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October 2007
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INTRODUCTION

Primary Industries in the Department of Primary Industry, Fisheries and Mines (DPIFM) in the Northern Territory (NT) of Australia conducts research, development and extension (RD&E) projects primarily in four major areas: Crops, Forestry and Horticulture; Pastoral Production; Biosecurity and Product Integrity; and Diagnostic Services. This work is conducted at the Department’s headquarters at Berrimah Farm in Darwin and at its regional facilities in Alice Springs, Katherine and Tennant Creek, at the Department’s R&D Farms and on private properties in collaboration with owners. RD&E projects and other related work are conducted in consideration of the needs of the plant and animal industries. This Technical Annual Report (TAR) provides a summary of the work conducted during the 2006-07 financial year, together with results where possible, and general recommendations.

The Crops Forestry and Horticulture Division supports plant industries across the NT through research, extension and capacity building projects. The division provides an up to date and easily accessible information service and works closely with other government departments and industry associations to deliver technical, scientific and development services.

The estimated gross value for plant industries in the NT in 2006 was $164.0m, which represents an increase of 32% over 2005.

Mango production continues to dominate plant industries. In 2006, 18 115 tonnes of mangoes were produced, valued at $53.4m, which reflects an increase of 74% over 2005. There are about 750 000 mango trees in the NT 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. This has resulted in many small farmers leaving the industry. There has been an increase in the planting of new commercial varieties, such as Calypso and green mango types such as Keow Savoy, Falan and Nam Dok Mai.

Compared to 2005, melon production in the Katherine, Douglas Daly and Darwin areas in 2006 increased by 191%, to reach 21 907 tonnes, valued at $25.0m. As such, melons have become a major horticultural crop in the NT.

Table grapes are the main horticultural crop in Central Australia where 2000 tonnes were produced in 2006 on 280 ha, valued at $9.0m. This represented a 55% increase in production over the previous year. Root-knot nematodes have been identified as the major cause of a recent decline in production. However, as growers replace vines on vinifera rootstocks with grafted vines on nematode-tolerant rootstocks, production is expected to increase. Vines were replaced on about 40 ha in 2007. The process will continue over the next two years.

Banana production increased by 212% in 2006, reaching 2083 tonnes valued at $10.9m. Prices were exceptionally high due to cyclone damage to the Queensland banana crop in March 2006. Research to identify resistant varieties is continuing and appropriate management procedures to reduce the spread of Panama disease are being developed.

Citrus production was 350 tonnes in 2006, due to average flowering in lemons and red-fleshed grapefruit. The low production, coupled with competition from Queensland limes, resulted in an income of only $0.7m from citrus.

Rambutan production was very poor due to fruit drop in the early and main season, which reduced yield to 31 tonnes, valued at $0.2m.
Vegetable production reached 6485 tonnes in 2006, valued at $26.9m. More than 50 farms now supply Asian and traditional vegetables to southern and local markets. There has been a significant increase in shade-house cucumber production.

The value of the nursery industry in 2006 was $14m. The value of the cut-flower industry was $3m and consisted mainly of heliconias, gingers and orchids.

The production of pasture, field crops and fodder increased by 19% over the previous year to reach 117 060 tonnes, valued at $18.9m. This consisted of 115 360 tonnes of hay and silage valued at $17.6m, 1594 tonnes of field crops valued at $0.8m and 106 tonnes of pasture seed valued at $0.5m.

Farm forestry is becoming a potential alternative for land development and rural business diversification in the NT. A strategy for producing African mahogany hardwood timber in the Top End was developed and launched in 2004. Further research aims 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 Biosecurity and Product Integrity Division supports both plant and animal industries by preventing the introduction of exotic pests and diseases into the NT and by eradicating, or effectively managing, those that are already present, in order to reduce the risk of diseases and chemical residues to industry, the environment and human health. Such a role also ensures the continued access of 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.

Highlights for the Division for the year included completion of the Bovine Tuberculosis Freedom Assurance Program (TFAP 2) in the NT as in the rest of Australia, the culmination of the Brucellosis and Tuberculosis Eradication Campaign (BTEC) program from 1970 to 1997 and TFAP from 1998 to 2006, and the successful completion of the national grapevine leaf rust eradication program in Darwin and Palmerston with the declaration of area freedom for the NT. The Grapevine Leaf Rust Eradication Program was conducted over four years at a cost of $2.1m.

The Diagnostic Services Division provides services to both plant and animal industries through Berrimah Veterinary Laboratories, Entomology, Agricultural Chemistry, Plant Pathology 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 arboviruses, termites, integrated pest management, *Fusarium* wilt in bananas and snake beans, and grapevine leaf rust. It provides a quality-assured laboratory service to support the horticulture, pastoral and aquaculture industries in the NT and assists in the implementation of Government policies on biosecurity, market access and product integrity.

The Pastoral Production Division supports animal industries through the sustainable development of the pastoral industry in the NT. In 2006, the industry turned off around 538 000 beef cattle, out of which over 223 000 went to the live export market. The rest were shipped interstate to feedlots or for slaughter. The industry is quite buoyant and has coped well with recent fluctuations in international exchange rates. The main issues facing the industry include profitability, reducing production costs, addressing increasing public accountability for the use of natural resources and animal welfare practices.

To assist in addressing these issues, the Pastoral Production Division is conducting focused research, development and extension programs to improve the efficiency of sustainable production on pastoral properties by improving breeding herd efficiency and grazing management, increasing the carrying capacity of current leases by encouraging infrastructure development and assisting indigenous land owners to increase pastoral production from their land.
Projects related to plant industries, irrespective of which departmental Division they come under, are listed under the heading ‘Plant Industries’ and are divided into two groups: ‘Scientific’ and ‘Technical’. Similarly, projects related to animal industries, irrespective of which departmental Division they come under, are listed under the heading ‘Animal Industries’ and are divided into two groups: ‘Scientific’ and ‘Technical’. Reports for DPIFM Research Farms appear under the group ‘Technical’ either in ‘Plant Industries’ or ‘Animal Industries’, depending on their main activity.

To assist readers to find projects of interest quickly in this TAR, three new indexes have been included at the end.
PLANT INDUSTRIES

SCIENTIFIC

Plant Industries Scientific projects conduct applied research in controlled trials to discover solutions to problems that affect the productivity and profitability of the industry and, where possible, to protect the environment and human health.

PROJECT: African Mahogany (Khaya senegalensis) Tree Improvement Program

Project Officers: D. Reilly and R. Connelly

Division: Plant Industries
Location: NT-wide
Keyword(s): African mahogany, Coastal Plains Horticulture Research Farm, forestry
Project Type: Scientific

Objectives:

To rapidly improve stem straightness and produce diverse, second-generation progeny.

To select by phenotype at least a few superior trees from each of the 24 provenances (from 11 countries of origin and one secondary) at Gunn Point and 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 and their progeny for second generation deployment.

To establish a series of clone tests for identification of deployment clones.

To establish a clonal seed orchard (CSO) with the apparent 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, relying on a general flowering in the established seed orchards.

To improve the expertise of DPIFM staff in genetics and tree breeding.

Background:

Provenance trials planted at Gunn Point and Melville Island in the early 1970s showed that a range of natural provenances grew well in the NT. These stands contain trees from 12 African countries where the species occur naturally, from Senegal in West Africa to Sudan and Uganda in the east. There are also trees derived from stands in New Caledonia.

Recognising the breadth of the base represented in the Top End of the NT (and nowhere else in Australia), the threats to the resource and its potential for initiating an improvement program, we selected superior trees in 2000, grafted them and planted them in December, 2001. These initial plantings were the beginning of a CSO and a CCB at Howard Springs and Berrimah Farm, respectively.
Method:

The composition of each of the newly established clone tests is shown in Table 1. The composition of previously established clone tests was described in previous reports. There are now eight established clone tests on both Government and private land, deploying 949 clones in replicated trials over a number of soil types and geographic regions. All clone tests (CT) are conducted in the same manner for propagation, cultivation, spacing and fertilising. This includes ripping planting lines, planting 1000 stems/ha and fertilising with 100g each of ‘Nitrophoska blue’ with trace and triple super as individual tree applications after planting.

Results:

The main achievements last year included:

- Continuing management of the Hedge Garden at Berrimah Farm for the production of cuttings for the establishment of clone tests with as many families as possible represented, with as many replicates as possible at each site.
- Continuing observations for flowering in the seed orchards at Berrimah and Howard Springs; seed collection where set.
- Introducing four seedling lines in a ‘provenance seedling’ trial (15 seed lots total) at Northern Tropical Timbers – Douglas Daly region.
- Measuring the clone tests established in 2004-05 at Coastal Plains Hoericulture Research Station (CPHRS).
- Identifying a number of pests negatively impacting on the retention of apical dominance in the trees.
- Establishing African mahogany clone tests with industry proponents on their land at Douglas Daly (Northern Tropical Timbers) and on Melville Island (Great Southern Plantations). These trials are replicated clone tests on two sites, using rooted cuttings from both hedge gardens (220 clones) and seedlings from Darwin street trees (controls). Genotype x environment interactions and provenance effects are observable.

Table 1. Summary of details of the composition of *Khaya senegalensis* clone tests established in the past 12 months

<table>
<thead>
<tr>
<th>Test material x test sites – showing numbers of clones or numbers of seedlings</th>
<th>CT 1g (Pickertaramoor, Melville Island, c. 50km north of Darwin) (3 ramets/ clone) Planted January 2007</th>
<th>CT 1h Northern Tropical Timbers Douglas Daly region 180 km southwest of Darwin (5 ramets/ clone) Planted March 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clones from open pollinated seedlings ex 11 of the 38 trees selected in 2003 in the NT plantings of the early 1970s at Gunn Pt and Howard Springs.</td>
<td>48 (includes many linking/common clones to CT 1a; and many links to CT 1b)</td>
<td>137 (includes many linking/common clones to CT 1a; and many links to CT 1b)</td>
</tr>
<tr>
<td>Clones from bulked seed ex Weipa, Qld selects</td>
<td>23</td>
<td>32</td>
</tr>
<tr>
<td>Clones ex NT wildlings</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>Other clones</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Clone total per rep</td>
<td>81</td>
<td>197</td>
</tr>
<tr>
<td>Seedlings – Ks 124 @ Howard Springs CSO</td>
<td>40 per rep</td>
<td>10 per rep</td>
</tr>
<tr>
<td>Seedlings ex Darwin street trees</td>
<td>39 per rep</td>
<td>33 per rep</td>
</tr>
<tr>
<td>Seedlings totals per rep</td>
<td>79</td>
<td>43</td>
</tr>
<tr>
<td>Grand total PLANTS per rep</td>
<td>160</td>
<td>240</td>
</tr>
</tbody>
</table>

Figures 1 and 2 summarise four aspects of data collected from 18 month old trees at CPHRS, including height, diameter at breast height (dbh), apical dominance and straightness. Within plots there is considerable
variability; however, early growth is noticeably better in seedlings or clones from NT select 12, 158, seedling 10 and the control – Darwin street trees. Straightness and apical dominance appear better in the slower growing taxa, although NT selects 70 and 12 have again ranked highly along with select 166 and seedlings from select 122.

**Figure 1.** Growth of African mahogany genetic material at CPHRS showing DBH at 18 months

**Figure 2.** Growth of African mahogany genetic material at CPHRS indicating the form characteristics of apical dominance and straightness of the stem
PROJECT: Banana Tropical Race 4 Panama Disease Management

Project Officers: G. Walduck and A. Daly

Division: Plant Industries
Location: Darwin
Keyword(s): banana, Panama disease, Coastal Plains Banana Quarantine Station
Project Type: Scientific

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 quarantine field management methods to reduce the spread of the disease and to extend the commercial life of existing plantations in the NT.

To commission and operate the Coastal Plains Banana Quarantine Station (CPBQS) incorporating the Coastal Plains Banana Quarantine Area (CPBQA) to conduct secure research on Fusarium oxysporum cubense - tropical race 4 (FOCTR4).

To locate and source banana varieties with likely or reputed resistance to FOCTR4 and screen them for resistance or tolerance to FOCTR4 within the CPBQA secure facility.

To test the commercial acceptability of any variety found resistant or tolerant to FOC TR4.

To develop and commercialise any resistant or tolerant variety found to be commercially acceptable.

To develop field management techniques to reduce the spread of the disease and extend the commercial life of existing plantations in the NT.

To develop field techniques to disinfest currently infested areas.

To assist other research organisations to conduct research on FOC TR4 which may benefit NT and Australian banana industries.

To assist with and facilitate appropriate legislation in the NT related to bananas.

Background:

Panama disease of bananas is caused by the fungus Fusarium oxysporum cf cubense. It is a soil-borne disease that attacks and kills banana plants. The FOC TR4 type attacks a wide range of banana types including the commercial Cavendish grown in Australia. In 1997, FOC TR4 was identified in the NT on a commercial property at Berry Springs. This was the first recording in Australia although it was widespread in Indonesia and Malaysia at the time. The property was quarantined and all banana plants on it were destroyed. Strict quarantine measures were put in place in the NT to attempt to stop the disease from spreading.

A project was developed to identify and test resistant varieties and develop suitable quarantine and management systems. It commenced in 2001 with support from the NT Government, local banana growers and the Australian Banana Growers Council, with matching funds from (Horticulture Australia) HAL.

Work has been centred at the purpose built CPBQA facility and was later extended to cooperating grower properties.
Method:

Variety testing for FOCTR4 resistance – Replicated trials at CPBQA.

Agronomic testing of resistant varieties – Replicated trials at CPBQS and CPBQA.

Replicated taste panel testing and unreplicated commercial assessment.

Field management - Replicated trials plus grower observations and demonstrations.

Extension – Presentations to both local growers as seminars and field walks, poster and media presentations, presentations at banana conferences in Australia and overseas.

Results:

The project field work is now complete.

Data collection is complete and final statistical analyses are underway.

A draft final report has been prepared.

A summary is presented below:

- Some 35 banana and plantain varieties from Australia and overseas were assessed for resistance to FOCTR4 at CPBQS. Testing commenced in 2001.
- Three commercial and potentially commercial varieties were found to be resistant to FoCtR4 during testing. They were the dessert varieties FHIA 01 [gold finger – sweet acid type released in Queensland] and FHIA 18 [released as lady finger type] and the cooking type FHIA25 which is unlikely to be commercially viable in Australia.
- Resistant Malaccensis types from Indonesia were tested and found to be resistant to FOCTR4. They are massive seeded types of no commercial value but may be useful in future breeding programs.
- As a result of this FOCTR4 resistance testing of a range of plants we have identified series of gene pool pairs of diploid, triploid and tetraploid bananas with resistance and susceptibility. This will be most useful in any future breeding or gene manipulation work on FOCTR4.
- FHIA 01 and FHIA18 fruit was taste-panel tested, confirming results from Queensland and NSW of acceptability by consumers.
- No Cavendish types were identified as resistant, although GCTV119 from Taiwan and CJ19 from Indonesia show better survival than other Cavendish types; however, still not enough to be commercially viable.
- Agronomic recommendations for growing FHIA01, FHIA18 and FHIA25 have been generally established for the NT. These include sources of planting material, plant spacing, fertiliser rates, crop cycles, indicative yields, harvesting and ripening guidelines.
- It was recognised early in the project that effective field management techniques were needed to protect new plantings and to prolong the life of commercial plantings of susceptible Cavendish varieties. A series of improved quarantine guidelines were implemented, legislation was upgraded and improved field management was developed. Early recognition and intervention techniques have proven effective in prolonging the life of commercial plantations. It is estimated that plantation life has been doubled in some cases.
- As part of the project, new more convenient identification and rating techniques were developed. These were put to good commercial use in the early intervention period to slow the spread of disease on commercial properties.
A combination of detailed studies of the development and spread of the disease at CPBQS and on infected commercial properties has yielded good quantitative data on disease development rates. Studies to estimate the temperature/time combinations to kill FOCTR4 have established that 65°C for 20 minutes in hot water is the minimum condition for killing hyphae, microspores and macrospores in banana plant tissue. Chlamydomonas require autoclaving to kill them.

A number of biological agents to suppress or inhibit infection of Cavendish plants by FOCTR4 were trialled in the field. None have proved effective. These included repeated regular treatment with a commercial preparation of Trichoderma in a large-scale field trial and a range of endophytes and organisms that had shown some activity against FOCTR4 in plate cultures in the laboratory.

As part of this project CPBQS was constructed by the NT Government in 2000-01. This is a world class secure field quarantine facility with its own quarantine and operating protocols.

