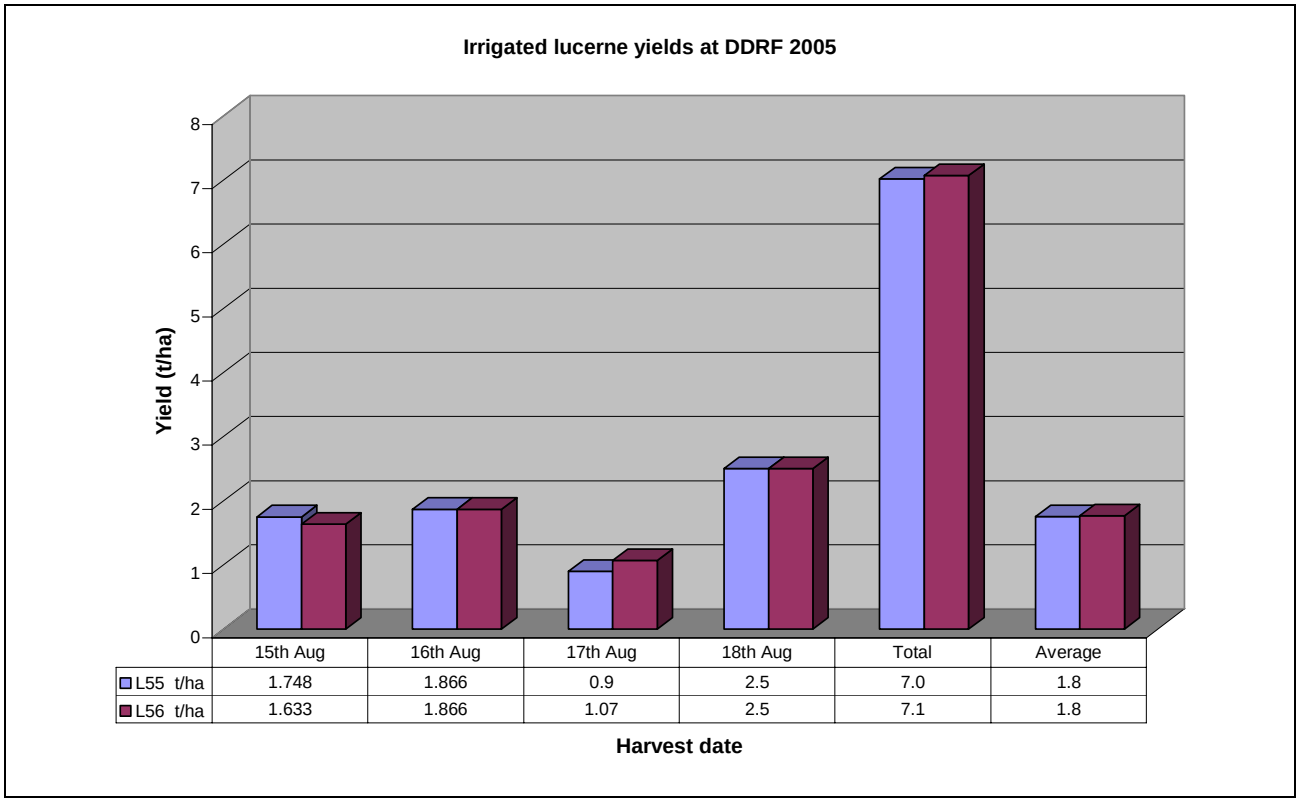
The second major constraint was the incidence of "little-leaf" which progressively invaded the crop. "Little-leaf" is a disease associated with microscopic organisms called mycoplasmas or phytoplasmas which are transmitted by leafhopper vectors. Phytoplasmas cause stunting, shortening of stems and a dramatic reduction in leaf size. Plants become unproductive and eventually die.

Hunterfield and Faulkner appeared equally susceptible to the disease and plants progressively became infected, reducing production and causing plant mortality. It was estimated that nearly 50% of the plant stand was affected by the end of 2005.