This project was a first for the horticultural industry in the NT as it was jointly funded by growers, the NTG, the Australian Banana Growers Council, and the Banana Industry Protection Board of Queensland, with matching funds from HAL. NT banana growers were part of the project management committee and cooperated in the trial.
**Table 1. Summary of Characters of Varieties being tested against FOCTR4 at CPBQA**

<table>
<thead>
<tr>
<th>Varieties being tested</th>
<th>Type</th>
<th>Agronomic characters</th>
<th>FOCTR4 Susceptible</th>
<th>Plant cycle</th>
<th>Ratoon cycle</th>
<th>Yield</th>
<th>Production attributes</th>
<th>Market acceptance</th>
<th>Leaf spot resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaccensis [FOC resistant]</td>
<td>AA</td>
<td></td>
<td></td>
<td>R</td>
<td>R</td>
<td>V Low</td>
<td>Poor</td>
<td>Seeded</td>
<td>Yes</td>
</tr>
<tr>
<td>Malaccensis [FOC resistant]</td>
<td>AA</td>
<td></td>
<td></td>
<td>R</td>
<td>R</td>
<td>V Low</td>
<td>Poor</td>
<td>Seeded</td>
<td>Yes</td>
</tr>
<tr>
<td>Malaccensis [FOC resistant]</td>
<td>AA</td>
<td></td>
<td></td>
<td>R</td>
<td>R</td>
<td>V Low</td>
<td>Poor</td>
<td>Seeded</td>
<td>Yes</td>
</tr>
<tr>
<td>FHIA-25 [Cooking type]</td>
<td>AA</td>
<td></td>
<td></td>
<td>R</td>
<td>R</td>
<td>High</td>
<td>V Good</td>
<td>Poor</td>
<td>Yes</td>
</tr>
<tr>
<td>FHIA-01 [Gold finger]</td>
<td>AA</td>
<td></td>
<td></td>
<td>SS</td>
<td>SS</td>
<td>High</td>
<td>V Good</td>
<td>Variable</td>
<td>Yes</td>
</tr>
<tr>
<td>FHIA-18</td>
<td>AA</td>
<td></td>
<td></td>
<td>SS</td>
<td>R</td>
<td>Medium</td>
<td>Poor</td>
<td>Good</td>
<td>Yes</td>
</tr>
<tr>
<td>Pissang jari buya</td>
<td>AA</td>
<td></td>
<td></td>
<td>SS</td>
<td>SS</td>
<td>Medium</td>
<td>Good</td>
<td>Smell</td>
<td>Some</td>
</tr>
<tr>
<td>Cavendish [GCTV-119] ex Taiwan</td>
<td>AA</td>
<td></td>
<td></td>
<td>SS</td>
<td>SS</td>
<td>Low</td>
<td>Poor</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>Cavendish [Williams]</td>
<td>AAA</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>High</td>
<td>Good</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>Cavendish [Grande nain]</td>
<td>AAA</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>High</td>
<td>Good</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>Cavendish [GCTV-Formosana]</td>
<td>AAA</td>
<td></td>
<td></td>
<td>S</td>
<td>S</td>
<td>High</td>
<td>Good</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>DPMZ5 [Cav. Parfitt ex QDPI]</td>
<td>AAA</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>High</td>
<td>Good</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>Novaria D [ex Malaysia]</td>
<td>AAA</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>High</td>
<td>Good</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>Novaria G [ex Malaysia]</td>
<td>AAA</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>High</td>
<td>Good</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>MutiarE [Ex Malaysia]</td>
<td>AAA</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>Low</td>
<td>Good</td>
<td>Good</td>
<td>Some</td>
</tr>
<tr>
<td>Pissang berungan [Lakatan]</td>
<td>AAA</td>
<td></td>
<td></td>
<td>EX</td>
<td>EX</td>
<td>High</td>
<td>Good</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>FHIA-17</td>
<td>AAA</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>Variable</td>
<td>Good</td>
<td>Good</td>
<td>Yes</td>
</tr>
<tr>
<td>FHIA-23</td>
<td>AAA</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>High</td>
<td>Poor</td>
<td>Average</td>
<td>Yes</td>
</tr>
<tr>
<td>SH-3640 [High Noon]</td>
<td>AAA</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>High</td>
<td>Good</td>
<td>Good</td>
<td>Some</td>
</tr>
<tr>
<td>Malaccensis [FOC susceptible]</td>
<td>AA</td>
<td></td>
<td></td>
<td>S</td>
<td>S</td>
<td>V Low</td>
<td>Good</td>
<td>Seeded</td>
<td>Yes</td>
</tr>
<tr>
<td>Malaccensis [FOC susceptible]</td>
<td>AA</td>
<td></td>
<td></td>
<td>S</td>
<td>S</td>
<td>V Low</td>
<td>Good</td>
<td>Seeded</td>
<td>Yes</td>
</tr>
<tr>
<td>Malaccensis [FOC susceptible]</td>
<td>AA</td>
<td></td>
<td></td>
<td>S</td>
<td>S</td>
<td>V Low</td>
<td>Good</td>
<td>Seeded</td>
<td>Yes</td>
</tr>
<tr>
<td>Pissang embung</td>
<td>AA</td>
<td></td>
<td></td>
<td>S</td>
<td>S</td>
<td>Low</td>
<td>Good</td>
<td>Seeded</td>
<td>Yes</td>
</tr>
<tr>
<td>Ducasse</td>
<td>AAB</td>
<td></td>
<td></td>
<td>S</td>
<td>S</td>
<td>Medium</td>
<td>Good</td>
<td>Good</td>
<td>Some</td>
</tr>
<tr>
<td>Improved lady’s finger</td>
<td>AAB</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>Low</td>
<td>Good</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>Pacific plantain</td>
<td>AAB</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>High</td>
<td>Good</td>
<td>Cooking</td>
<td>No</td>
</tr>
<tr>
<td>Pissang celan [Mysore]</td>
<td>AAB</td>
<td></td>
<td></td>
<td>S</td>
<td>S</td>
<td>Low</td>
<td>Good</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>D5 [ex. South Africa]</td>
<td>AAA</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Some</td>
</tr>
<tr>
<td>PKZ [ex. South Africa]</td>
<td>AAAB?</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Yes</td>
</tr>
<tr>
<td>RSS3 [ex. South Africa]</td>
<td>AAAB?</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Some</td>
</tr>
<tr>
<td>Blue Java</td>
<td>ABB</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>High</td>
<td>Good</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>Dwarf red dacca</td>
<td>AAA</td>
<td></td>
<td></td>
<td>VS</td>
<td>VS</td>
<td>Medium</td>
<td>Good</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>Dwarf French plantain</td>
<td>ABB</td>
<td></td>
<td></td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

**EX** - Extremely susceptible [most die before bunch emergence]  
**VS** - Very Susceptible [most develop symptoms before bunch emergence, some die before harvest]  
**S** - Susceptible [few symptoms before bunch emergence, most show symptoms by bunch harvest]  
**SS** - Slowly susceptible [no symptoms at bunch emergence, some plants show symptoms at harvest]  
**R** - Resistant [no or very rare symptoms recorded]  
**High-Medium** - Commercially acceptable  
**Good-V good** - Commercially acceptable  
**Seeded** - Commercially unacceptable
## Summary of Characters of Varieties being tested against FOCTR4 at CPBQA

<table>
<thead>
<tr>
<th>Varieties being tested</th>
<th>Type</th>
<th>FOCTR4 susceptible</th>
<th>Agronomic characters</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Plant cycle</td>
<td>Ratoon cycles</td>
<td>Yield</td>
</tr>
<tr>
<td>Malaccensis [FOC susceptible]</td>
<td>AA</td>
<td>S</td>
<td>S</td>
<td>V Low</td>
</tr>
<tr>
<td>Malaccensis [FOC susceptible]</td>
<td>AA</td>
<td>S</td>
<td>S</td>
<td>V Low</td>
</tr>
<tr>
<td>Malaccensis [FOC susceptible]</td>
<td>AA</td>
<td>S</td>
<td>S</td>
<td>V Low</td>
</tr>
<tr>
<td>Pissang embung</td>
<td>AA</td>
<td>S</td>
<td>S</td>
<td>Low</td>
</tr>
<tr>
<td>Ducasse</td>
<td>AAB</td>
<td>S</td>
<td>S</td>
<td>Medium</td>
</tr>
<tr>
<td>Improved lady’s finger</td>
<td>AAB</td>
<td>VS</td>
<td>VS</td>
<td>Low</td>
</tr>
<tr>
<td>Pacific plantain</td>
<td>AAB</td>
<td>VS</td>
<td>VS</td>
<td>High</td>
</tr>
<tr>
<td>Pissang celan [Mysore]</td>
<td>AAB</td>
<td>S</td>
<td>S</td>
<td>Low</td>
</tr>
<tr>
<td>D5 [ex. South Africa]</td>
<td>AAA</td>
<td>VS</td>
<td>VS</td>
<td>n/a</td>
</tr>
<tr>
<td>PKZ [ex. South Africa]</td>
<td>AAAB?</td>
<td>VS</td>
<td>VS</td>
<td>n/a</td>
</tr>
<tr>
<td>RSS3 [ex. South Africa]</td>
<td>AAAB?</td>
<td>VS</td>
<td>VS</td>
<td>n/a</td>
</tr>
<tr>
<td>Blue Java</td>
<td>ABB</td>
<td>VS</td>
<td>VS</td>
<td>High</td>
</tr>
<tr>
<td>Dwarf red Dacca</td>
<td>AAA</td>
<td>VS</td>
<td>VS</td>
<td>Medium</td>
</tr>
<tr>
<td>Dwarf French plantain</td>
<td>ABB</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

**EX** - Extremely susceptible [most die before bunch emergence]

**VS** - Very susceptible [most develop symptoms before bunch emergence, some die before harvest]

**S** - Susceptible [few symptoms before bunch emergence (most show symptoms by bunch harvest)]

**SS** - Slowly susceptible [no symptoms at bunch emergence, some plants show symptoms at harvest]

**R** - Resistant [no or very rare symptoms recorded]

**High-Medium** - Commercially acceptable

**Good-V good** - Commercially acceptable

**Seeded** - Commercially unacceptable
OBJECTIVES:

To identify banana varieties that are resistant/tolerant to Tropical Race 4 Fusarium wilt.

To conduct other studies for the improvement of on-farm disease management to minimise plant losses.

BACKGROUND:

The Tropical Race 4 strain of banana Fusarium wilt, caused by *Fusarium oxysporum cf cubense* (FOC TR4), a fungal disease for which there is no effective chemical control has been detected in several localities in Darwin’s rural area since 1997. The incursion highlighted the need to seek resistant varieties to the pathogen and assess ways in which the disease can be better managed. A site at the Coastal Plains Research Farm named the Coastal Plains Banana Quarantine Station (CPBQS) was opened in 2001 for conducting secure research and artificially infecting plants with the soil-borne disease. The susceptibility of a number of different varieties has been assessed. The varieties were planted in five stages (batches) in each year between 2001 and 2004 and in early 2006. Management options for the disease have been investigated at commercially producing properties and at CPBQS.

METHOD:

Plants under field assessment for resistance were surveyed and rated for external disease symptoms on a fortnightly basis for a period of two crop cycles. The rating system was initially based on five stages but later reduced to three:

1. No symptoms
2. First symptoms
3. Severe symptoms

Plants with external symptoms of disease at stage 3 or higher were examined internally for vascular discoloration i.e., internal symptoms of maroon/red/brown threads or streaks running up the pseudo-stem tissue. This was rated as:

0 - Absent
1 - Present

Samples were taken for laboratory confirmation (generally from an area low down in the pseudo-stem showing typical symptoms).
Sampling occurred from at least one symptomatic plant in each replicate of each genotype. Often, however, more than one sample was collected, particularly to confirm infection where symptoms were deemed atypical (some genotypes displayed atypical yellowing of leaves or discoloration of vascular strands).

Confirmation of infection with FOC TR4 was made by vegetative compatibility analysis as described by Correll et al. (1987) or by Polymerase Chain Reaction analysis as described by Bentley et al. (2001) in at least one sample from each variety throughout the trial.

As well as field assessments, pot trials were conducted in a shade house constructed within the facility. The first trial consisted of two inoculated treatments: naturally infested soil/potting mix (1:1) and artificially infested soil/potting mix (1:1); and one control treatment of un-infested soil/potting mix (1:1). Each treatment consisted of 20 tissue cultured (TC) Cavendish plants 15-20 cm in height at commencement of the trial. Each pot in the artificially infested treatment was supplied with 5 g of sorghum grain inoculum (the same as that used to inoculate the field site and estimated to contain $5.4 \times 10^5$ spores/g of grain). Plants were monitored on a monthly basis for six months. Plants which died were dissected on site to examine for discoloration in the rhizome. A second trial consisted of two inoculated treatments: one consisting of TC Cavendish plants and the other TC FHIA 25 plants. (FHIA is a variety). The control consisted of un-inoculated TC Cavendish. Each treatment group consisted of 10 plants. They were grown in 1:1 soil/potting mix and were 15-20 cm in height at the beginning of the trial. Inoculation was by direct injection into the rhizome of 1 mL of a Foc TR4 spore suspension (containing approximately $4.2 \times 10^6$ spores/mL) in two places. The control plants were injured in the same manner with a syringe. Plants were monitored on a monthly basis for six months. Plants which died were dissected after removing from pots on site to examine for discoloration in the rhizome.
Results:

Variety susceptibility assessments

Table 1. Details of banana varieties assessed for resistance to the tropical race 4 strain of Fusarium wilt and their susceptibility to the disease in Darwin

<table>
<thead>
<tr>
<th>Variety</th>
<th>Batch</th>
<th>Genome</th>
<th>Susceptibility (plant crop)</th>
<th>Susceptibility (ratoon crops)</th>
<th>Market acceptance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Williams (Cavendish)</td>
<td>1</td>
<td>AAA</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>GCTCV-119 (Cavendish, ex Taiwan)</td>
<td>1</td>
<td>AAA</td>
<td>+</td>
<td>+</td>
<td>Good</td>
</tr>
<tr>
<td>FHIA-01 (Gold finger)</td>
<td>1</td>
<td>AAAB</td>
<td>++</td>
<td>+</td>
<td>Variable</td>
</tr>
<tr>
<td>FHIA-17</td>
<td>1</td>
<td>AAAA</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>FHIA-18 (Bananza)</td>
<td>1</td>
<td>AAAB</td>
<td>++</td>
<td>+</td>
<td>Good</td>
</tr>
<tr>
<td>FHIA-25 (Cooking type)</td>
<td>1</td>
<td>AAA</td>
<td>+++</td>
<td>+++</td>
<td>Poor</td>
</tr>
<tr>
<td>SH-3640 (High noon)</td>
<td>1</td>
<td>AAAB</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>Musa acuminata sub. sp. malaccensis (845)</td>
<td>1</td>
<td>AA</td>
<td>++</td>
<td>++</td>
<td>Seeded</td>
</tr>
<tr>
<td>Musa acuminata sub. sp. malaccensis (846)</td>
<td>1</td>
<td>AA</td>
<td>++</td>
<td>++</td>
<td>Seeded</td>
</tr>
<tr>
<td>Musa acuminata sub. sp. malaccensis (850)</td>
<td>1</td>
<td>AA</td>
<td>R</td>
<td>R</td>
<td>Seeded</td>
</tr>
<tr>
<td>Musa acuminata sub. sp. malaccensis (851)</td>
<td>1</td>
<td>AA</td>
<td>R</td>
<td>R</td>
<td>Seeded</td>
</tr>
<tr>
<td>Musa acuminata sub. sp. malaccensis (852)</td>
<td>1</td>
<td>AA</td>
<td>R</td>
<td>R</td>
<td>Seeded</td>
</tr>
<tr>
<td>Pisang berungan</td>
<td>1</td>
<td>AA/AAA</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>FHIA 23 (hybrid)</td>
<td>2A</td>
<td>AAA</td>
<td>+++</td>
<td>+++</td>
<td>Average</td>
</tr>
<tr>
<td>Mutiarra E</td>
<td>2A</td>
<td>AAB</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>Novaria D (Cavendish)</td>
<td>2A</td>
<td>AAA</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>Novaria G (Cavendish)</td>
<td>2A</td>
<td>AAA</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>Pisang embun</td>
<td>2A</td>
<td>AA</td>
<td>++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>Pisang jari buaya</td>
<td>2A</td>
<td>AA</td>
<td>+</td>
<td>+++</td>
<td>Average</td>
</tr>
<tr>
<td>Ducasse</td>
<td>2B</td>
<td>ABB</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>Grand Nnin (Cavendish)</td>
<td>2B</td>
<td>AAA</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>Improved lady finger</td>
<td>2B</td>
<td>AAB</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>Pacific plantain (cooking type)</td>
<td>3</td>
<td>AAB</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>Pisang Celan</td>
<td>3</td>
<td>AAB</td>
<td>++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>GCTCV Formasana (Cavendish)</td>
<td>3</td>
<td>AAA</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>D5 (ex South Africa)</td>
<td>3</td>
<td>AAA</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>DPM25 (ex DPI&amp;F)</td>
<td>3</td>
<td>AAA</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>PKZ (ex South Africa)</td>
<td>3</td>
<td>AAAB</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>RSS3 (ex South Africa)</td>
<td>3</td>
<td>AAA</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>CJ19 (Cavendish, ex Indonesia)</td>
<td>4</td>
<td>AAA</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>Dwarf Parfitt</td>
<td>4</td>
<td>AAA</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>Blue Java</td>
<td>4</td>
<td>AAA</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>Dwarf red dacca</td>
<td>4</td>
<td>AAA</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
<tr>
<td>Williams (Cavendish)</td>
<td>4</td>
<td>AAA</td>
<td>+++</td>
<td>+++</td>
<td>Good</td>
</tr>
</tbody>
</table>

NB.  R = resistant and + = susceptible, based on internal disease symptoms and the number of plant deaths (more + symbols indicate higher susceptibility).

As shown in Table 1, there is a high degree of susceptibility in both the plant crop and the ratoon crop cycles for most varieties. The plants in Batch 4 are still under assessment for the first signs of disease.

Some of the plants showed resistance. However, FHIA-25, a hybrid variety developed in Honduras, is only suitable for use in cooking and the three *M. acuminata* sub. sp. *malaccensis* types are selections from a wild, seeded type that is completely unsuitable for consumption. The genes it possesses which confer resistance however, may be useful in conventional breeding programs or for genetically engineering edible bananas with resistance.
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), which is 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 QLD and NSW where it is resistant to the sub-tropical strain of FOC, the eating quality is variable when grown under tropical conditions. 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 by the market as a suitable replacement 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.

**Pot trials**

The first pot trial was conducted to establish if small, potted tissue cultured banana plants become diseased when growing in shade house conditions following inoculation with FOC TR4. Successful inoculation under these conditions would allow development of small plant bioassay to detect FOC TR4 in naturally-infested soil. No symptoms typical of FOC invasion were observed. There were random flecks of discolouration towards the base of almost every rhizome but no concentration of discolouration in a ring at the junction of the cortex and central cylinder, characteristic of FOC infection. The flecks seemed to be attributed to death of the oldest roots at the base and some basal rotting. There was also some weevil borer damage which resulted in discolouration. Five plants from each treatment were randomly sampled at the rhizome for laboratory isolations. Although none of the plants showed typical disease symptoms, FOC was isolated from the base of one of the plants from the naturally-infested soil treatment.