New lucerne varieties

Two new lucerne varieties, Pioneer L55 and L56, were sown in June 2005 at DDRF to determine whether they had improved persistence, productivity and better tolerance to "little-leaf". The varieties were in single

un-replicated observation plots of about 0.6 ha each. L55 has performed well in north Queensland for several years and L56 is a relatively new line. L55 and L56 produced practically the same yield as Hunterfield and Faulkner in the first year of their establishment. The average yield of L55 and L56 over four harvests was 1.8 t/ha while the average for Hunterfield and Faulkner in the first year of establishment was 1.7 t/ha over five harvests. There was no measurable or observable yield difference between L55 and L56 in 2005.



	15th Aug	16th Aug	17th Aug	18th Aug	Total	Average
L55 t/ha	1.748	1.866	0.9	2.5	7.0	1.8
L56 t/ha	1.633	1.866	1.07	2.5	7.1	1.8

Figure 3. Irrigated lucerne yields at DDRF in 2005

From these preliminary observations, it appears that the varieties have a similar yield potential in the first year of production. Total yield is determined by the number of harvests which will be determined by planting time. Establishing the crop early in the dry season (April) will allow five or six harvests. As the crop in this trial was planted later than the Hunterfield and Faulkner crops, only four harvests were achieved.

Both L55 and L56 persisted through the 2005-06 wet season, which was a particularly long season due to cyclone Monica which hit the Top End in April 2006. Unfortunately, it appears that these varieties have a similar susceptibility to “little leaf” as Hunterfield and Faulkner. Both varieties seemed to have a significant level of "little-leaf” infection at the end of 2005. These observations will be continued along with screening of other varieties in 2006-07.

Forage oats

Due to the interest in growing export quality hay, 1.5 ha of forage oats were sown under the centre pivot at DDRF to get some baseline information. Two varieties, Drover and Taipan, were sown on June 20, 2006 at 40 kg/ha. Both varieties established well. The crop is planned to be harvested in October and yield and quality components will be measured.

Summary

These preliminary forage trials have shown that both Rhodes grass and forage sorghum can be grown successfully under irrigation. Rhodes grass has proven to be productive and persistent for four years and has the potential to produce export grade hay. Forage sorghum is more an annual proposition as the plant population progressively declines with repeated harvests. By the end of the first season the population of

forage sorghum plants will be below what is required for optimum production. Therefore the crop will need to be re-sown each season.

Lucerne has shown to be productive into its second year; however, weed competition and “little-leaf” disease seem to be the most limiting factors. “Little leaf” renders plants unproductive and possibly contributes to plant mortality. If varieties with greater tolerance or resistance to “little-leaf” could be identified, lucerne may persist past three years and may potentially be a viable irrigated crop.

Program: Dry Land Cropping

Project: Bio-fuel Crops for the NT

Project Officers: M. Bennett, M. Kahl and D. Owens

Location: Katherine Research Station

Objective:

Provide farmers with a shortlist of potential crops suitable for producing bio-fuels (bio-diesel or ethanol) in the NT.

Background:

Australia’s largest bio-diesel facility is being built in Darwin by Natural Fuels Australia Limited. The design capacity for this renewable fuel plant is 140 ML of bio-diesel per year. Natural Fuels Australia will import palm oil from Asia to service this plant. NT farmers have expressed an interest in providing locally-produced vegetable oils to replace some of the imported palm oil.

Australian farmers, including many in the NT, are investigating on-farm production and consumption of bio-diesel and ethanol to reduce their increasing fuel costs. This project will short list the most economically viable crops for the production of bio-diesel or ethanol.

Method:

1. Identify bio-fuel crops agronomically adapted to the NT.
2. Collate crop production figures (grain biomass, oil or carbohydrate content).
3. Estimate cost of production per hectare.
4. Rank crops according to economic viability.

In May 2006, nine bio-fuel crops were planted at Katherine Research Station. They included soybean, African palm oil, canola, mustard, cassava, sesame, sunflower, safflower and maize. These crops were selected for evaluation because they had either never been grown in the NT, or had never been grown on clay loam soils or never established under dry season irrigated conditions in Katherine.