The second pot trial was conducted to establish if resistant varieties can become diseased following direct injection of FOC TR4 spores into the rhizome. This could give an indication of the resistance mechanisms in such plants, specifically whether the location of the plant’s defence response is at the root level or is also operational within the rhizome. At the completion of the trial, all plants were dissected on site and examined for discolouration in the rhizome. No symptoms typical of FOC invasion were observed. The same type of discolouration observed in the preceding trial (see above) was observed. Five plants of each treatment were randomly sampled at the rhizome for laboratory isolations. Again, FOC was isolated from one plant (inoculated Cavendish treatment). No Foc was recovered from any of the FHIA 25 plants.

As the internal symptoms were common to nearly all of the plants assessed, it is questionable whether the symptoms were clinical signs of disease in the two plants from which FOC was successfully recovered. It is possible that the fungus existed as latent infection in some of the plants and may have been a result of damage to the rhizome at the base where roots had died. The assessments highlighted the unreliability of a potted plant system for susceptibility studies and as a soil bioassay. Meldrum (2005), using different methods of inoculation, was similarly unsuccessful in artificially infecting potted banana plants.
PROJECT: Bio-fuel Crops for the NT

Project Officers: M. Bennett, M. Kahl and D. Owens

Division: Plant Industries
Location: Katherine
Keyword(s): bio-fuels, ethanol, Katherine Research Station
Project Type: Scientific

Objective:

To provide farmers with a short list of crops potentially suitable for producing bio-fuels (bio-diesel or ethanol) in the NT.

Background:

Australia’s largest bio-diesel facility has been built in Darwin by Natural Fuels Australia Limited. The designed capacity for the renewable fuel plant is 140 ML of bio-diesel per year. The company will import palm oil from Asia to service the plant. NT farmers have expressed interest in providing locally-produced vegetable oils to replace some of the imported palm oil.

Australian farmers, including many in the NT, are investigating ways to produce bio-fuels on-farm to meet their energy needs and reduce 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 that are agronomically suitable for the NT.
2. Collate crop production figures (grain biomass, oil or carbohydrate content).
3. Rank crops according to economic viability.

In May 2006, ten bio-fuel crops were planted at Katherine Research Station. They included soybean, African oil palm, coconut, 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 never established under dry season irrigated conditions on clay loam soils in Katherine.

It is planned to establish a perennial bio-fuel crops trial at Coastal Plains Research Station in 2008.

Results:

Annual crops and highest yields

<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>10.6 t/ha</td>
</tr>
<tr>
<td>Sunflower</td>
<td>5.1 t/ha</td>
</tr>
<tr>
<td>Safflower</td>
<td>2.5 t/ha</td>
</tr>
<tr>
<td>Sesame</td>
<td>0.1 t/ha</td>
</tr>
<tr>
<td>Soybeans</td>
<td>2.5 t/ha</td>
</tr>
<tr>
<td>Canola</td>
<td>3.5 t/ha</td>
</tr>
<tr>
<td>Mustard</td>
<td>1.5 t/ha</td>
</tr>
<tr>
<td>Cassava</td>
<td>55.8 t/ha</td>
</tr>
<tr>
<td>Linseed (2007)</td>
<td>to be harvested</td>
</tr>
</tbody>
</table>
Sunflower and cassava are being considered for further investigation in 2007-08.

**Perennial crops**

African oil palm and coconut trees will be ready for harvest in 2010. *Pongamia pinnata* (a leguminous tree) was sown in April 2007 and will be ready for harvest in 2011.

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**PROJECT: Biological Farming Systems for the Top End**

**Project Officers:** M. Bennett, D. Owens and M. Kahl

**Division:** Plant Industries  
**Location:** Katherine  
**Keyword(s):** biological farming  
**Project Type:** Scientific

**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 soils. Local horticultural and agricultural industries are eager to learn how to reduce soil degradation and enhance soil health. Research in biological farming systems in the NT has been increased to include soft/biological solutions to problems of insects, weeds and diseases.

**Method:**

In the second year of this project, two action plans will be conducted:

- 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. Test strips in each crop area will be tested for the effect of applied potassium chloride and potassium sulphate on soil biology.
- Soil health data will be collected from five Katherine and three Darwin farms producing irrigated horticultural crops.

Experimental areas at Katherine Research Station will be sown in January 2008.

Soil health data from the eight commercial farms will be compared with the baseline data collected in 2007.

Five biological indices will be used as key indicators of soil health:

1. Total carbon (C) is a measure of recent and historic organic additions to the soil. Measuring total soil organic C provides information on overall soil fertility. The expected range in local soils is 0 – 2.5%.
2. Liable C represents the recent additions of organic matter to the soil and is sensitive to changes in cropping practices. Liable C provides the food source for microbial activity. Microbial activity is essential for nutrient cycling. The expected range in local soils is 0 - 20% of total C.

3. Microbial biomass C is a measure of the mass of living micro-organisms. The greater the microbial biomass the greater the capacity for microbial activity and nutrient cycling. The expected range in local soils is 0 - 500 mg/kg soil.

4. Microbial activity is determined by carbon dioxide (CO2) respiration and measures the amount of biological activity in the soil. Microbial activity depends on soil moisture, temperature and liable C. The expected range in local soils is 0 - 20 mg CO2/kg soil/day.

5. Soil nitrogen (N) supply is an index of the potential for microbial activity to mineralise soil organic matter to plant available N. The expected range in local soils is 0 - 50 mg N/kg soil.

**PROJECT:** Monitoring of Deep Drainage and Pesticides in Katherine Cotton Soils

**Project Officers:** C. Martin, R. Eastick, A. Dougall, M. Kahl and N. Hartley

**Division:** Plant Industries

**Location:** Katherine

**Keyword(s):** cotton, pesticides, deep drainage

**Project Type:** Scientific

**Objectives:**

*To determine if the irrigation schedule used resulted in deep drainage.*

*To determine if there are increases in insecticide or herbicide levels in soils where cotton had been grown at KRS.*

**Background:**

Cotton has a poor public image in the NT where there is little irrigated agriculture. In 2004, the Australian Cotton Cooperative Research Centre Management Committee resolved to improve cotton’s image by determining if it could be grown without polluting ground water and rivers. This was to be achieved by giving more attention to environmental monitoring of cotton crops, particularly deep drainage and pesticide levels in soils where cotton had been grown at Katherine Research Station (KRS).

**Method:**

*Pesticides*

Pesticides were analysed on three sites at KRS where cotton had been previously grown over one to six years. Soil cores were taken in 2002 to a depth of 2 m, divided into 20 cm sections and sent to Diagnostic Services, Berrimah Farm. The samples were solvent-extracted to dichloromethane, concentrated and analysed by gas chromatography using electron capture for Chlorpyrifos, Chlorpyrifos methyl, Fipronil, Endosulfan Sulphate, Bifenthrin and Pendimethalin.
Deep drainage

Deep drainage was measured under half of the 27.5 ha centre pivot irrigator at KRS from 2004 to 2006. The soil was sampled by taking six to 10 cores to a depth of 2.1 m along the radius of the centre pivot. The cores were divided into seven depth intervals of 30 cm. Chloride analyses were done on the saturation extract and 1:5 soil:water suspension by CSBP Soil and Plant Analysis Service, Bibra Lake, WA. The soil sampling periods were 30 April 2004, 12 October 2004, 3 March 2005, 10 November 2005 and 17 May 2006. The intervals between the sampling dates corresponded to the dry season cropping in 2004, the 2004-05 wet season, the 2005 cropping season and the 2005-06 wet season, respectively.

The actual values for deep drainage, which is downward movement of water below the root zone (195 cm for cotton at KRS) in mm/time unit, were calculated using the Chloride Mass Balance Model. In this model, the differences in chloride levels between the beginnings and ends of the cropping seasons were used in conjunction with rainfall, evaporation and soil water-holding capacity to calculate the volume of water that moved below the 195 cm soil level.

Irrigation schedule

The volume of irrigation water intended to replace that lost by evapo-transpiration was applied twice a week, which was equal to pan evaporation multiplied by a crop factor. The crop factors used at different stages of development are shown in Table 1.

<table>
<thead>
<tr>
<th>Growth stage</th>
<th>Date</th>
<th>Crop factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sowing</td>
<td>9/3/05</td>
<td>0.4</td>
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<tr>
<td>7 nodes</td>
<td>9/4/05</td>
<td>0.7</td>
</tr>
<tr>
<td>First flower</td>
<td>5/5/05</td>
<td>1.0</td>
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<tr>
<td>Peak flowering</td>
<td>13/5/05</td>
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<tr>
<td>Cut-out t</td>
<td>20/6/05</td>
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<tr>
<td>Maximum boll number</td>
<td>7/7/05</td>
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</table>

Results:

Objective 1: To determine if the irrigation schedule used resulted in deep drainage

Table 2 shows the deep drainage, irrigation, rainfall and evaporation for the seasons over which measurements were taken. During the wet seasons, the deep drainage was much higher in 2005-06 because the rainfall was much higher and well above average. Deep drainage was very low in 2004-05 because rainfall was well below average.

During the dry (cropping) seasons, deep drainage was negative in 2004 and positive in 2005 when more irrigation water was applied. In 2004 the appropriate crop factors were not used which led to an under-watering of the crop. The appropriate factors were used in 2005 (Table 2) which led to 38 mm of deep drainage. The 38 mm deep drainage was reasonable considering that 138 mm of rain fell soon after sowing when the soil profile was full and most of that would have deep-drained. Had it not been for that 138 mm, deep drainage would have been lower than the 38.7 mm shown in Table 2, suggesting that our irrigation schedule with appropriate crop factors, would lead to minimal deep drainage.
Table 2. Deep drainage out of the 1.95 m depth assuming steady state conditions and rainfall, irrigation and evaporation for the wet and dry seasons from 2004 to 2005-06

<table>
<thead>
<tr>
<th>Season</th>
<th>Deep drainage out of the 195 cm depth (mm/season)</th>
<th>Rainfall (mm)</th>
<th>Irrigation (mm)</th>
<th>Class A pan evaporation (mm)</th>
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</thead>
<tbody>
<tr>
<td>Dry season 2004</td>
<td>-9.1 ± 13.2</td>
<td>0</td>
<td>642</td>
<td>1038</td>
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<tr>
<td>Dry season 2005</td>
<td>37.8 ± 17.2</td>
<td>138</td>
<td>729</td>
<td>1161</td>
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<tr>
<td>Wet season 2004-05</td>
<td>5.5 ± 8.4</td>
<td>620</td>
<td>0</td>
<td>673</td>
</tr>
<tr>
<td>Wet season 2005-06</td>
<td>421 ± 17</td>
<td>1233</td>
<td>0</td>
<td>1035</td>
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</table>

(1) Cotton was grown during the dry season. (2) Means ± 95% Confidence Intervals.

Objective 2: To determine if there were increases in insecticide or herbicide levels in soils where cotton had been grown at KRS

Results of the soil pesticide analyses are presented in Table 3. Tape 1 and A1 had cotton from 1996 to 2002 whereas the centre pivot had had cotton for only one season, i.e. 2002. Despite these differences in time under cotton the pesticide levels were low, and very similar, indicating that there was no pesticide build up. The only pesticide detected was pendimethalin at very low levels. Pendimethalin was used to control weeds every year cotton was grown.
Table 3. Soil pesticide analyses

<table>
<thead>
<tr>
<th>Soil Depth cm</th>
<th>Chlorpyrifos (0.03) mg/kg</th>
<th>Chlorpyrifos methyl (0.03) mg/kg</th>
<th>Fipronil (0.02) mg/kg</th>
<th>Endosulfan sulphate (0.02) mg/kg</th>
<th>Bifenthrin (0.03) mg/kg</th>
<th>Pendimethalin (0.03) mg/kg</th>
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<tr>
<td><strong>Centre pivot Side 1</strong></td>
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1 Detection limits, mg/kg, in parentheses.
Outcomes

The main outcomes were:

- Confidence in the overhead irrigation schedule developed to grow cotton with efficient water use and minimum deep drainage.
- Confidence in the integrated pest management and agronomic systems developed that would not lead to an increase in soil pesticide levels.
- Overall, cotton could be grown with a small environmental footprint with respect to water and pesticides.

PROJECT: Grapevine Leaf Rust Disease Research

Project Officers: A. Daly, C. Hennessy and L. Tran-Nguyen

Division: Plant Industries
Location: Darwin
Keyword(s): grape disease, grapevine leaf rust
Project Type: Scientific

Objectives:

To identify the risk of re-introducing disease to northern Australia by air stream transmission of urediniospores.

To develop a real time Polymerase Chain Reaction (PCR) test to identify Phatopsora euvitis.

To develop the capacity to identify infection of plant tissue by P. euvitis.

Background:

Grapevines are primarily grown in Darwin for their leaves, which are used in Greek-style cooking. A disease affecting the household vines, known as grapevine leaf rust (GLR), caused by the fungal pathogen Phakopsora euvitis, was detected in 2001. The Primary Industries Ministerial Council (PIMC) approved an eradication program, conditional on industry support, research, including replacement of grapevines, communication and public relations. Since the detection of GLR, research has included many in vitro assessments including Vitis and native grape species for resistance, fungicidal control, temperature and leaf wetness influences on disease development and PCR identification of the pathogen. During 2006-07 effort concentrated on the production of the final report on work conducted in the previous three years and a submission for new research. Further funding was awarded to identify the risk of re-introducing the disease to northern Australia, to develop a real-time PCR test and to develop the capacity to identify the pathogen in symptom-less plant tissue by PCR.
Method:

1. Identify the risk of re-introducing the disease to northern Australia by air stream transmission of urediniospores:
   a. The Bureau of Meteorology in Darwin will model air stream movement at low, mid and high levels.
   b. Spore viability in air stream conditions will be investigated in Japan:
      i. *P. euvitis* spores will be exposed to sub-zero temperatures for different periods of time and then tested for viability by germination on agar.
      ii. *P. euvitis* spores will be exposed to UV radiation for different periods of time and then tested for viability by germination on agar.

2. Develop a real-time PCR test to identify *P. euvitis*:
   a. DNA from *Phakopsora* spp. spores will be extracted in Japan. This will be carried out using the current extraction protocol. The DNA will be used for:
      i. Reference standards in diagnostic PCR tests in Australia.
      ii. Developing a real-time PCR assay for *P. euvitis*.
   b. Sequences of DNA from *P. euvitis* will be used to develop a probe for use in real-time PCR. Probe specificity will be tested by running the real-time PCR assay with several different rust species as well as other grapevine pathogens.

3. Develop the capacity to identify infection of plant tissue with *P. euvitis*:
   a. Extraction of *P. euvitis* DNA from plant tissue will be trialled using a number of commercially available test kits. The diagnostic PCR assay currently available in Darwin will be used for detection.

Results:

Project activity so far has included a visit to Japan to work at the Ibaraki University with Professor Yoshitaka Ono. The disease is endemic in Japan, which makes it is suitable for conducting research with viable rust spores. Yoshitaka Ono is very experienced in GLR and has the facilities to conduct the desired research. However, due to a colder than average spring, there were very few obvious symptoms of GLR and no active sporulation. The rust was only just beginning to emerge from the dormant phase of its life cycle. Laboratory inoculation of the alternative host *Meliosma myriantha* had been conducted to provide diseased material but was also delayed. This severely hampered the research efforts. Several attempts were made to get immature Aeciospores to germinate without success (not unusual as spore germination only occurs in fully mature specimens). As a result, a work-plan was drawn up for the research and will be carried out by students at the facility when spores become available. The necessary equipment and instructions were left at the laboratory. There was only a small time frame in which the trip could be undertaken for several reasons including the season, the availability of Professor Ono (work takes him away from the laboratory for long periods of time) and the relocation of the department to a new building this June –July, making both the laboratory and equipment inaccessible. The short time frame available to complete certain components of the research project meant that a visit in the first half of the year was far more preferable. The lack of infection was both unfortunate and unforeseeable, but will not stop the project from achieving the intended outcomes.

Funding was provided by the Grape and Wine Research and Development Corporation.
**PROJECT:** Evaluation of Irrigated Maize on Blain Soils at Douglas Daly Research Farm

**Project Officers:** F. O’Gara, Douglas Daly Research Farm Staff and M. Hearnden

**Division:** Plant Industries

**Location:** Darwin

**Keyword(s):** maize, irrigation, Douglas Daly Research Farm

**Project Type:** Scientific

**Objective:**

To evaluate the performance, agronomic requirements and commercial viability of irrigated maize on sandy surfaced soils in the Daly Basin.

**Background:**

Maize is a highly productive sub-tropical crop with many uses, such as food for humans, feed for stock and raw material for industry. It is being increasingly used for ethanol production. Maize is an ideal rotation crop with peanuts and has the potential to be an integral part of an irrigated farming system in the NT. However, its performance as a wet season crop has been poor, especially on light soils where it has suffered from nutritional disorders and establishment failures due to high soil temperatures.

Current interest in irrigated peanut production made it necessary to find suitable rotation crops. Maize was seen as one of the best options. However, its commercial potential as an irrigated crop on light soils required an evaluation before recommending it to industry.

**Method:**

A four-year trial of commercial maize varieties was conducted at Douglas Daly Research Farm (DDRF) under centre pivot irrigation. Between eight and 11 varieties were grown in replicated plots each season from 1999 to 2002 and assessed for nutrient and water requirements, disease and insect pressure and grain yield.

**Results:**

The trial demonstrated that high irrigated maize yields can be achieved on sandy surfaced soils in the Daly Basin. Average seasonal yields of 9 to 11 t/ha were achieved with one variety reaching 12.7 t/ha. The evaluation also identified serious pest and disease problems, and effective control practices. The results have been recently published in a DPIFM Technical Bulletin *Irrigated Maize Production in the Top End of the Northern Territory.*
PROJECT: Mango Flower Insects and their Effect on Fruit Quality in the Northern Territory

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

Division: Plant Industries
Location: NT-wide
Keyword(s): thrips, dimpling bug, mango, integrated pest management, fruit quality
Project Type: Scientific

Objective:

To determine the main pests that attack mango flowers and fruit in the NT and their effect on yield.

Background:

Monitoring for mango pests and their natural enemies was carried out on five commercial mango (Kensington Pride) orchards in the Northern Territory (NT) as a part of an Integrated Pest Management and training program for growers. The main insects that were monitored due to grower concerns (or potential damage to flowers and fruit, were thrips and dimpling bug (Campylomma austrina) Malipatil. Two orchards were monitored in Katherine in 2004 and three orchards in Darwin in 2005. Monitoring in Katherine concentrated on sampling for thrips species and dimpling bugs, and their damage on developing fruit. The species of thrips that were collected from mango flower panicles from Katherine and Darwin included Thrips imaginis Bagnall, Thrips hawaiiensis Morgan, Thrips unispinus Moulton, Thrips coloratus Schmutz, Frankliniella schultzei Trybom, Scirtothrips dorsalis Hood and Haplothrips sp. Dimpling bug (Campylomma austrina) was recorded from Katherine and Darwin. The dominant groups of insects and spiders collected from mango flower panicles from three orchards in Darwin included (prior to fruit set): flower thrips (Thysanoptera) 93%, ants (Hymenoptera: Formicidae) 2%, spiders (Araneida) 2%, beetles (Coleoptera) 1%, dimpling bugs (Hemiptera: Miridae) 1% and others 1%; (after fruit set): flower thrips 66%, ants 10%, beetles 9%, caterpillars (Lepidoptera) 4%, dimpling bugs 4%, spiders 3%, wasps (Hymenoptera) 2%, flower bugs (Hemiptera: Anthocoridae) 1% and others 1%. Fresh feeding damage caused by dimpling bugs and thrips was observed on developing fruits 10-15 mm in diameter; however, this feeding damage fades as the fruit matures and was hardly noticeable on fruit post-harvest.

Mangoes are the most important horticultural crop in terms of value and production in the NT. The main production areas are the Darwin region in the Top End and the Katherine region 300 km south of Darwin. Mangoes are a dry season crop and flowering occurs from May onwards and fruit is harvested between October and December.

Method:

In the last few years there has been a growing concern about the effect of thrips and dimpling bugs in mango flower panicles. Field trials were conducted during the flowering period and fruit development from July to September, 2004 and 2005 and at post-harvest in October 2005. Monitoring was conducted during the dry season of 2004 on mango flower panicles in Katherine. Trials in Katherine sampled for thrips and dimpling bugs and assessed the level of damage to young developing fruit. The trials in 2005 were in Darwin and included sampling for thrips and dimpling bugs as well as collecting data on the distribution of other insect orders found in flower panicles.

The project focused on determining the effect flower pests have on fruit quality as well as observing the diversity of pollinators and natural enemies of the pests that visit or occupy the flower panicles.
Katherine - Two mango orchards were monitored in 2004, at Zimin Drive, about five km of Katherine and Victoria Drive, 15 km south of Katherine. The Zimin Drive orchard is small with 7000 eight-year-old trees. The Victoria Drive orchard is larger with 41000 20-year-old trees. The trees were large and had not been pruned, which made IPM difficult.

Darwin - Three mango orchards were monitored in 2005, within 60 km south of Darwin, including a property at Darwin River with 5000 trees, Lambells Lagoon with 4000 trees and Batchelor with 240 trees. The blocks at Darwin River and Lambells Lagoon are conventional orchards that incorporate the use of insecticides as part of IPM, whereas the property in Batchelor produces “organic” fruit without the use of insecticides.

Field sampling

Katherine - Sampling was carried out at 2-3 weekly intervals between 22 September and 20 October 2004. Ten trees were selected randomly from each orchard and five fruit of each tree were tagged and assessed for thrips or dimpling bug damage to the skin of the fruit. Ten to 20 samples were also taken by ‘tapping’ flower panicles into plastic bags and collecting all species that were on the flower panicle.

Darwin - The properties were monitored between July and October 2005. Two main samplings were carried out on the flower panicles, one prior to fruit set and the other just after fruit set. For each property, 20 trees were selected at random and monitored for pests and 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 for sorting in the laboratory.

Results:

The effect of thrips and dimpling bugs on developing fruit

Katherine - The species of thrips collected from mango flower panicles from Katherine included *Thrips imaginis*, *Thrips hawaiiensis*, *Thrips unispinus*, *Thrips coloratus*, *Frankliniella schultzei*, *Scirtothrips dorsalis* and *Haplothrips* sp. (Table 1). Higher numbers of thrips were recorded from Victoria Drive with a mean of 156.23 thrips per flower panicle prior to fruit set and 4.70 thrips after fruit set. For Zimin Drive there were a mean of 31.70 thrips per flower panicle prior to fruit set and 4.30 thrips after fruit set.

The damage caused by thrips and dimpling bugs was assessed and 50 flower panicles (five panicles from each tree) were tagged and monitored on ten trees. It was shown that the damage on the skin of the fruit caused by thrips and dimpling bugs becomes less obvious as the fruit increases in size during growth (Table 2).
### Table 1. Mean number of thrips per flower panicle collected from two mango orchards in Katherine

<table>
<thead>
<tr>
<th>Orchard</th>
<th>Thrips species</th>
<th>Mean no. of thrips per flower panicle (prior to fruit set)</th>
<th>Mean no. of thrips per flower panicle (after fruit set)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Victoria Drive</td>
<td><em>Thrips</em> spp.</td>
<td>17.33</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td><em>Frankliniella schultzei</em></td>
<td>9.67</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td><em>Scirtothrips dorsalis</em></td>
<td>0.67</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td><em>Haplothrips</em> spp.</td>
<td>3.67</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td><em>Phlaeothripridae nymphs</em></td>
<td>2.22</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td><em>Thripidae nymphs</em></td>
<td>122.67</td>
<td>3.18</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>156.23</td>
<td>4.70</td>
</tr>
<tr>
<td>Zimin Drive</td>
<td><em>Thrips</em> spp.</td>
<td>2.40</td>
<td>1.20</td>
</tr>
<tr>
<td></td>
<td><em>Frankliniella schultzei</em></td>
<td>1.90</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td><em>Scirtothrips dorsalis</em></td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td><em>Haplothrips</em> spp.</td>
<td>0.40</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td><em>Phlaeothripridae nymphs</em></td>
<td>1.40</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td><em>Thripidae nymphs</em></td>
<td>25.60</td>
<td>3.00</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>31.70</td>
<td>4.30</td>
</tr>
</tbody>
</table>

Sampling dates: Victoria Drive prior to fruit set: 29 June, after fruit set: 2 September (20 panicles were sampled for each period)
Zimin Drive: prior to fruit set: 30 June, after fruit set: 3 September (10 panicles were sampled for each period)

*Note: Scirtothrips nymphs may also be included in the group 'Thripidae nymphs'*

### Table 2. A comparison of the surface area of the fruit affected by thrips and dimpling bugs, and the size of the fruit

<table>
<thead>
<tr>
<th>Orchard</th>
<th>Mean size of fruit (mm) sample size =50</th>
<th>Mean surface area (%) of the fruit skin affected (per fruit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Victoria Drive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 Sep</td>
<td>40.46</td>
<td>24.72</td>
</tr>
<tr>
<td>07 Oct</td>
<td>42.45</td>
<td>23.66</td>
</tr>
<tr>
<td>19 Oct</td>
<td>84.61</td>
<td>19.45</td>
</tr>
<tr>
<td>Zimin Drive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23 Sep</td>
<td>46.18</td>
<td>4.28</td>
</tr>
<tr>
<td>07 Oct</td>
<td>78.24</td>
<td>4.75</td>
</tr>
<tr>
<td>20 Oct</td>
<td>93.82</td>
<td>1.61</td>
</tr>
</tbody>
</table>

*Darwin* - 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 3 and Table 3. The number of *Scirtothrips* and *Campylomma* were very low, ranging from 0.15 to 0.55 for *Scirtothrips* and 0.05 to 0.70 for *Campylomma*. No *Scirtothrips* were recorded in Darwin River. The mean number of thrips (all species) per flower panicle was 27.2 for Lambells Lagoon, 29.5 for Darwin River and 35.3 for Batchelor.

A comparison of damage contributed by *Campylomma* to developing fruit as observed in the field and on mature post harvested fruit is shown in Table 4. Darwin River and Lambells Lagoon had a lower proportion of developing fruit with damage at 18.6% for Darwin River and 21.3% for Lambells Lagoon. The orchard at Batchelor which did not have any pesticides applied to the crop pre-harvest had a higher proportion of fruit with damage. The mean percentage of damage to each fruit varied from 0.39 for Darwin River, 0.41 for Lambells Lagoon and 5.7 for Batchelor. Although both Darwin River and Lambells Lagoon orchards had applied pesticides to treat *Campylomma* in the field, the benefits of the sprays were not reflected in the post-harvested fruit. The percentages of post-harvested fruit with damage were 73.8 for Darwin River, 16.3 for Lambells Lagoon and 12.5 for Batchelor. The mean percentage of damage per fruit was 8.68 for Darwin River, 0.85 for Lambells Lagoon and 1.4 for Batchelor. Apart from the occasional fruit showing thrips damage, there was not enough damage noticed to be recorded. Post-harvest inspections were made at the...
packing shed to observe damage on the fruit from each property. All growers packed their fruit at the We-Pack shed at Berry Springs.

![Thrips species graph](image)

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

**Table 3.** Mean number of thrips and dimpling bugs sampled from each orchard

<table>
<thead>
<tr>
<th>Orchard</th>
<th>Mean number per flower panicle</th>
<th>Thysanoptera</th>
<th>Scirtothrips</th>
<th>Campylomma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darwin River</td>
<td>29.5</td>
<td>0</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Lambells Lagoon</td>
<td>27.2</td>
<td>0.15</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Batchelor</td>
<td>35.3</td>
<td>0.55</td>
<td>0.35</td>
<td></td>
</tr>
</tbody>
</table>

**Table 4.** Observations of dimpling bug damage on immature and post harvested fruit

<table>
<thead>
<tr>
<th>Orchard</th>
<th>Immature fruit - Mean % of sampled crop affected (fruit size 10-65 mm)</th>
<th>Immature fruit - mean % dam per fruit (fruit size 10-65 mm)</th>
<th>Post harvested fruit - mean % of sampled crop affected</th>
<th>Post harvested fruit - mean % dam per fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darwin River</td>
<td>18.60%</td>
<td>0.39</td>
<td>73.8</td>
<td>8.68</td>
</tr>
<tr>
<td>Lambells Lagoon</td>
<td>21.30%</td>
<td>0.41</td>
<td>16.3</td>
<td>0.85</td>
</tr>
<tr>
<td>Batchelor</td>
<td>78.80%</td>
<td>5.70</td>
<td>12.5</td>
<td>1.40</td>
</tr>
</tbody>
</table>
**Table 5.** Details of the quantity and quality of fruit from each orchard that was processed at the packing shed

<table>
<thead>
<tr>
<th>Orchard</th>
<th>Number of trees harvested</th>
<th>Class</th>
<th>Trays</th>
<th>% Trays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darwin River</td>
<td>3000</td>
<td>First</td>
<td>2869</td>
<td>63.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second</td>
<td>1172</td>
<td>25.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Third</td>
<td>502</td>
<td>11.0</td>
</tr>
<tr>
<td>Lambells Lagoon</td>
<td>2450</td>
<td>First</td>
<td>9339</td>
<td>61.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second</td>
<td>4184</td>
<td>27.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Third</td>
<td>1620</td>
<td>10.7</td>
</tr>
<tr>
<td>Batchelor</td>
<td>220</td>
<td>First</td>
<td>583</td>
<td>81.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second</td>
<td>106</td>
<td>14.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Third</td>
<td>31</td>
<td>4.3</td>
</tr>
</tbody>
</table>

**Insect damage on post harvested fruit**

The level of insect damage noticed on the fruit in the packaging shed was minimal. All fruit was inspected prior to processing on the packing line, where possible. The main insect damage noticed was dimpling bug and mango scale (*Pseudaulacaspis cockerelli*) (Cooley) (Hemiptera: Diaspididae). Although a larger range of insects was seen in the field, many fall off the fruit or are removed by pickers at harvest. Dimpling bug 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. This is when the fruit is most likely attacked. As the fruit increases in size, the dimpling bug damage generally expands, fades and becomes 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 5. The two conventional orchards, Darwin River and Lambells Lagoon, had 63.2% and 61.7% of first class fruit compared to 81% for Batchelor which did not have any pre-harvest insecticide treatment to the crop. Although the Batchelor orchard had a higher amount of dimpling bug damage on fruit during early development, the damage “grows out” and by the time the fruit matures, the symptoms are reduced and often not detectable at post harvest.

**Other insects and spiders in mango flower panicles**

The dominant groups of insects and spiders collected from mango flower panicles from three orchards in Darwin included (prior to fruit set) (Figure 2) flower thrips (Thysanoptera) 93%, ants (Hymenoptera: Formicidae) 2%, spiders (Araneida) 2%, beetles (Coleoptera) 1%, dimpling bugs (Hemiptera: Miridae) 1% and others 1%; (after fruit set) (Figure 3) flower thrips 66%, ants 10%, beetles 9%, caterpillars (Lepidoptera) 4%, dimpling bugs 4%, spiders 3%, wasps (Hymenoptera) 2%, flower bugs or minute pirate bugs (Hemiptera: Anthocoridae) 1% and others 1%. Further details from these figures are shown in the species list (Table 6).
### Darwin River

<table>
<thead>
<tr>
<th>Order</th>
<th>Family</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thysanoptera</td>
<td>Thripidae</td>
<td>Thrips sp.</td>
</tr>
<tr>
<td>Araneida (spiders)</td>
<td>Phlaeothripida</td>
<td>Scirtothrips dorsalis</td>
</tr>
<tr>
<td>Hemiptera (bugs)</td>
<td>Anthocoridae</td>
<td>Frankliniella schultzei</td>
</tr>
<tr>
<td>Diptera (flies/midges)</td>
<td>Flatidae</td>
<td>Colgaroides acuminata</td>
</tr>
<tr>
<td>Hymenoptera</td>
<td>Formicidae (ants)</td>
<td>Iridomyrmex sanguineus</td>
</tr>
<tr>
<td>Araneida (spiders)</td>
<td>Various species</td>
<td></td>
</tr>
<tr>
<td>Hemiptera (bugs)</td>
<td>Flatidae</td>
<td>Variegata sp.</td>
</tr>
<tr>
<td>Diptera (flies/midges)</td>
<td>Calliphoridae</td>
<td>Trypoxylon sp.</td>
</tr>
<tr>
<td>Hymenoptera</td>
<td>Formicidae (ants)</td>
<td>Iridomyrmex sp. (brown)</td>
</tr>
</tbody>
</table>

### Lambells Lagoon

<table>
<thead>
<tr>
<th>Order</th>
<th>Family</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thysanoptera</td>
<td>Thripidae</td>
<td>Thrips sp.</td>
</tr>
<tr>
<td>Araneida (spiders)</td>
<td>Phlaeothripida</td>
<td>Scirtothrips sp.</td>
</tr>
<tr>
<td>Hemiptera (bugs)</td>
<td>Anthocoridae</td>
<td>Frankliniella sp.</td>
</tr>
<tr>
<td>Diptera (flies/midges)</td>
<td>Flatidae</td>
<td>Siphanta sp.</td>
</tr>
<tr>
<td>Hymenoptera</td>
<td>Formicidae (ants)</td>
<td>Iridomyrmex sanguineus</td>
</tr>
<tr>
<td>Araneida (spiders)</td>
<td>Various species</td>
<td></td>
</tr>
<tr>
<td>Hemiptera (bugs)</td>
<td>Flatidae</td>
<td>Variegata sp.</td>
</tr>
<tr>
<td>Diptera (flies/midges)</td>
<td>Calliphoridae</td>
<td>Trypoxylon sp.</td>
</tr>
<tr>
<td>Hymenoptera</td>
<td>Formicidae (ants)</td>
<td>Iridomyrmex sp. (brown)</td>
</tr>
</tbody>
</table>

### Batchelor

<table>
<thead>
<tr>
<th>Order</th>
<th>Family</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thysanoptera</td>
<td>Thripidae</td>
<td>Thrips sp.</td>
</tr>
<tr>
<td>Araneida (spiders)</td>
<td>Phlaeothripida</td>
<td>Scirtothrips sp.</td>
</tr>
<tr>
<td>Hemiptera (bugs)</td>
<td>Miridae</td>
<td>Campylophora sp.</td>
</tr>
<tr>
<td>Diptera (flies/midges)</td>
<td>Calliphoridae</td>
<td>Trypoxylon sp.</td>
</tr>
<tr>
<td>Hymenoptera</td>
<td>Formicidae (ants)</td>
<td>Iridomyrmex sanguineus</td>
</tr>
<tr>
<td>Araneida (spiders)</td>
<td>Various species</td>
<td></td>
</tr>
<tr>
<td>Hemiptera (bugs)</td>
<td>Flatidae</td>
<td>Variegata sp.</td>
</tr>
<tr>
<td>Diptera (flies/midges)</td>
<td>Calliphoridae</td>
<td>Trypoxylon sp.</td>
</tr>
<tr>
<td>Hymenoptera</td>
<td>Formicidae (ants)</td>
<td>Iridomyrmex sp. (brown)</td>
</tr>
</tbody>
</table>

### Psocoptera (book lice)

<table>
<thead>
<tr>
<th>Order</th>
<th>Family</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blattodea (cockroaches)</td>
<td>Various families</td>
<td>Silvanolomus sp.</td>
</tr>
<tr>
<td>Psocoptera (book lice)</td>
<td>Various families</td>
<td>Silvanolomus sp.</td>
</tr>
</tbody>
</table>
Discussion:

Thrips and dimpling bugs

There has been concern from growers in the Darwin and Katherine regions that thrips and dimpling bug are causing considerable damage to flowers and developing fruit and therefore sampling has been concentrated on these species. The appearance of thrips and dimpling bug damage are similar. Although the main distinction that was observed particularly on the Katherine properties was that thrips damage generally occurs near the stem end and is seen as rough white patches or scarring. Dimpling bug damage on the fruit skin appears as white streaks, patches, dimples, pits or raised spots on very young fruit. It was observed that thrips attack the fruit when it is 10-15 mm in diameter and dimpling bug attack fruit when it is less than 3 mm in diameter. Unless the damage is observed within a day or two after it occurs, it is often very difficult to determine whether the damage is caused by thrips or dimpling bugs. The damage that was assessed on developing fruit in Katherine included both thrips damage and dimpling bug damage but since it was often not possible to distinguish “older damage” both types of damage were assessed together. Thrips did not damage young developing fruit in Darwin orchards, but dimpling bugs did.