Progress

Annual crops

Maize, sunflower, canola and mustard are flowering extremely well and should produce good grain yields.

Soybean, safflower and sesame have poor plant establishment and hence low yield potential.

Perennial or biannual crops

Cassava has established well, while the small African palm oil plants suffered sunburn on the under side of their leaves due to windy conditions. Both crops should grow vigorously in the coming wet season.

All crops except cassava and African palm oil will be harvested by the end of October 2006. Cassava will be harvested in April 2007 and April 2008 while the first harvest of African palm oil seed may be in 2009.

Project: Sesame Industry Development

Project Officers: M. Bennett, D. Owens and J. Avenell

Location: Katherine Research Station

Objective:

To identify and develop new sweet sesame genotypes suitable for northern New South Wales, central Queensland and northern Australia.

Background:

Commencing in 1998, experiments were conducted to identify and develop new sesame cultivars for the sesame growing regions of Australia. These externally-funded experiments were completed in 2004. Plant Breeders' Rights for cultivars, Rakabe and Rosemarie, were obtained in June 2005. National and international interest in the remaining experimental lines as a "sweet" cultivar with export potential to Japan resulted in screening the best 20 experimental lines, three internationally-recognized sweet cultivars, plus the commercial Australian cultivars Edith, Yori, Giles, Rakabe and Rosemarie in 2005. The sweetness of the international cultivars provided a benchmark on which to score the experimental selections and the Australian cultivars. The Australian cultivar Giles proved superior in flavour and suitability for mechanised agriculture. It was quickly recognised that within Giles, superior selections were also available. This year, Giles was screened to identify 40 superior selections.

Method:

This wet season 20 plots of Giles sesame each of four rows, 5 m long with row spacing of 50 cm were established on 30 January. Plots were hand-fertilised with the equivalent of 60 kg N/ha, 20 kg P/ha and 50 kg K/ha nine days after sowing (DAS). Plants were thinned 15 DAS to an intra-plant spacing of 10 cm. Weeds and insects pests were controlled as required. Ten consecutive plants from an inside row were identified for measurement from four randomly selected plots. These plants provided the description for Giles. Ten plants visually assessed as being either earlier flowering, having greater yield potential or resistant to *Macrophomina phaseolina* were tagged in each of the remaining 16 plots. At physiological maturity all tagged plants were harvested and plant characteristics scored on a scale 0 to 10. Total scores were ranked to identify the best 40 selections.

Progress report

Forty selections have been identified for evaluation next year. The best 10 selections from next year's evaluations will be sent to Japan for flavour assessment. The superior line will be released the following year.

Program: Agroforestry

Project: Strategy and Progress of a Tree Improvement Program for African Mahogany (*Khaya senegalensis*) in the Northern Territory

Project Officers: **D. Reilly, B. Robertson, R. Connelly and G. Nikles - Queensland Forestry Research Institute (QFRI)**

Location: Top End of the NT including Melville Island

Objectives:

To rapidly improve stem straightness and to produce diverse, second-generation progeny.
To phenotypically select at least a few superior trees from each of the 24 provenances (from 11 countries of nativity and one secondary) represented on the mainland at Gunn Point and on Melville Island.
To establish grafted clones of these trees in both a gene recombination orchard (GRO) and in a conservation clone bank (CCB) for security, to ensure protection and use of the best of the provenance diversity present.
To establish a series of clone tests for identification of deployment clones.
To establish a clonal seed orchard (CSO) with the seemingly best 20 selected trees available to enable a seedling deployment option and culling the GRO after planting a second generation of trees.
To plant a second cycle base population as open-pollinated GRO families and infusions to enable future selection of superior, second-generation trees for on-going improvement.
To develop protocols for the vegetative propagation of African mahogany.
To match K. senegalensis to sites and determine optimal silviculture, nutrition and management regimes, and wood improvement needs
To improve the expertise of DPIFM staff in genetics and tree breeding.

Provenance trials planted at Gunn Point and Melville Island in the early 1970s show that a range of natural provenances grew well in the NT. These stands contain trees from 12 African countries in which the species occur naturally (from Senegal in West Africa to Sudan and Uganda in the east of the continent) and from derived stands in New Caledonia.

Method:

Superior trees were selected in 2000, grafted and then planted in December 2001 in a CSO and a CCB at Howard Springs and Berrimah Farm, respectively.

The main aspects of the improvement program successfully achieved in previous years are:

- Maintenance and monitoring of African mahogany and other promising species in the NHT species trials established between 1998 and 2001.
- Continued management of the hedge garden at Berrimah Farm for the production of cuttings to establish clone tests with as many families as possible, represented by as many replicates as possible at each site.
- Measuring the clone tests established in 2004-05 at CPHRS, further establishment of clone tests at Katherine Research Station and re-plant the clone test at DDRF that failed after a planting in July 2005.
- Establishing African mahogany clone tests on Northern Tropical Timbers land in the Douglas/Daly region and on Great Southern Plantations on Melville Island. These trials are replicated clone tests using rooted cuttings taken from both hedge gardens (120 clones) and seedlings from Darwin street trees (controls). Checks for genotype x environment interaction and provenance effect can be observed.

The composition of each of the newly established clone tests is included in Table 1. The following components were included as per the clone tests established in the 2004-05 wet season.

During the 2004-05 wet season, the following activities were conducted:

- Established replicated clone tests on four sites using rooted cuttings taken from the above hedge gardens, seed collected from locally grown trees and striplings from the same 10 sites in the hedges. To ensure security of the project, the testing phase of the program to enable provenance to site-matching was done at Coastal Plains Horticulture Research Station (CPHRS), Douglas/Daly Research Farm (DDRF) and Katherine Research Station (KRS). Commercial interest in the project enabled testing phases of the program to be extended to commercial growers on private land. This will enable more rapid deployment of untested superior clones and later deployment of genetically improved clonal material.
- Infusion of rooted cuttings from the stump coppice of 39 trees felled for the timber evaluation study into the hedge garden.
- Infusion of rooted cuttings from CSO and CCB of the 16 trees included in the timber evaluation study.
- Propagation of seedlings from newly imported Khaya senegalensis seed from Burkina Faso through Honduras.

Table 1 indicates the range of countries and provenances on which the African mahogany improvement program is based.

Table 1. Provenances of *Khaya senegalensis* represented by year of planting at Gunn Point (superior selected trees in brackets)

Seed code	Provenance	1970/71 (EP 363b)	1971/72 (EP388)	1972/73 (EP420)
D391	Central African Republic	+ (7)	+ (1)	-
D407	Uganda	+ (5)	-	-
D408	Uganda (West Nile)	+ (3)	-	-
S9620	Uganda (West Nile)	+ (2)	+ (3)	-
S10053	Uganda	-	-	+ (4)
D411	Togo	+ (6)	-	-
D415	Upper Volta	+ (4)	+ (4)	-
D416	Upper Volta	+ (4)	+ (5)	-
D417	Senegal	+ (5)	+ (4)	-
S9392	Senegal (69)	+ (5)	-	-
S10066	Senegal	-	-	+ (5)
S9368	Sudan	+ (2)	-	-
S9687	Sudan	+ (5)	+ (5)	-
D477	New Caledonia	-	+ (3)	-
D487	New Cal.(ex Ivory Coast)	-	+ (6)	-
D522	Noumea New Caledonia	-	-	+ (4)
S10050	Ivory Coast	-	+ (5)	-
D480	Nigeria (Jos)	-	+ (6)	-
D486	Nigeria (Yola)	-	+ (5)	-
D500	Ghana	-	+ (5)	+ (6)

Table 2 indicates the components of the clone tests for African mahogany that were established at four sites in the NT in 2005-06.