Most of the thrips species sampled were pollinators or predators; however, Scirtothrips dorsalis Hood (Thysanoptera: Thripidae) feeds on new flush of mangoes and is also found in flowers and on developing fruit-lets. S. dorsalis has been suspected of feeding on developing fruit, usually at size 10-15 mm in diameter. Samples of developing fruit were tagged and monitored throughout the season but the results did not confirm which species were involved in damaging the fruit. Although damage was observed on the fruit and various samples of thrips were collected from damaged fruit, the thrips were nymphs and could not be confirmed to species level.

Hoskins et al. (2004) monitored two orchards in Katherine and observed that thrip nymphs were noticed to feed on fruit just larger than a small marble and that the feeding activity creates a sand-paper-like texture on the skin. Unlike the damage caused by dimpling bugs, it was noticed that the scarring remains as the fruit matures.

The dimpling bug has appeared in higher numbers on mango flower panicles during cooler dry season periods. Two of these periods included the dry season of 1990 and 2002 when dimpling bug numbers were very high in flower panicles, particularly in the Katherine region. A trial was carried out by Layland and Brown during the 1990 dry season in Katherine and it was determined that there was no significant difference in the abortion rate between fruit affected by dimpling bugs and that not affected by dimpling bugs. It was also determined that a low level of fruit was downgraded at harvest (Chin et al., 2004).

Connolly et al. (2002) carried out a trial at Katherine Research Station to assess the effect of dimpling bugs on fruit damage and fruit retention. Results indicated that although dimpling bugs appeared to cause early fruit abortion, there was no significant difference in the final yield or fruit quality between mango trees affected the dimpling bug and those not affected.

During the 2003-04 mango seasons in Katherine there was an extended flowering period due to inclement weather. Extended flowering can increase the potential impact of various mango flower pests. Hoskins et al. (2004) indicated that at least five generations occurred by the end of flowering in 2003. The nymphs were highly mobile and moved around the panicle feeding on very small fruit (< 3 mm diameter). Initial damage is seen as dark, raised pimples but as fruit matures the damage grows out with cell expansion and becomes a shallow dimple on the skin. In extreme cases there were up to 20 or more injuries per fruit.

Results from the trials in Katherine and Darwin indicate that thrips and dimpling bugs blemish young developing fruit. It is uncertain how much damage is caused by thrips when the older damage symptoms can be confused with that of dimpling bugs. The assessments on developing fruit and post harvested fruit in Darwin indicated that there was no obvious effect on fruit quality, particularly when there were other blemishes which were more unsightly and affected a larger surface area of the fruit. Some of these
blemishes included cleavage scars, sap burn, lenticel blow out and wind abrasion. Cleavage scars and wind abrasion in particular were noticed to downgrade the fruit.

Other mango flower insects

Flowers are important resources for pests and pollinators and may also serve as important resource patches for predatory arthropods (Young 2005). A large range of insects and spiders were collected from flower panicles at the three orchards in Darwin. Besides the thrips and dimpling bugs, the samples included other “pests” of mangoes such as plant hoppers (Colgaroides acuminata) (Walker) and Siphanta sp., mango large tip borer (Penicillaria jocosatrix) Guenee. There was a large range of ants predominantly Iridimyrmex sanguineus Forel, Iridomymex spp., Monomorium sp., Opisthopsis sp., Tetraponera sp. Crematogaster sp. and Tapinoma sp. (Hymenoptera: Formicidae) which were attracted to the nectar from the flowers. It is unknown if the ants play a significant role in pollination. There was a range of pollinators which included flies, midges and bush bees (Trigona sp.) (Hymenoptera: Apidae) Beetles were scavengers such as Anthicus sp. (Anthicidae), or feeders of dead plant material or fungi which included Cortinicara sp. (Lathridiidae) and Silvanolomus sp. Silvanidae). Other beetles (Scirtes sp.) (Sciridae) and various species of curculionids and nitidulids were also collected in the flower panicles.

The dominant predators collected from flowers included the mite-eating ladybird (Stethorus sp.) (Coccinellidae) which is predacious on aphids, scales mealy bugs, mites and other small insects; and flower bugs (Orius sp.) (Anthocoridae) and the big-eyed bug (Geocoris sp.) (Lygaeidae) which are predators of both thrips and other insects (Rondon et al., 2004). Generalist predators such as various spiders and praying mantises were also common in the flowers.

The technique used for sampling insects from the flower panicles favoured the collection of non-flying insects. Flying insects such as bees, flies, moths, midges, plant hoppers and leafhoppers are more mobile and may have contributed to their lower numbers in the samples. A small trial was carried out by Chin et al. (2004) at a mango orchard in Lambells Lagoon near Darwin to observe pollinators of mango flower panicles. The most important pollinators were flower thrips, hoverflies, bush flies, blowflies, native bee (Trigona), European honeybee and wasps.

Mango leafhopper (Idioscopus nitidulis) which is a major pest of mangoes in the NT was not recorded in the samples, due to effective pest management programs each grower carried out prior to flowering.

Conclusion and recommendations

Thrips and dimpling bugs as well as a range of pests, pollinators and their predators utilise mango flowers. Hundreds of thrips may be observed in any one panicle; however, the majority of the species are pollinators or predators. Scirtothrips dorsalis attacks new flush and has been found on young developing fruit. Other thrips have also been found on young developing fruit and it is unknown which species contribute to the main damage. Damage to young developing fruit, seen as spots, pits, dimples, white streaks is contributed by dimpling bugs. Thrips have been observed to cause white rough patches or scarring usually at the stem end of small developing fruit.

The damage to young developing fruit caused by dimpling bug usually grows out and generally does not affect the marketability of the fruit. Other blemishes and disorders such as cleavage scars and wind damage appeared to be more noticeable in downgrading the fruit quality for three orchards in Darwin. Although dimpling bug does not appear to downgrade fruit quality, more information needs to be gathered to determine the effect on fruit abortion and whether this significantly influences yield. Further work is required on flower thrips in Katherine to determine which species attack young developing fruit and provide an assessment of damage on post harvested fruit.
Acknowledgements

We are grateful to Tim Elliott and staff of WEPack for taking an interest in IPM and for inviting DPIFM Entomology staff to present IPM workshops to growers. We would also like to thank Margaret Hwang, Stuart Cox and Sonia Tidemann for the use of their orchards to conduct field trials and for their cooperation and enthusiasm in helping us with insect monitoring. We would also like to thank Katherine growers, Bob Dodd and Bruce Toohill for the use of their orchards. We are grateful to Megan Hoskins, a former staff member of Entomology based at Katherine Research Station, who assisted with the field trials and encouraged mango growers to adopt IPM practices. We extend our appreciation to Tom Weir who visited Darwin at the ‘right’ time and provided identifications of beetle and other specimens.

References:


PROJECT: Weed Control in Soybean

Project Officers: R. Eastick, M. Bennett, M. Kahl and N. Hartley

Division: Plant Industries
Location: Katherine
Keyword(s): weeds, soybean, biodiesel, bio-fuels, Katherine Research Station
Project Type: Scientific

Objectives:

To evaluate herbicides for weed control in wet season soybean production.

To compare oil yield between soybean and sunflower.

Background:

Soybean is not grown commercially in the Northern Territory (NT), although there is interest in its production for biodiesel. Energy Crops Australia (ECA) is conducting a project to assess the commercial viability of soybean production for oil, to partly supply the recently commissioned Darwin biodiesel plant. A number of technical and agronomic challenges face soybean production in the NT, exacerbated by weather extremes in the wet season. Among them is effective weed control.

Two soybean varieties (cultivars Leichhardt and Stuart) and sunflower were evaluated for yield at Katherine Research Station (KRS) over the 2006-07 wet season. A number of herbicides were assessed in conjunction with this experiment for efficacy in weed control, particularly sickle pod, in soybeans.

Method:

The trial site had been kept as a sabi grass fallow for the previous two years, with a history of broadleaf weeds. The area was mulched on 20 December 2006 to reduce sabi biomass (3-6 t/ha). Then 3L/ha glyphosate (450 g/kg) was applied on 29 January 2007 to fresh regrowth. The area was mulched again on 2 and 3 January due to large amounts of remaining biomass. Soybean was sown in 25-cm rows on 11 January using a John Shearer trash-culti-drill planter. The intended population was 350 000 to 450 000 plants/ha. Sunflower was sown adjacent to the soybean plots. Fertiliser was applied relatively late on 14 February at 200 kg/ha Superphosphate by ground rig, 8 L/ha Super-Zinc® (7.5% Zn) and 60 kg/ha nitrogen through the lateral move irrigator.

Pre-emergent herbicides were applied on 12 January at 100L/ha water volume, using an 18-m boomspray. The main weeds were regenerating sabi and emerging pigweed (Trianthema portulacastrum). About 30 mm of rain fell two days after the herbicide application.

The trial was a randomised complete block (four blocks) of six herbicide treatments (Table 1) within each of the two cultivars, Leichhardt and Stuart. Plot size was 18 m by 18 m.
Table 1. Herbicide treatments

<table>
<thead>
<tr>
<th>Trade name</th>
<th>Active (g/kg or g/L)</th>
<th>When applied</th>
<th>Rate/ha</th>
<th>Amount ai/ha (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual Gold and Spinnaker WDG</td>
<td>Metolachlor (960) and Imazethapyr (700)</td>
<td>Pre, Post</td>
<td>2L, 140 g</td>
<td>192, 98</td>
</tr>
<tr>
<td>Spinnaker WDG</td>
<td>Imazethapyr (700)</td>
<td>Pre</td>
<td>140 g</td>
<td>98</td>
</tr>
<tr>
<td>Spinnaker WDG</td>
<td>Imazethapyr (700)</td>
<td>Post</td>
<td>140 g</td>
<td>98</td>
</tr>
<tr>
<td>Sencor 480SC</td>
<td>Metribuzin (480)</td>
<td>Pre</td>
<td>750 mL</td>
<td>360</td>
</tr>
<tr>
<td>Broadstrike</td>
<td>Flumetsulum (800)</td>
<td>Pre</td>
<td>50 g</td>
<td>40</td>
</tr>
<tr>
<td>Control</td>
<td>No herbicide</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Emergence

Soybean emergence counts and biomass samples (2 by 1 x 0.5 m quadrat per plot) were taken on 25 January to assess phytotoxicity. Weed ratings were also conducted to determine efficacy of herbicide treatments on grass and broadleaf weed control. Ratings were given as follows: 0 = no weed; 1 = very low (<5% coverage, isolated emerging plants); 2 = low infestation (5-25% coverage, weeds less than 5 cm diameter or height); 3 = medium infestation (25-50% coverage, weeds between 5-10 cm diameter and height; 4 = high infestation (>50% coverage, weeds greater than 10 cm diameter or height).

Verdict 520® (haloxyfop) at 400 mL/ha was applied on 26 January (two weeks after pre-emergent treatment application) to all plots except the control, to control regenerating perennial sabi, emerging sabi and barnyard grass (*Echinochloa* spp.). The post-emergent application of Spinnaker was done on 31 January.

Early biomass

The first biomass harvest for crop, grass and broadleaf weed was conducted on 14 February (two weeks after post-emergent treatment application) to evaluate early weed control.

Final harvest

The final harvest was conducted on 2 May at crop maturity to evaluate crop, grass, and broadleaf weed biomass, and soybean grain yield. Plots were hand-harvested and material was hand-threshed, which gave an estimated additional 20% soybean seed by weight than a machine harvest would have yielded. Ten plants from each of the four Spinnaker pre-emergent plots were also collected separately to assess oil yield and soybean physiological parameters such as plant height, number of pods, total grain weight per plant and 100 seed weight. This herbicide treatment was expected to provide the maximum yield and minimum herbicide effect on selected parameters.

Sunflower (8 x 1m by 1m) was also collected to estimate yield.

Results:

Emergence counts and weed ratings

Establishment was patchy, due to inconsistencies in mulch levels at sowing, but there were no treatment effects on the number of soybeans plants per plot, or soybean weight per plant, during emergence counts. Grasses, mainly barnyard grass, were the dominant weeds. Pigweed was the dominant broadleaf weed. Unfortunately, no Senna, and only isolated Cavalcade, had emerged in any treatment plot, including the control. The Dual Gold, Spinnaker pre-emergent, and Sencor treatments provided significantly better grass weed control compared with no herbicide. All herbicide treatments, with the exception of Spinnaker post-emergent, which was effectively another control at the time of first ratings, resulted in fewer broadleaf weeds compared with no herbicide (Figure 1).
Early biomass

The average grass biomass in the control plots four weeks after sowing was 647 kg/ha and 526 kg/ha for Stuart and Leichhardt, respectively. As there were very few grasses in any herbicide treated plots, biomass samples were not collected. This demonstrated the effectiveness of grass herbicide (Verdict®) application about three weeks earlier.

The main broadleaf weeds present were pigweed, buffalo clover, tridax daisy, tarvine, gooseberry and Cavalcade. The effect of herbicide treatment was variable between the Leichhardt and the Stuart plots. The trend was that Spinnaker-post, Sencor and control plots had more broadleaf weed biomass than the other treatment plots.

There was no herbicide effect on soybean biomass.

Final harvest

Consistent with the early biomass harvest, there was very little grass weed in any treatment plots. However, control plots had an average of 1231 kg/ha and 1277 kg/ha grass, mainly sabi, in Stuart and Leichhardt, respectively. As a result, grass biomass was not sampled. Also, there was very scattered incidence of broadleaf weeds, including in the control plots. Most of the 1 m x 0.5 m quadrats sampled did not have broadleaf weeds. To provide some estimate of herbicide effectiveness, a count was taken of the total number of broadleaf weeds in the plot. The main weeds present were gooseberry and Senna, although their distribution was patchy. Results were inconsistent, but in general, the Spinnaker pre- Spinnaker-post and Dual + Spinnaker treatments provided the best broadleaf control. The Sencor, Broadstrike and control plots had the highest incidence of weeds.

Results for final grain weight were inconsistent between the two varieties. Sencor treated plots produced the largest yield for Leichhardt (significantly different only to the control). The results are presented in Figure 2.
Results for the oil analyses are provided in Table 2.

**Table 2.** Composition of soybean and sunflower samples

<table>
<thead>
<tr>
<th>Crop</th>
<th>Protein (%)</th>
<th>Oil (%)</th>
<th>Nitrogen (%)</th>
<th>Seed yield (t/ha)</th>
<th>Oil yield (kg/ha)#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean Leichhardt</td>
<td>44.8</td>
<td>19.0</td>
<td>7.17</td>
<td>3.97</td>
<td>754</td>
</tr>
<tr>
<td>Soybean Stuart</td>
<td>45.2</td>
<td>17.9</td>
<td>7.23</td>
<td>4.59</td>
<td>822</td>
</tr>
<tr>
<td>Sunflower H47</td>
<td>17.6</td>
<td>46.7</td>
<td>2.82</td>
<td>2.04</td>
<td>954</td>
</tr>
</tbody>
</table>

#not necessarily amount of oil obtained after commercial extraction (some literature states 14% extraction for soybean, 32% extraction for sunflower).

**Conclusions**

Imazethapyr (Spinnaker®) is currently the main herbicide used for weed control in wet season minimum tillage soybean production in the NT. Results from this experiment confirm this, although the patchiness and limited weed spectrum did not allow for a wider evaluation of herbicide efficacy on different weeds, particularly Senna. Further work is required to assess available herbicides on a wider weed spectrum, including legume weeds such as sicklepod, Cavalcade, Crotalaria spp, phasey bean (*Phaseolus macroptilium*) and buffalo clover (*Alysicarpus vaginalis*). Ideally, inclusion of the herbicides imazaquin and chlorimuron available in the USA, offers the potential for more effective weed control options in the NT. Chlorimuron is considered the best choice for control of sicklepod in soybean, based on environmental behaviour, as well as cost-effectiveness. The scope to include these herbicides is uncertain. Shielded sprayers may also be more suited to dry season than wet season production, due to better access and trafficability. Herbicide options with this method of application need to be evaluated.

Ideally, variety should have been incorporated into the experimental design to allow assessment of the variety by herbicide treatment interaction. However, due to planting constraints, Leichhardt and Stuart were analysed separately.

Identifying suitable in-crop herbicides is one of the major strategies for weed management in soybean. However, other weed-control options, including crop rotations, mulch management and minimal tillage, need to be incorporated into a holistic weed management strategy. The use of sunflower as an alternative or complementary oilseed crop, particularly given the oil yield results above, may be one crop rotation option.
Biology and Management of the Spiralling Whitefly


Division: Plant Industries
Location: Darwin
Keyword(s): spiralling whitefly, biological control, Encarsia
Project Type: Scientific

Objective:

To study the biology of the spiralling whitefly and monitor its control by the introduced parasite Encarsia sp.

Background:

The spiralling whitefly (Aleurodicus disperses) is native to the Caribbean region and Central America. The pest is also found in 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 and was first detected in Darwin in March 2006. The spiralling whitefly has now been recorded in many localities in Darwin, Palmerston, and nearby rural areas. It has not been detected in Batchelor, Adelaide River, Jabiru, Nhulunbuy, Katherine or Alice Springs.

Appearance

The spiralling whitefly is a small sap-sucking insect, related to mealy bugs and aphids. To the naked eye, the adults look like very small moths and have a body length of about 2 mm. The wings of adults are plain white, or occasionally have pale or dark spots on the forewings. Eggs are elliptical and yellow to tan in colour, 0.3 mm long and are laid singly at right angle to leaf veins and are associated with irregularly spiralling deposits of white flocculent wax. The 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 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 in length. 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) 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.
Life cycle

At a temperature range of between 20°C and 39°C, the development from egg to adult takes from 34 to 38 days: eggs 9-11 days; first instar (stage) larvae 6-7 days; second instar 4-5 days; third instar 5-7 days; and fourth instar larva (pupa) 10-11 days. Under laboratory conditions the adult can live for up to 39 days.

Symptoms of damage

The spiralling whitefly attacks a large range of plants including vegetables, fruit trees, ornamentals, native plants and weeds. Some common hosts that it has been found on in the Darwin area include acalypha, a local weed called *Euphorbia heterophylla* (sometimes referred to as “milkweed”), chillies, capsicum, bauhinia, sweet potato, guava, pawpaw, poinsettia, banana, tomato, heliconia, eggplant, mulberry, frangipani and ground orchids. The spiralling whitefly will also deposit eggs on non-hosts.

The whitefly produces 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. Wet season weather is less favourable to the whitefly, when it will generally be found in low numbers. Higher populations are more common during the favourable weather conditions of the dry season.
Host list

The spiralling whitefly has been confirmed on the following host plants in the Northern Territory: acacia, acalypha, aglaomena, banana, barleria, bauhinia, begonia, bougainvillea, caladium, canna lily, capsicum, cassava, Centrosema, chilli, cordyline, crotalaria, custard apple, Delineata, desert rose, eggplant, Euphorbia snowflake, 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, Rangoon creeper, rose, rosewood, scindapsas, sweet potato, tapioca, taro and tomato.

Pest management

The whitefly is able to build up resistance to most chemical pesticides and should not be treated with them. Spraying with chemicals also destroys natural enemies or biological control agents that have been released. Potassium soap such as Natrasoap or Neemtech potassium soap with added spray oil may assist in managing populations on host plants. Note that other potassium soap products may also be effective.

Examples of spray oils include Eco oil, DC tron plus, Spraytech oil, Synertrol Hort oil or any other suitable horticultural spray oil. In home gardens, cooking oils such as canola and other vegetable oils are suitable. It is important to spray both sides of leaves to runoff and repeat every three days until control is achieved. The spray solution may cause leaf burn in sensitive plants. The best time to apply sprays is in the early morning or late afternoon.

Suggested spray rates: Natrasoap 20 mL/L + spray oil 2 mL/L or Neemtech 30 mL/L + spray oil 2 mL/L.

Note: The recommended rate of spray listed above is for canola and other vegetable cooking oils. If you are using a horticultural spray oil, follow instructions on the container.

Biological control with the Encarsia wasp parasite

Shortly after the spiralling whitefly was detected in March 2006, DPIFM introduced a microscopic wasp parasite (Encarsia sp.) from Cairns through QDPI&F to assist in its management. The wasp parasite is 0.1 mm long and is harmless to humans. It is now established in many localities in Darwin, Palmerston and the rural area. It has been observed to reduce spiralling whitefly numbers in several areas. The Section has continued to monitor and promote the establishment of Encarsia in all major suburbs and rural areas where the whitefly has been detected. The wasp will spread naturally to nearby areas after release and will take between one to six months to establish at a new site, depending on the suitability of the vegetation and how well the garden is maintained. In general, Encarsia is more likely to establish quickly and control the spiraling whitefly if the garden is well maintained and has plenty of shade.

Up to June 2007, the spiralling whitefly was detected in the Darwin suburbs of Alawa, Anula, Berrimah, Brinkin, Coconut Grove, Fannie Bay, Karama, Jingili, Knuckey's Lagoon, Leanyer and Woodleigh Gardens, Malak, Nakara, Nightcliff, North Lakes, Parap, Stuart Park, Wagaman, Wanguri, Wulagi, Tiwi and 11 Mile. It was detected in the Palmerston suburbs of Bakewell, Driver, Durack, Gray, Gunn, Marlow Lagoon, Moulden, Roseberry and Woodroffe. In rural areas it was detected in Bees Creek, Howard Springs, Humpty Doo, McMinns Lagoon and Virginia.

The wasp was released at many sites in the Darwin, Palmerston and rural areas. It is now spreading naturally. Encarsia has now established in the Darwin suburbs of Alawa (1 site), Anula (2 sites), Berrimah (1 site), Coconut Grove (1 site), Jingili (1 site), Karama (2 sites), Leanyer (1 site), Malak (1 site), Moil (2 sites), Stuart Park (1 site), Wagaman (2 sites), Wanguri (1 site) and Wulagi (2 sites).

In Palmerston suburbs it is now established in Bakewell (1 site), Driver (1 site), Gray (1 site), Marlow Lagoon (3 sites), Moulden (1 site) and Woodroffe (1 site).
In rural areas it is established in Bees Creek (1 site), Howard Springs (2 sites) and Humpty Doo (7 sites).

**Figure 5.** *Encarsia* wasp parasite (0.1 mm long)

**Figure 6.** Whitefly larvae parasitised by *Encarsia*

### PROJECT:

**Elite Rootstocks and Scion Cultivars for Improved Productivity of NT Mangoes and Citrus**

**Project Officers:** C. Wicks, G. Azam, R. Renfree, M. Kahl, M. McRae, M. Connelly, M. Traynor and M. Hoult

**Division:** Plant Industries  
**Location:** NT-wide  
**Keyword(s):** mango, citrus, rootstocks, varieties, Katherine Research Station  
**Project Type:** Scientific

### Objective:

To identify elite rootstocks and scion cultivars for improving productivity in the NT mango and citrus industries.

### Background:

Improving productivity and efficiency are continuing issues for the horticulture industry which strives to offset increasing costs and declining returns. This has been compounded by increasing “environmental pressures” on resource users. The simple selection of elite scion cultivars by rootstock combinations allows industry to improve productivity without any increase in additional inputs such as nutrients and water. It has key implications for better resource management and improved returns on investment. This project will attempt to identify elite rootstocks and scion cultivars which impart improved productivity and better biennial bearing.

### Method:

*Mango rootstocks* - There are two trial sites in the Katherine district – Zimin Drive, on a shallow “Tippera” clay loam and the Venn on Fox Road, on a deep, sandy “Blain” red earth. All soil types in the district are characterised by a high pH of 8 but low conductivity and organic carbon. The Zimin Drive trial has 64 stock treatments replicated with five, single datum trees and the Fox Road site has 100 stock treatments replicated as for the other site.
Treatments 1 to 64 are same stock treatments for both sites as is the scion, which is Kensington Pride (KP). Katherine Research Station (KRS) clone ex Ian Curtis. For ease of presentation only the top 15 stocks and the worst five stocks along with NT 16 KP (standard) are presented for the larger Fox Road site.

For the 2006 assessment, data was collected for tree size (canopy area and trunk girths) (not presented), fruit number per datum tree (counts per tree by two experienced mango workers and averaged), average fruit weight per datum tree (data not presented), fruit maturity (days to soft ripe from harvest) and quality (° brix). After several years, data from the Zimin Drive site was only collected from the 20 best and the five worst performing stocks in previous years. Likewise, not all stocks at the Fox Road site were studied, as some established poorly and/or were killed by termites.

**Citrus rootstocks** - This trial is based in Bees Creek, in the Darwin rural area. Fremont mandarin is the scion on 12 different rootstocks and it is replicated four times with single datum trees. The assessment data collected annually includes tree size (canopy area and trunk girths) (data not presented), crop yield (fruit number by average fruit weight) and in future seasons, fruit maturity and quality. The trial site also serves as a “best practice/training” block for the NT Citrus Growers Association (NTCGA) under the national “Cittgroup” initiative. The site is partly funded by NTCGA.

**Mango scion cultivars**

The mango cultivar planting at KRS consisted of two to four trees of 12 cultivars randomly distributed within the block. Trees are spaced at 8 m x 6.5 m. The cultivars Neldica, Heidi, Joa, Chene and E10-5/3 were planted on 24 May 2001 (Table 1). The cultivars R2E2, Celebration and KP were planted on 5 June 2001. Each of cultivars R2E2, Celebration, N10E10, Neldica, E10-5/3, KP, Chene, Joa, Heidi, and N10E56 has four trees. Each of cultivars N6E35 and N8E54 has only two trees (Table 1). Harvest data was collected on the 10 and 14 November 2006. Weight of marketable and unmarketable fruit was recorded and combined to obtain total yield for each cultivar. A 10-fruit sub-sample at harvest was allowed to ripen and its brix was determined.

**Citrus scion cultivars**

The following cultivars have been established at KRS with the bulk of scions grafted onto Swingle citrumello. Cultivars planted on 14 May, 2004 are on Benton citrange, Cox mandarin and Fraser hybrid:


**Pomello:** Nam Roi

Data collected for 2006-07 included fruit counts and a sub-sample of 10 fruits for average fruit weight.

**Results:**

**Mango rootstocks**

The rootstock “NT16” is Kensington Pride (KP), as KP was grafted to KP seedlings and is a stock/scion combination that would represent the bulk of existing commercial orchards in the Top End of the NT. As such, it serves as a useful standard (control) to judge all other stock/scion combinations from these experiments. As in previous years, a number of stocks have outperformed KP on the number of fruit per tree, depending on site. It is clear that there is a trend suggesting a “rootstock by soil type” interaction with a...
number of stocks showing low productivity on one site but higher productivity on another site. Other data collected (not presented) also shows individual stock selections are influencing canopy size and there is a group of stocks which induce smaller canopies and yet maintain good production.

Within rootstock variation is considerable for several treatments and suggests that there maybe an issue with level of zygotes (seedlings genetically different to “mother” seed tree) within supposedly nucellar, “polyembryonic” selections (seedlings genetically the same as “mother” seed trees) and/or soils at the trial sites are variable. A more robust statistical analysis utilising “nearest neighbour” analysis should account for site and soil variability and further investigation of the zygote to nucellar embryo ratio within a stock selection may resolve some of the high variance for some stock treatments. Nonetheless, a number of stocks are consistently performing better than the standard KP, with reasonable uniformity among datum trees.

We are also observing trends in fruit quality and maturity time that are being influenced by a given stock. Much of the current data supports earlier reported trials on the obvious impact of rootstock selection on scion performance in mango and reflects the same phenomena that are utilised economically in other tree crops such as citrus and pome fruit.

We have identified a number of elite rootstocks that have influenced key commercial criteria for the main Australian commercial cultivar, KP. Soil type and site appear to influence different rootstocks and their performance. We have no information on the influence of rootstock on new cultivars such as Calypso and Honey Gold. Many of the cultivars/selections evaluated as potential rootstocks are held only as single trees in germ-plasm collections and as such availability of seed in commercial quantities is very limited. Also a number of the parent stock trees used as rootstock treatments have died.

Table 1. Fruit counts and quality, Zimin Drive rootstock trial - November, 2006

<table>
<thead>
<tr>
<th>Rootstock code</th>
<th>Fruit number</th>
<th>Days to soft ripe (DSR)</th>
<th>Av. °brix</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean no./tree</td>
<td>sd</td>
<td>cv %</td>
<td>sd</td>
</tr>
<tr>
<td>NT12</td>
<td>203</td>
<td>19.1</td>
<td>9.4</td>
<td>16.0</td>
</tr>
<tr>
<td>NT63</td>
<td>196</td>
<td>31.4</td>
<td>16.0</td>
<td>22.2</td>
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<td>NT13</td>
<td>194</td>
<td>40.9</td>
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<td>22.1</td>
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<td>NT52</td>
<td>179</td>
<td>23.0</td>
<td>12.8</td>
<td>23.9</td>
</tr>
<tr>
<td>NT14</td>
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<td>19.9</td>
<td>11.3</td>
<td>22.8</td>
</tr>
<tr>
<td>NT47</td>
<td>166</td>
<td>18.8</td>
<td>11.3</td>
<td>24.1</td>
</tr>
<tr>
<td>NT10</td>
<td>165</td>
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<td>18.7</td>
<td>24.1</td>
</tr>
<tr>
<td>NT19</td>
<td>162</td>
<td>27.4</td>
<td>16.9</td>
<td>21.0</td>
</tr>
<tr>
<td>NT39</td>
<td>161</td>
<td>25.6</td>
<td>15.9</td>
<td>22.7</td>
</tr>
<tr>
<td>NT46</td>
<td>161</td>
<td>28.2</td>
<td>17.5</td>
<td>22.8</td>
</tr>
<tr>
<td>KP (NT16)</td>
<td>157</td>
<td>24.5</td>
<td>15.6</td>
<td>22.9</td>
</tr>
<tr>
<td>NT9</td>
<td>156</td>
<td>23.3</td>
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<td>22.9</td>
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<tr>
<td>NT11</td>
<td>136</td>
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<td>22.6</td>
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<td>NT59</td>
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<td>40.4</td>
<td>31.0</td>
<td>23.3</td>
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<tr>
<td>NT55</td>
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<td>29.5</td>
<td>22.8</td>
<td>21.5</td>
</tr>
<tr>
<td>NT45</td>
<td>109</td>
<td>8.3</td>
<td>7.7</td>
<td>22.0</td>
</tr>
</tbody>
</table>
Table 2. Fruit counts and quality, Fox Rd. rootstock trial - November, 2006

Note: Only 15 best and five worst yielding samples along with KP as standard are presented.

<table>
<thead>
<tr>
<th>Rootstock code</th>
<th>Fruit number</th>
<th>2006 rank</th>
<th>Mean no./tree</th>
<th>sd</th>
<th>cv %</th>
<th>Days to soft ripe (DSR)</th>
<th>sd</th>
<th>Av. o\text{brix}</th>
<th>sd</th>
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</thead>
<tbody>
<tr>
<td>NT52</td>
<td>1</td>
<td>192</td>
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<td>4.8</td>
<td>48.6</td>
<td>22.5</td>
<td>0.5</td>
<td>14.9</td>
<td>0.9</td>
</tr>
<tr>
<td>NT65</td>
<td>2</td>
<td>185</td>
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<td>70.9</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>NT1</td>
<td>3</td>
<td>177</td>
<td>33.2</td>
<td>18.8</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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<tr>
<td>NT10</td>
<td>4</td>
<td>176</td>
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<td>25.6</td>
<td>-</td>
<td>15.0</td>
<td>0.0</td>
<td>15.9</td>
<td>0.7</td>
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<tr>
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<td>-</td>
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<td>18.2</td>
<td>-</td>
<td>15.0</td>
<td>0.0</td>
<td>16.0</td>
<td>1.0</td>
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<td>NT33</td>
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<tr>
<td>NT40</td>
<td>9</td>
<td>167</td>
<td>20.6</td>
<td>12.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NT46</td>
<td>10</td>
<td>164</td>
<td>16.3</td>
<td>9.9</td>
<td>-</td>
<td>19.5</td>
<td>2.6</td>
<td>15.6</td>
<td>1.3</td>
</tr>
<tr>
<td>NT30</td>
<td>11</td>
<td>163</td>
<td>16.7</td>
<td>10.3</td>
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<td>-</td>
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<td>NT94</td>
<td>12</td>
<td>163</td>
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<td>NT26</td>
<td>13</td>
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<td>10.3</td>
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<td>-</td>
<td>-</td>
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<td>-</td>
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<tr>
<td>NT12</td>
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<td>163</td>
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<td>17.2</td>
<td>-</td>
<td>20.5</td>
<td>2.4</td>
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</tr>
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<td>NT61</td>
<td>15</td>
<td>161</td>
<td>18.5</td>
<td>11.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>KP (NT16)</td>
<td>44</td>
<td>145</td>
<td>38.1</td>
<td>26.3</td>
<td>-</td>
<td>17.0</td>
<td>0.0</td>
<td>16.1</td>
<td>0.8</td>
</tr>
<tr>
<td>NT51</td>
<td>87</td>
<td>105</td>
<td>7.8</td>
<td>7.4</td>
<td>-</td>
<td>20.0</td>
<td>0.0</td>
<td>17.1</td>
<td>1.3</td>
</tr>
<tr>
<td>NT96</td>
<td>88</td>
<td>103</td>
<td>37.8</td>
<td>36.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NT86</td>
<td>89</td>
<td>101</td>
<td>14.1</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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<td>NT68</td>
<td>90</td>
<td>91</td>
<td>17.5</td>
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<tr>
<td>NT42</td>
<td>91</td>
<td>91</td>
<td>19.6</td>
<td>21.6</td>
<td>-</td>
<td>21.2</td>
<td>0.4</td>
<td>15.6</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Citrus rootstocks

The fruit count data presented is for the first significant fruiting year and is from three-year-old trees. Variation between replications is very large and may reflect young age of trees and some issues with soil type variability and management inputs, notably irrigation. Fruit quality assessments and continuing yield data will be compiled for the coming seasons.