Table 2. Summary of the composition of *Khaya senegalensis* clone tests

Test material x test sites – showing numbers of clones or numbers of seedlings	**CT 1c (Douglas DDRF, S of Darwin) (3 ramets/ clone) *Re-planted Feb. 06***	**CT 1d (KRS, c. 300 km south of Darwin) (3 ramets/ clone) *Planted Jan. 06***	**CT 1e (Yapilika, Melville Is. north of Darwin). (1 ramet/ clone) *Planted April 06***	**CT 1f (Imalu) Melville Is. north of Darwin) (2 ramets/ clone) *Planted April 06***
Clones from OP seedlings ex 11 of the 38 trees selected in 2003 in the NT plantings of the early 1970s at Gunn Pt and Howard Springs	44 (includes many linking/common clones to CT 1a; and many links to CT 1b)	117 (includes many linking/common clones to CT 1a; and many links to CT 1b)	88 (includes many linking/common clones to CT 1a; and many links to CT 1b)	51 (includes many linking/common clones to CT 1a; and many links to CT 1b)
Clones from bulked seed from Weipa, Qld selects	6	83	20	26
Clones from NT wildlings	11	34	5	12
Other clones	2	4	5	1
Clone total per rep	63	238	118	90
Seedlings from Honduras	15 per rep	50	100	60
Seedlings from Darwin street trees	18 per rep	62	82	50
Seedlings totals per rep	33	112	182	110
Total plants per rep	**96**	**350**	**300**	**200**

Results:

The first two clone tests established at CPHRS in early 2005 were measured at six months and 12 months for height growth and branching that had occurred. Any trees with extraordinary growth or form are also noted. The latter measurements have greatly extended the parameters being measured including height, diameter (DBH), number of branches above and below DBH, apical dominance, bole length and stem straightness. This will provide more accurate assessment of tree performance, as tall trees are not always productive trees. Brief details of the best performing trees in terms of growth in height is shown in Tables 3 and 4 for clone test 1(a) and 1 (b) at CPHRS.

Table 3. Clone test 1 (a) indicating 12 months growth

Number	Origin	Ht (cm) 9/2/06
332	Family169 R/c	345
580	Street tree seedling	330
279	Family158 R/c	330
572	Family 12 seedling	320
575	Family122 seedling	320
468	Weipa R/c	320
572	Family 12 seedling	320
580	Street tree seedling	310
580	Street tree seedling	310
580	Street tree seedling	310
278	Family158 R/c	310
266	Family158 R/c	310
575	Family122 seedling	310
417	Wild near tree 16 GP R/c	310
287	Family 158 R/c	310
580	Street tree seedling	310
571	Family 10 seedling	305
288	Family 158 R/c	305
94	Family 12 R/c	300
572	Family 12 seedling	300
580	Street tree seedling	300
580	Street tree seedling	300
577	Family 158 seedling	300
294	Family 158 R/c	300
246	Family 151 R/c	300
580	Street tree seedling	300
424	Wild near tree 121H/s R/c	300
295	Family 158 R/c	300
580	Street tree seedling	300
580	Street tree seedling	300
580	Street tree seedling	300
580	Street tree seedling	300

Table 4. Clone test 1 (b) indicating 12 months growth.

Number	Origin	Ht (cm) 8/2/06
580	Street tree seedling	310
580	Street tree seedling	300
449	Weipa R/c	300
580	Street tree seedling	300
266	Family 158 R/c	295
99	Family 12 R/c	290
290	Family 158 R/c	290
572	Family 12 seedling	285
575	Family 122 seedling	285
580	Street tree seedling	285
337	Family 169 R/c	285
580	Street tree seedling	280
580	Street tree seedling	275
580	Street tree seedling	270
580	Street tree seedling	270
288	Family 158 R/c	270
572	Family 12 seedling	270
580	Street tree seedling	270
580	Street tree seedling	270
580	Street tree seedling	270
580	Street tree seedling	270
300	Family 166 R/c	270
580	Street tree seedling	270
580	Street tree seedling	270
415	Wild near tree 16 GP R/c	265
294	Family 158 R/c	265
572	Family 12 seedling	265

Program: Weeds Management

Project: Broadleaf Weed Control in Perennial Grass Pastures

Project Officers: N. Hartley and R. Eastick

Location: Kumbyechants / Douglas Daly

Objectives:

To determine the optimum herbicide or herbicide combination for effective broadleaf control in newly sown and established perennial grass pastures.
To provide a basis for herbicide recommendations to farmers.