Table 3. Fruit counts Fremont rootstock trial, Bees Creek - March, 2007

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Av. fruit number/tree</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Lockyer&quot; Rough Lemon</td>
<td>121</td>
<td>20.1</td>
</tr>
<tr>
<td>Poncirus trifoliate</td>
<td>88</td>
<td>21.6</td>
</tr>
<tr>
<td>US812 hybrid</td>
<td>74</td>
<td>14.7</td>
</tr>
<tr>
<td>Rangpur lime</td>
<td>72</td>
<td>22.6</td>
</tr>
<tr>
<td>Cox Mandarin hybrid</td>
<td>66</td>
<td>14.3</td>
</tr>
<tr>
<td>Volkmermeriana</td>
<td>65</td>
<td>22.8</td>
</tr>
<tr>
<td>Swingle citrumello</td>
<td>63</td>
<td>40.7</td>
</tr>
<tr>
<td>C35 citrange</td>
<td>58</td>
<td>31.3</td>
</tr>
<tr>
<td>Troyer citrange</td>
<td>56</td>
<td>34.3</td>
</tr>
<tr>
<td>Fraser hybrid</td>
<td>53</td>
<td>26.0</td>
</tr>
<tr>
<td>C32 citrange</td>
<td>35</td>
<td>26.6</td>
</tr>
<tr>
<td>Benton citrange</td>
<td>31</td>
<td>16.0</td>
</tr>
<tr>
<td>Tetraploid Benton citrange</td>
<td>30</td>
<td>29.8</td>
</tr>
<tr>
<td>Cleopatra mandarin</td>
<td>29</td>
<td>10.1</td>
</tr>
</tbody>
</table>
Mango scion cultivars

Table 4. New mango cultivar total and marketable yield, KRS - November, 2007

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Av. marketable fruit wt. (kg/tree)</th>
<th>Av. reject fruit wt. (kg/tree)</th>
<th>Av. total fruit wt. (kg/tree)</th>
<th>Marketable fruit %</th>
<th>Av. brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>N6E35</td>
<td>71.5</td>
<td>5.7</td>
<td>77.2</td>
<td>92</td>
<td>-</td>
</tr>
<tr>
<td>N10E10</td>
<td>19.6</td>
<td>22.2</td>
<td>41.8</td>
<td>45</td>
<td>16.3</td>
</tr>
<tr>
<td>E10-5/3</td>
<td>30.4</td>
<td>7.8</td>
<td>38.3</td>
<td>78</td>
<td>18.5</td>
</tr>
<tr>
<td>N8E54</td>
<td>13.4</td>
<td>2.7</td>
<td>16.1</td>
<td>84</td>
<td>15.5</td>
</tr>
<tr>
<td>N10E56</td>
<td>30.8</td>
<td>5.8</td>
<td>36.6</td>
<td>84</td>
<td>17.5</td>
</tr>
<tr>
<td>R2E2</td>
<td>39.3</td>
<td>4.2</td>
<td>43.5</td>
<td>90</td>
<td>13.6</td>
</tr>
<tr>
<td>Celebration</td>
<td>37.5</td>
<td>7.1</td>
<td>44.7</td>
<td>84</td>
<td>-</td>
</tr>
<tr>
<td>Neldica</td>
<td>34.2</td>
<td>6.7</td>
<td>40.9</td>
<td>84</td>
<td>-</td>
</tr>
<tr>
<td>KP</td>
<td>52.2</td>
<td>9.2</td>
<td>61.4</td>
<td>85</td>
<td>16.7</td>
</tr>
<tr>
<td>Chene</td>
<td>16.4</td>
<td>19.7</td>
<td>36.1</td>
<td>44</td>
<td>-</td>
</tr>
<tr>
<td>Joa</td>
<td>41.7</td>
<td>9.2</td>
<td>50.9</td>
<td>82</td>
<td>14.6</td>
</tr>
<tr>
<td>Heidi</td>
<td>36.2</td>
<td>4.8</td>
<td>41.1</td>
<td>88</td>
<td>-</td>
</tr>
</tbody>
</table>

This is the third harvest year for this planting. A number of local growers have observed these new cultivars and the general view is there is little to warrant commercial planting. Most of the South African patented cultivars have flavours unsuitable for the Australian domestic market and mature later than KP. This planting will be reviewed after the 2007 season.

Citrus scion cultivars

Table 5. Fruit counts, new citrus variety block, KRS - March, 2007

<table>
<thead>
<tr>
<th>Scion cultivar</th>
<th>Stock</th>
<th>Age</th>
<th>Av. fruit no./tree</th>
<th>Av. fruit wt (g)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nova</td>
<td>Swingle</td>
<td>6 yrs</td>
<td>22</td>
<td>142</td>
<td>Granulated</td>
</tr>
<tr>
<td>Daisy</td>
<td>Swingle</td>
<td>6 yrs</td>
<td>243</td>
<td>132</td>
<td>Good quality and rind colour, tree with termites</td>
</tr>
<tr>
<td>CSIRO 2762</td>
<td>Swingle</td>
<td>6 yrs</td>
<td>69</td>
<td>104</td>
<td>Poor fruit</td>
</tr>
<tr>
<td>Cam Sahn</td>
<td>Swingle</td>
<td>6 yrs</td>
<td>6</td>
<td>172</td>
<td>“Ugli” type</td>
</tr>
<tr>
<td>Algerian clementine</td>
<td>Swingle</td>
<td>6 yrs</td>
<td>6</td>
<td>124</td>
<td>Poor fruit</td>
</tr>
<tr>
<td>Fremont</td>
<td>Swingle</td>
<td>6 yrs</td>
<td>112</td>
<td>98</td>
<td>Good quality &amp; rind colour</td>
</tr>
<tr>
<td>Encore</td>
<td>Swingle</td>
<td>5 yrs</td>
<td>61</td>
<td>103</td>
<td>Poor fruit</td>
</tr>
<tr>
<td>Lisbon ‘Limoneira’</td>
<td>Fraser</td>
<td>3 yrs</td>
<td>16</td>
<td>-</td>
<td>Good size</td>
</tr>
</tbody>
</table>

Daisy and Fremont were the only two mandarin cultivars that showed promise, with Fremont’s adaptability to the Katherine climate supporting earlier evaluations of this cultivar. Many other cultivars have failed to fruit (five to six year-old trees) during the study period. Of those that have produced fruit, quality and/or maturity time were very poor. Only one of the CSIRO breed lines has cropped and its fruit was very unattractive and of poor internal quality. There is merit in industry evaluating Fremont and Daisy in limited trial plantings. Both these cultivars are marketed on the Australian domestic market and with appropriate soil moisture manipulation for early, concentrated flowering, the very early January to March domestic market window could be targeted.
PLANT INDUSTRIES

TECHNICAL

Plant Industries Technical projects use established scientific principles to solve problems that affect the productivity and profitability of the industry and, where possible, to protect the environment and human health.

PROJECT: Product Description Languages for Asian Vegetables and Minor Tropical Crops

Project Officers: G. Walduck, J. Thomas, M. Connelly and G. McMahon

Division: Plant Industries
Location: Darwin
Keyword(s): product description language, Asian vegetables
Project Type: Technical

Objective:
To produce product description languages (PDLs) and supporting material for a range of Asian vegetables and minor tropical crops.

Background:
Accurate information describing the quality, packaging and handling of produce is an essential part of an efficient market chain. A need for such information was identified for marketing small volumes or minor crops from the Northern Territory. Product description languages produced in a base electronic format addressed this need in an inexpensive and flexible way. This format allows for short print runs for hard copy and flexibility in the layout of information. The Rural Industries Research and Development Corporation (RIRDC) funded the production of a number of PDLs for Asian vegetables and minor tropical crops.

Method:
Suitable formats and compatible software were developed and work was undertaken with producers, transport operators, wholesalers and retailers to identify the key parameters to be included in any particular PDL. Produce draft documents for comment and testing.

Results:
A suitable series of template formats have been developed. A number of draft PDLs have been produced and several more are being produced.

Acknowledgement
Funding for this project was provided by RIRDC.
**PROJECT:** Implementation of the *Fusarium oxysporum* f. sp. *cubense* Tropical Race 4 Molecular Diagnostic Test

**Project Officers:** R. Meldrum, L. Tran-Nguyen and A. Daly

**Division:** Plant Industries  
**Location:** Darwin  
**Keyword(s):** banana, *Fusarium*, Coastal Plains Banana Quarantine Station  
**Project Type:** Technical

**Objective:**

*Implement a molecular diagnostic test to detect Fusarium oxysporum f. sp. cubense tropical race 4 (FOC TR4).*

**Background:**

The Northern Territory (NT) banana industry is economically significant to both the NT and Australia. In 2006 the industry was valued at $10.9m. The Tropical Race 4 strain of banana Fusarium wilt, caused by FOC TR4 is arguably the most serious disease of bananas, which was initially detected in the NT in 1997. Until now, it has not been reported elsewhere in Australia. There is currently no effective chemical control for this fungal pathogen and early detection is imperative.

The Cooperative Research Centre for Tropical Plant Protection (CRCTPP) developed a molecular test for the detection of FOC TR4. Following the closure of CRCTPP, it was necessary for DPIFM to implement the FOC TR4 diagnostic test. This will ensure the Section is recognised as a provider of diagnostic services for FOC TR4.

**Method:**

Infected plant material was obtained from the Coastal Plains Banana Quarantine Station (CPBQS). Sections of the pseudo-stem of banana plants, both fresh and dried, as well as culture samples were extracted using two different DNA extraction methods. First, direct tissue extraction using a buffer based protocol and second, extraction of Fusarium DNA from fungal cultures using a method developed by CRCTPP. Specific FOC TR4 Polymerase Chain Reaction primers designed by CRCTPP were used to identify the fungus.

**Results:**

DIFM is now able to conduct molecular diagnostic FOC TR4 tests for rapid screening of quarantine sensitive samples. Three different DNA sources (culture, dried pseudo-stem strands and fresh pseudo-stem tissue) may be submitted for analysis. This method enables infected samples to be confirmed within two days of receipt. Rapid turnaround time is crucial for quarantine sensitive material especially in the case of FOR TR4. Best management practice is to prevent the further spread of the pathogen as there are no means of eradicating the fungus. Using this rapid and reliable method, DPIFM is now recognised nationally as a diagnostic service provider for this pathogen.
**PROJECT:** New and Improved Ornamental Crops

**Project Officers:** D. Marcik, L. Chidwick, R. Connelly, M. Hoult and J. Bonson

**Division:** Plant Industries

**Location:** Darwin

**Keyword(s):** cut-flowers, heliconia, ginger flowers, curcuma

**Project Type:** Technical

**Objective:**

To enhance market opportunities for the NT ornamental industry by providing new and unique cut-flower and ornamental plants.

**Background:**

This project report highlights the progress of the open-pollinated (OP) seedlings of *Heliconia chartacea* ‘Sexy Pink’ and OP seedlings of *Etlingera elatior* var. ‘Alba’ which were established in the field at Berrimah Farm. It also describes commercial field evaluation of the ‘Singapore Gold’ x ‘Apricot’ and ‘Apricot’ x ‘Singapore Gold’ *Zingiber* hybrids and some recent Zingiberale introductions. The report also covers progress on the Curcuma breeding work, and evaluation and selection phases of the cut-flower hybrid field trial and potted colour commercial nursery trial.

*Heliconia and ginger*

In November 2005, a field trial of OP *H. chartacea* ‘Sexy Pink’ seedlings was established at Berrimah Farm. The aim was to screen and select potential new and improved varieties. Preliminary observations and yield counts were conducted on the seedlings over the first flowering season. In the same field, OP *E. elatior* var. ‘Alba’ seedlings were established to screen for potential new and improved varieties.

The on-farm commercial field trial evaluation of the 16 *Zingiber* hybrid plants of ‘Singapore Gold’ x ‘Apricot’ and two plants of ‘Apricot’ x ‘Singapore Gold’ was completed. The ‘best-bet’ cut-flower types were selected. A number of new heliconias and gingers were introduced.

**Results:**

About 74% of the ‘Sexy Pink’ seedlings flowered in the first season. Some of them showed good vigour and produced more than 30 flowers per plant. Preliminary observations showed no significant variation in inflorescence colour or form among seedlings in the field trial. There was variation in size, which was attributed mainly to plant vigour.

In October 2006, a couple of ‘Sexy Pink’ seedling plants suffered from Fusarium wilt disease of heliconia (*Fusarium oxysporum* f.sp. *cubense* race 3 (Foc)) (see Figures 1 and 2). Plant pathology tests confirmed Fusarium wilt disease. It is not known how the disease was introduced as no heliconias had been grown in that block in the past. Cultural hygiene practices have been introduced to control the spread of the Fusarium wilt disease in the ‘Sexy Pink’ seedling trial area. A screening test for seedling resistance to the disease is being conducted.
No flowering was observed in the OP seedlings of *E. elatior* var. ‘Alba’ due to severe damage caused by the *alpinia* borer (*Cognogethes* spp). The *alpinia* borer is a major pest in *Alpinia* and other ginger varieties such as *Etlingera* ‘torch’ ginger. It bores into the stems of the plant causing a decline in vigour and flower production. Stems infested with borers in the field trial were cut and removed. The rest of the plants were then sprayed with the insecticide Axe® (active ingredient Permethrin at 2mL/L) at weekly intervals for three weeks. Spraying was stopped for two weeks and was repeated the following week. Later monitoring indicated that borer activity had been controlled. With regular monitoring, the ‘Alba’ seedlings should start to flower this wet season.

The six ‘Singapore Gold’ *Zingiber* hybrids that were reported in the 2005-06 report are the final selected ‘best-bet’ cut-flower types. Five of the hybrids are ‘Singapore Gold’ x ‘Apricot’ and the other is ‘Apricot’ x ‘Singapore Gold’. As reported last year, these six hybrids exhibited strong vigour and good tolerance to rhizome rots. They have been released to the cut-flower grower company Tropical Ornamental Association for commercialisation.

In 2006-07 three new *Zingiberale* were accessed. They are open-pollinated seeds of *Heliconia chartacea* ‘Yellow Sexy’ ex. tropical Rockhampton; open-pollinated seeds of *Heliconia solomonensis* var. Panga ex. Solomon Islands; and open-pollinated seeds of *Alpinia* sp. ‘White’ ex. Solomon Islands. *Curcuma*

The final evaluation and selection phase of the *Curcuma* cut-flower breeding trial was completed. The commercial nursery trial hybrids were further assessed during the 2006-07 flowering season to determine the ‘best-bet’ potted colour types. The results are being analysed. A commercialisation strategy is being developed for releasing the new ornamental *Curcuma* varieties in 2008.
PROJECT: Indigenous Economic Development

Project Officer: G. Kenna

Division: Plant Industries
Location: Alice Springs
Keyword(s): table grapes, production training, indigenous development, Ti Tree, capacity building
Project Type: Technical

Objective:
To facilitate training for the Anmatjere people to enable them to develop skills in horticulture production in order to gain employment in the industry in the Ti Tree region.

Background:
In the past, the commercial horticulture industry in the Ti Tree region sourced skilled labour from interstate. Now the industry is focusing on the potential of local Anmatjere people to meet labour demand.

A program is in place to identify Anmatjere people, both male and female, who are interested in working in the industry and are willing to learn the skills needed to gain employment.

Method:
The program was initiated about two years ago. It consists of a partnership between the Anmatjere Community Government Council and the table grape industry under the auspices of the Northern Territory Table Grape Growers Association. DPIFM is the facilitator.

The program has a number of facets, including:

- Training programs for Anmatjere people at the Ti Tree Research Farm. This consists of a program to teach skills in irrigation maintenance and management, preparation of ground for planting, planting, machinery maintenance and operation. These programs are delivered by DPIFM staff and registered training organisations.
- The delivery of training programs on commercial properties. This enables trainees to work in a commercial environment and develop skills directly related to commercial horticulture production.
- Participants establishing and managing their own vegetable plantings at their homes at Pmara Jutunta.

Results:
The program has achieved excellent results.

The trainees have worked on a contract basis on a number of properties in the region in the past 12 months. The work has included pruning, vine planting, training and harvesting table grapes. Trainees have also been employed in the melon industry. The work has enabled trainees to meet industry standards, including completing work in a timely manner and to a high standard.

Accredited training has been delivered during this time to enable trainees to continue to increase their skill levels.
Objective:

To facilitate the establishment of community market gardens in indigenous communities.

To use the experience gained in the process to refine indigenous development strategies and methods for developing crops, forestry and horticulture.

Background:

In 2005, the NT Government launched its indigenous economic development (IED) strategy. As a part of the strategy, DPIFM developed a program to increase the capacity of indigenous communities and individuals to participate in plant-based enterprises. The community gardens project is part of this program.

Method:

The project provides resource assessments to communities investigating the feasibility of establishing and managing sustainable market gardens. Community consultations are then undertaken to gauge the level of support and capacity within the communities to establish and manage community farms. Recommendations are then made on the size and scale of operations. Technical assistance is provided in planning, establishment and management of the gardens. Through a consultation process and observations, qualitative information is gathered on the obstacles to community market garden development in indigenous communities in order to refine the strategy and service delivery.

Results:

A limited number of communities have the resources required, or the internal capacity, to progress market garden concepts and ideas to the establishment and management phase. A range of factors have been identified that affect the establishment and sustainability of community gardens.

These factors include:

- A lack of horticulture knowledge within the community.
- Inadequate horticulture training of local people.
- Difficulty in attracting suitably experienced individuals.
- A non-defined market.
- Lack of incentive to work.
- No “real” jobs in market gardens.
- High turnover of staff capable of managing enterprises.
- Poor succession management.
- Horticultural problems.

A combination of any of these factors is enough to stop the development of community market gardens.
In order to address these issues, the project is investigating alternative food production and distribution systems that may have positive, economic, social, health and environmental impacts on remote and regional indigenous communities.

The project continues to provide advice and technical assistance to communities that have established community gardens.

**PROJECT: An Environmental Management Plan for Centrefarm Aboriginal Horticulture Programs**

**Project Officer:** D. Maynard

**Division:** Plant Industries

**Location:** Alice Springs

**Keyword(s):** environmental management planning, indigenous development, capacity building

**Project Type:** Technical

**Objective:**

*To produce a series of whole of project environmental management plans (EMP) that will provide environmental policies, strategies and guidelines for individual Centrefarm projects at all stages of development.*

**Background:**

Centrefarm Aboriginal Horticulture Limited is a body established by Aboriginal land owners in Central Australia to facilitate the development of commercial horticulture on Aboriginal land. Horticultural development in Central Australia introduces a number of potential impacts on natural resources and the environment that must be minimised. DPIFM negotiated a working partnership with Centrefarm to address these issues. The results of this project will provide comprehensive guidelines to reduce and manage environmental impacts and ensure that horticultural development is sustainable.