Background:

Broadleaf weed invasion is a major production constraint in perennial grass pastures. A range of broadleaf herbicides were assessed in previous studies, where best overall results were obtained with diuron and 2,4-D mix, especially as these also effectively controlled annual grass weeds such as *Pennisetum pedicellatum*. The mix of Brushoff and 2,4-D also produced good results and was probably the most cost-effective treatment. Ideally, these herbicides should be applied early in the growing season, when weeds are small and lower rates are effective.

However, there was uncertainty whether these herbicides would cause damage to newly sown pasture, especially when applied in the first month after pasture germination. The Brush-off label states that severe damage may occur to newly-sown pastures. Diuron has grass activity at certain rates on certain species and some grass and cereal species have listed tolerance levels for 2,4-D amicide.

In the 2004-05 season, results for the first-year sown pasture species indicated that 2,4-D and atrazine provided the greatest weed control and least damage to the newly-sown pasture species, minimal damage from the Brush-off + 2,4-D treatment, and moderate damage from the diuron + 2,4-D treatment, although it was difficult to quantify due to the presence of weed competition. However, the control plots, where no herbicide was applied, indicated that not applying herbicide would cause a greater reduction in yield through weed competition than herbicide damage in high weed densities.

This was the second year of the experiment, so herbicide treatments were evaluated on established pastures this season.

Method:

Experimental design Randomised split-split plot

Site Kumbyechance, Douglas Daly - the paddock opposite the front gate

Fenced area was 80 m x 100 m. Site area was 67 m by 88 m. Plot size was 8 m x 7 m.

Treatments

Main plot: Pasture species

- Jarra
- Sabi
- Strickland

Sub-plot: Herbicide (details in the table below)

- Pasture only – hand-weeded
- Grass + weeds - unsprayed
- 2,4-D amicide only
- 2,4-D amicide + metsulfuron
- 2,4-D amicide + diuron
- 2,4-D amicide + atrazine

Sub-sub-plot: Time of application

- Early (E)
- Late (L)

Trade name	Active ingredient	Rate (product/ha)
Diuron(flow able) and Amicide 625	Diuron (500 g/L) & 2, 4-D amicide (625 g/L)	**E:** 1.5 & 0.8 L **L:** 3 & 1.6 L
Brush-off® & Amicide 625	Metsulfuron (600 g/kg) & 2,4-D amicide (625 g/L)	**E:** 7.5 g & 0.8 L **L:** 15 g & 1.6 L
Amicide 625	2,4-D amicide (625 g/L)	**E:** 0.8 L **L:** 1.6 L
Nu-trazine flow able and amicide 625	Atrazine (500 g/L) & 2,4-D amicide (625 g/L)	**E:** 1.5 L & 0.8 L **L:** 3 L & 1.6 L

Measurements and sampling

The early herbicide treatment was applied on 18 November 2005; pasture height was about 30 – 40 cm with a lot of young grass and broadleaf weeds just under the grass canopy, mainly Sickle pod (*Senna obtusifolia*), spiny-headed Sida (*Sida acuta*) and Hyptis (*Hyptis suaveolens*).

The late herbicide application was applied on 15 December 2005. Pasture was 1-1.2 m in height and seeding. Weeds were up to 1 m tall, with coverage restricted by the dense stand of surrounding grass. BS1000 was applied at application as a wetter for each herbicide treatment.

Hand weeding was required in all control plots continually over the long wet season with prolific grass pasture and weed growth. The area was fertilised with 200 kg/ha of N-12.P-5.K-14 on 25 November 2005.

Biomass cuts (1 m x ½ m quadrat) and damage ratings (0-10 for no damage to total kill) were taken at three times:

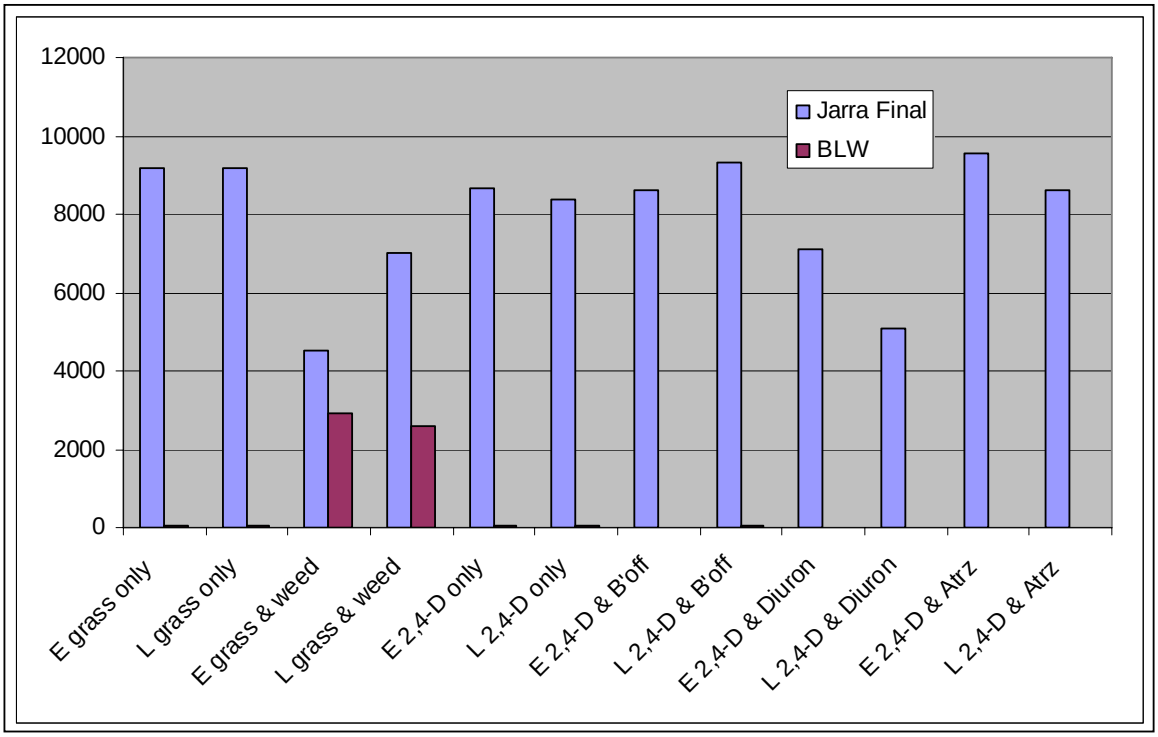
- Four weeks after early herbicide application (12 December 2005).
- Four weeks after late herbicide application (11 January 2006)
- Final biomass (10 May 2006)

At each harvest time, biomass samples were sorted into broadleaf weeds and pasture species. Visual estimation of annual grass weed present was also assessed.

Results:

All the data analyses are yet to be finalised, but at final harvest, yields were very impressive in the herbicide treatments. Jarra grass was the highest yielding, then Strickland, followed by sabi grass. All herbicide treatments significantly reduced broadleaf weed biomass compared with the untreated control. Diuron caused unacceptable damage to Jarra, particularly when applied late, reducing the time for compensatory growth, and also caused pasture yield loss in sabi and Strickland, although this was less than the yield reduction caused by weed competition in the unsprayed plots. Early application, at lower rates, produced similar weed control and pasture yield to the later application, demonstrating that earlier application is more cost effective. Maintaining a competitive pasture sward by strategic grazing management aided in reducing subsequent weed emergence.

Future work will assess manipulating rates for early application to further minimize herbicide cost.



E: early application treatment. **L:** late application treatment. **BLW:** broadleaf weed biomass

Figure 1. Jarra yield (kg/ha) at final harvest at Kumbyechance, 10 May 2006

Project: Sucker Control in Newly-sown Jarra Grass Pasture

Project Officers: N. Hartley, P. Hausler and R. Eastick

Location: Tipperary Station, Douglas Daly

Objective:

To determine if there is a cost-effective chemical option for control of sucker regrowth (Eucalyptus and other tree species) prior to the establishment of improved pasture.

Background:

Control of woody regrowth is a problem after land clearing from species such as *Erythrophloem* (ironwood), *Eucalyptus miniata* (woolly butt), *E. tetrodonta* (stringy bark) and Acacia species. There is current interest in sowing improved pastures on previously cleared areas, where control methods such as cut-stump and basal bark spraying are labour-intensive and mechanical methods may be time-consuming, costly or impractical. Therefore, there is demand for an effective over-the-top herbicide application.

Tipperary Station intended to sow areas of Jarra pasture on previously cleared areas now infested with sucker regrowth ranging from 0.5 to 2.5 m in height. Although the area had been chained, burnt and pin-wheeled, new suckers were appearing. Cultivation was not an option. As metsulfuron is effective against a range of woody weeds, it was suggested that high rates may be effective in controlling suckers. There was concern that this may cause damage to newly-planted Jarra seedlings. The influence of water carrier volume used and the addition of wetting agents was also uncertain. This experiment evaluated the efficacy of a number of chemical treatments on sucker control, and potential for Jarra phyto-toxicity.

Method:

Site

An area was selected in consultation with Tipperary Station.

Experimental design

Herbicide treatments were applied in non-replicated demonstration strips in areas up to 25 ha per treatment.

Table 1. Treatments

Chemical applied	Rate (product/ha)	Water volume (L/ha)	Wetter
Roundup Max 520®	4 L	100	None
Roundup Max 520®	4 L	100	Pulse
Roundup Max 520® and Muron®	2.6 L and 300 g	100	Pulse
Roundup Max 520® and Muron®	2.6 L and 300 g	50	Pulse
Muron®	300 g	100	Pulse
Muron®	150 g	100	Pulse
Muron®	75 g	100	Pulse
Muron®	300 g	50	Pulse
Muron®	300 g	200	Pulse
Grazon®	2L	100	Pulse
Control (no herbicide)			

Muron®: Active ingredient metsulfuron-methyl at 600 g/kg

Herbicide application commenced on 23 February 2006 and continued for three days. Herbicide purchase and application was done by Tipperary using a 500 L ground rig with a 30 m boom spray.

Measurements

A description and visual assessments of all suckers and weeds was made prior to herbicide application. Four 50 m transects were randomly selected within each treatment. Twenty plants along each transect were individually tagged and numbered. Plant species, height, trunk width and general comments were recorded. Total number of suckers within a 10 m by 10 m area adjoining each transect was counted.

Damage was assessed as percent leaf drop and percent brown-out of any remaining leaves for each tagged plant. The first measurements were done on 29 March, about one month after herbicide application. The second measurements were done on the 11 July, corresponding to a mid-dry season assessment. It is intended the next measurements will be in early 2006-07 wet season to assess regeneration with the onset of rainfall.

Soil samples were taken to coincide with timing of plant measurements and were submitted for laboratory analysis of metsulfuron residues. We intended to take more soil samples at six and nine months. However, as results from the first two tests showed no herbicide residues, no further soil samples will be taken.

Progress report

The first observations looked promising especially in the Roundup treatments. All sucker foliage and grass matter had been browned of with some leaf drop in suckers. In all plots there was a certain amount of sucker re-shooting and variation in damage to the same species. By the time of the second ratings, there was more than 90% leaf drop for all treatments, but there was substantial re-shooting, primarily from the plant base. No treatment caused significant leaf drop for ironwood suckers. Grazon showed the most promising results, with the least amount of re-shooting, but further assessment at the commencement of the wet season is required. Results generally demonstrated that over-the-top herbicide application, even at very high rates, will provide poor sucker control. Therefore, other options need to be considered.

PUBLICATIONS, CONFERENCE PAPERS AND PRESENTATIONS

Scientific Journal/Proceeding Publications

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