**Method:**

The most advanced Centrefarm trial at the commencement of this project was at Ali Curung on the Warrabri Aboriginal Land Trust land. It became the pilot program for developing an EMP. Baseline data was collected from various surveys and studies that had been conducted by the Department of Natural Resources, Environment and the Arts (DNRETA) and independent consultancies. The data included information on groundwater resources, soils, biodiversity, landform and climate. A general survey of the area was conducted by the project officer to identify any other considerations that needed to be included. It was decided to develop the EMP around an activity-based structure for ease of use and simplicity. Based on the proposed use of the area for horticulture, a list of activities that would occur during the construction and operation of the development was compiled. The following seven separate management plans were included in the EMP:

- A water management plan to ensure sustainable extraction, prevent deleterious impacts on local and regional groundwater resources and facilitate the most efficient use of water.
- A soil management plan to control erosion, compaction, degradation and promote soil health.
- A biodiversity management plan to minimise the impact on local native flora and fauna, including from burning.
- An air quality management plan to prevent impacts from dust, spray drift, noise and other pollution.

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• A hazardous substances management plan to control the use and storage of fertilisers, pesticides, cleaning products, fuels and oils.
• A pest management plan to ensure that there are no impacts from weeds and other invasive species.
• A waste management plan to provide guidelines on best disposal practices and encourage recycling.

Each plan has an overview, a situation analysis, an environmental policy statement, a management strategy, applicable legislation, policies and references, and environmental management guidelines for any relevant activity. Environmental risks or issues were identified for each activity that was relevant to a particular management plan. Each risk or issue was flagged as having a legal requirement or not and given a risk category. This was then followed by the objective to minimise the risk, control measures that could be put in place, any monitoring required and who was responsible. The draft was distributed widely to stakeholders and relevant government departments for comment and revision.

Results:

The first working version of the Ali Curung EMP was produced in February 2007. This document is now ready for implementation as soon as development work starts at the Ali Curung site. Work has commenced on adapting the Ali Curung EMP for other Centrefarm projects in the Ti Tree area. An audit process is in place to facilitate adaptive management of the plan and to adhere to guidelines.

PROJECT: Evaluation of Irrigated Forages on Blain Soils at Douglas Daly Research Farm

Project Officers: F. O’Gara and Douglas Daly Research Farm Staff

Division: Plant Industries
Location: Darwin
Keyword(s): irrigation, Douglas Daly Research Farm
Project Type: Technical

Objective:

To evaluate the performance, agronomic requirements and commercial potential of irrigated forage crops in the Daly Basin.

Background:

The fodder industry in the Top End is small but important, producing between 70 000 and 100 000 tonnes of hay and silage annually, supporting the NT’s $250m live-cattle export industry. However, due to the limited size of the local fodder market the industry is now investigating interstate and overseas opportunities. Export markets require fodder of high nutritional quality and good colour. Irrigated hay production is one option for achieving this goal.

In the mid-1990s DPIFM initiated an irrigated cropping R&D program at Douglas Daly Research Farm (DDRF) to evaluate a range of tropical crops and pastures in small plots. In 2002, larger plots were established for the most promising species under centre pivot irrigation to further assess their potential for commercial production.
Method:

Semi commercial plots (1.5 to 4 ha) of Rhodes grass, forage sorghum, maize, lucerne and forage oats were established under centre pivot irrigation at DDRF. The plots were maintained and harvested over several seasons using commercial machinery. Persistence, yield, nutritional quality (protein, energy and digestibility), and disease and insect pressure were recorded.

Results:

The evaluation provided base line information on the performance, quality and suitability of the forage species trialled. It has identified species which have potential for commercial production and highlighted agronomic issues. The results will be presented in a Technical Bulletin. A number of farms are now producing Rhodes grass, forage sorghum and some lucerne in the Katherine Daly Basin.

PROJECT: Improving Producer Economic Management

Project Officer: M. Connelly

Division: Plant Industries
Location: NT-wide
Keyword(s): mango, cut-flowers, nursery, citrus, melon, rambutan, table grapes, capacity building
Project Type: Technical

Objective:

To build a capacity in primary producers and their associations to enable them to make informed decisions on future economic management issues.

Background:

In 2005-06 this project came under “Sector Liaison” to provide connectivity between industry stakeholders and government departments. During that year the name was modified to “Capacity Building”, with a charter to help build the capacity for practice change within the primary production sector. Rather than concentrate on the producer and the crop only, the focus has shifted to embrace other elements such as the environment, economic strategies and the social aspects that change can bring. Together, the Northern Territory Horticultural Association (NTHA) and DPIFM have developed an effective operational partnership that can develop and foster practice change capabilities in a wide range of primary producers. See Table 1 for a list of field days, workshops and displays.

Examples of capacity building:

- The mango crop forecasting results of 2005-06 enabled the mango and allied industries to plan for a successful and profitable mango harvest. Strong and lasting partnerships were forged between DPIFM, NTHA, the Australian Mango Industry Association, labour and transport providers, the Commonwealth Department of Environment and Water Resources, Centre Link and growers. This was capacity building at a whole of industry level.
- Hay producers in the NT are working towards a quality control program under the name of a “vendor declaration”, which will be capacity building in a marketing group.
- Through the Better Melons Project with the Queensland Department of Primary Industries and Fisheries (QDPI&F) Katherine melon growers have gained confidence and useful agronomic
information to produce a quality crop. This is an example of focused networking and effective relationships.

Results:

A water use survey of nursery businesses in the Darwin region showed that most irrigation was delivered through overhead sprinklers, with an average application rate of 17 ML per year. There is scope to reduce this use through a range of different growing media and more efficient watering systems. The potting media workshop held in October encouraged a number of nurseries to trial coir bark mixes which have a great capacity for water retention.

The Australian nursery industry, in partnership with Horticulture Australia Limited, has developed an environmental management system called EcoHort, which provides a risk assessment-based pathway for production nurseries to determine environmental impacts, efficient resource use and sound strategies to meet environmental obligations. Four nurseries in the Darwin area have adopted EcoHort. There are now 10 accredited nurseries in the NT including an Alice Spring nursery which was accredited in May 2006.

The North Australian Cut-flower Group (NACG) is represented on a steering committee to foster and process the development of a national peak body for the Australian traditional cut flower industry. Australian wildflower growers have not joined this national peak body. NACG assisted in hosting the Heliconia Society International Conference in Darwin which was attended by 60 delegates from many countries.

About 150 tonnes of citrus, mainly lemons and Tahitian limes, were sold to southern markets. During the year many farms were sold and new owners did not continue with citrus production.

Cucumber production remained at record levels in 2006, building on the rapid expansion in protected shade-house and hydroponic production which occurred from 2003 to 2005. The industry is dominated by non-English speaking background growers. It is thriving due to a combination of water shortages in Queensland and high heating costs in southern glasshouse production. Cucumbers growers are adopting good soil health practices by using green manure in the wet season. This system was developed by DPFM.

In 2006, the Tropical and Exotic Fruit Association (TEFA) was established across northern Australia to include the NT and north Queensland. This group is in the process of formulating its strategic plan with the help of NTHA. Rambutan growers successfully trialled the use of plastic bags for marketing their produce in partnership with Western Australia and Queensland under the research program of TEFA, which will eventually replace the expensive use of punnets.

In 2006, the melon industry demonstrated the value of the QDPIF/DPIFM Better Melon Project by achieving a record production and value for melons in the NT. Seedless watermelon dominates melon production. Production is in Katherine, Mataranka and Darwin. The bulk of the crop is harvested in the dry season when backpacker labour is available. DPIFM officers assisted NT growers to implement effective food safety and quality assurance systems recommended by the national melon industry.

A joint project between industry and DPIFM aims to establish “best practice” table grape planting at Ti Tree Research Farm (TTRF). The planting will consist of one table grape cultivar on three rootstocks. Two different types of trellis will be used to evaluate yield and fruit quality. The industry continues to receive advice on agronomic issues including nutrition, pests and disease control.

A program to evaluate the potential of new table grape selections bred by CSIRO continues with a range of new selections being established at the TTRF. This program is funded by the national table grape research levy. A cooperative program between the Anmatjere Community Government Council, DPIFM and industry continues to train Anmatjere people in skills that enhance employment opportunities. Trainees have secured a number of contracts for vine pruning and planting.
The 2006 mango season was exceptionally good for NT mango growers when a long dry harvest period resulted in near record yield, good quality fruit and consistent good prices. Harvest labour and transport were well planned and coordinated through pre-season forums, effective communication and collaboration.

The better outcomes mango project has been building grower capacity in the WEPack group, which has demonstrated its value to industry. Growers in this group produced premium fruit which was packed in brand cartons. It attracted premium prices throughout the season, even beating other high quality fruit. The brand won buyer confidence in the internal and external quality of the fruit.

A number of workshops were conducted by the project to build on the information and decision-making tools presented over the previous year. These workshops were open to any grower outside the group. However, mainly WEPack quality marketing group growers attended. The workshops provided an effective measure of the value of extension and training to improve industry and individual outcomes. In contrast, general meetings deliver little measurable value and struggle to get reasonable attendance.
Table 1. Workshops, field days, shows, displays and industry development activities in 2006-07

<table>
<thead>
<tr>
<th>Subject</th>
<th>Event</th>
<th>Venue</th>
<th>Date</th>
<th>Presenter(s)</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian vegetables</td>
<td>Chemical review</td>
<td>Palmerston</td>
<td>29/6/07</td>
<td>G. Walduck/NTHA</td>
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<td>Bananas</td>
<td>ACIAR project – presentation on FOC research work</td>
<td>Padang University, Indonesia</td>
<td>Feb 2007</td>
<td>G. Walduck</td>
<td>20</td>
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<td>ACIAR project – presentation on FOC research work</td>
<td>Malacassa University, Indonesia</td>
<td>Feb 2007</td>
<td>G. Walduck</td>
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<td>ACIAR project – presentation at Fusarium workshop</td>
<td>University of Padang, Indonesia</td>
<td>Aug 2006</td>
<td>G. Walduck</td>
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<td>ACIAR project – presentation at Fusarium workshop</td>
<td>IFURI, Sumatra Indonesia</td>
<td>Aug 2006</td>
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<td></td>
<td>Australian Banana Conference – presentation on FOC research</td>
<td>Brisbane</td>
<td>16/6/07</td>
<td>G. Walduck</td>
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<td>FOCTR4 - Australian Banana Congress</td>
<td>Queensland</td>
<td>15-17/6/07</td>
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<td>ACIAR project – power-point presentation</td>
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<td>Best practice for sustainable land use in agriculture</td>
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<td>Biofuel</td>
<td>Field walk</td>
<td>KRS</td>
<td>17/5/07</td>
<td>M. Bennett, D. Owens</td>
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<td>Broad Acre Crops/Irrigation</td>
<td>Australian Fodder Industry Association Conference visit</td>
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<td>Irrigation Association of Australia delegate visitors</td>
<td>DDRF</td>
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<td></td>
<td>North Australia fodder exports visit</td>
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<td>DDRF management Irrigation Officer</td>
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<td>Cittgroup</td>
<td>Field walks</td>
<td>Lowther Rd, Bees Creek Duff Road, Wanderie</td>
<td>9/9/06</td>
<td>M. Connelly</td>
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<td>Finding a balance in your orchard</td>
<td>Power Road, Humpty Doo</td>
<td>29/11/06</td>
<td>A. Krajewski, M. Connelly</td>
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<td>Finding a balance in your orchard</td>
<td>Eumaralla, Lowther Road, Katherine</td>
<td>30/11/06</td>
<td>A. Krajewski, M. Connelly</td>
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<td>Subject</td>
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<td>Cut-flowers</td>
<td>4th International Symposium on the family Zingiberaceae – presentation on ‘development of curcuma hybrids: an evaluation of flowering characteristics and floral features for ornamental use’</td>
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<td>D. Marcsik</td>
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<td>4th International Symposium on the family Zingiberaceae to the North Australian Cut-flower Group meeting</td>
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<td>Flower display</td>
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<td>15/2/07</td>
<td>D. Marcsik, R. Connelly</td>
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<td>Geoff Meehan’s property Napier Road, Katherine</td>
<td>23/7/06</td>
<td>D. Reilly</td>
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<td></td>
<td>Forestry measuring and thinning demonstration for DPIFM and GANT staff</td>
<td>Geoff Meehan’s property Napier Road, Katherine</td>
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<td>Forestry forum for plantation MIS companies</td>
<td>Darwin Airport Hotel</td>
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<td>Timber industry network AGM and grower field day</td>
<td>Gorge Road, Katherine</td>
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<td>Planting fruit trees - national accredited course for Anmatjere trainees</td>
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<td>Visit to Tangentyere Nursery to learn nursery practices</td>
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<td>Meeting with representatives from Anmatjere Council – trainees and industry</td>
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<td>Mango rootstock and parent tree orchard walk</td>
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<td>Mango pruning and orchard rehabilitation</td>
<td>Manbulloo, Katherine</td>
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<td>Berry Springs</td>
<td>27/8/06</td>
<td>G. Owens</td>
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<td>Controlling mango growth to improve profit field day</td>
<td>Growers properties</td>
<td>10/12/06</td>
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<td>Mango post-season harvest labour forum</td>
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<td>Mango post-season transport forum</td>
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<td>Delivering mango technology project – 1st steering group meeting</td>
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<td>Delivering mango technology project – 2nd steering group meeting</td>
<td>BARC</td>
<td>4/5/07</td>
<td>D. Hamilton, G. Owens, B. Thistleton, B. Conde</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Mango Nutrition Workshop</td>
<td>CPHRF</td>
<td>14/6/07</td>
<td>G. Owens, D. Hamilton, B. Thistleton, S. Kandiah</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Presentation to AMIA mango conference &quot;using crop forecasting&quot;</td>
<td>Surfers Paradise</td>
<td>23/5/07</td>
<td>NTDPIFM/NTHA</td>
<td>180</td>
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<tr>
<td>Melons</td>
<td>Pollination meetings</td>
<td>KRS</td>
<td>23/8/06</td>
<td>J. Bird</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Pollination meetings</td>
<td>KRS</td>
<td>12/5/07</td>
<td>J. Bird, D Owens</td>
<td>15</td>
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<td>Nursery</td>
<td>Tropical garden spectacular display</td>
<td>Darwin Botanic Gardens</td>
<td>12-13/8/06</td>
<td>CFH staff</td>
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<tr>
<td></td>
<td>Potting media workshop</td>
<td>BARC</td>
<td>29/9/06</td>
<td>J. McDonald</td>
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<td></td>
<td>NIASA workshop</td>
<td>Sydney</td>
<td>7/12/07</td>
<td>Rt Prince</td>
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<tr>
<td>Subject</td>
<td>Event</td>
<td>Venue</td>
<td>Date</td>
<td>Presenter(s)</td>
<td>Participants</td>
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<td>Rambutan</td>
<td>Electronic marketing and product coordination systems for tropical fruit</td>
<td>Growers properties and NTHA Office</td>
<td>12-14/9/06</td>
<td>G. McMahon, G. Owens</td>
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<td>Table Grapes</td>
<td>Group discussion</td>
<td>AZRI</td>
<td>5/10/06</td>
<td>G. Kenna</td>
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<td>Vegetables</td>
<td>Snake bean field walk</td>
<td>Growers properties</td>
<td>29/6/07</td>
<td>G. Walduck</td>
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<td></td>
<td>Pesticide review</td>
<td>Palmerston</td>
<td></td>
<td>NTHA</td>
<td>9</td>
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<tr>
<td>Weeds Management in Crops</td>
<td>Douglas Daly farm walk/talk</td>
<td>DDRF</td>
<td>29/3/06</td>
<td>CFH + Pastures Staff</td>
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<td></td>
<td>Field talk on broadleaf control in improved pastures</td>
<td>Kumbyechants property Douglas Daly</td>
<td>31/10/06</td>
<td>N. Hartley</td>
<td>12</td>
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<td></td>
<td>Showing producers trial work done on sucker regrowth control</td>
<td>Fleming town site, Douglas Daly</td>
<td>31/10/06</td>
<td>P. Hausler, N. Hartley</td>
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<td>NT Show Circuit / Displays</td>
<td>Katherine farm and garden day</td>
<td>KRS</td>
<td>31/3/07</td>
<td>KRS Staff/D. Reilly</td>
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<td></td>
<td>Fred's Pass Show</td>
<td>Coolalinga</td>
<td>26-27/5/07</td>
<td>DPIFM Staff</td>
<td>-</td>
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<tr>
<td></td>
<td>Alice Springs Show</td>
<td>Alice Springs</td>
<td>7-8/7/06</td>
<td>AZRI Staff</td>
<td>-</td>
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<td></td>
<td>Katherine Show</td>
<td>Katherine</td>
<td>21-22/7/06</td>
<td>KRS Staff</td>
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<td></td>
<td>Darwin Show</td>
<td>Darwin</td>
<td>27-29/7/06</td>
<td>M. Connelly</td>
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</table>
PROJECT: Local Best Practice Groups

Project Officers: D. Rock, J. Bird and D. Owens

Division: Plant industries
Location: Katherine
Keyword(s): mango, OH&S, best management practice
Project Type: Technical

Objectives:

To facilitate the improvement of farm management practices in the Katherine region.

To promote the local best management practice group’s activities in the Katherine region.

Background:

Local best practice group extension activities are determined by the Katherine Plant Industries Advisory Forum (KPIAF) formerly KHAF. These activities promote and support a holistic approach to farming in the Katherine region.

Method:

Activities

Mango pests and beneficials - Seventeen growers attended an on-farm discussion on 6 July 2006 conducted by Darwin Entomology staff on mango pests and beneficial insects.

OH&S workshop - Twenty-seven people attended an NT Worksafe Occupational Health and Safety workshop at Katherine Research Station (KRS) on 30 August 2006. The workshop covered safe work practices and the important legislation farms are expected to follow. The horticultural safety package was distributed.

Best practice for sustainable land use - On 13 September 2006, six people attended a meeting at KRS organised by NTHA to report back to growers in the Katherine region on the draft best practice for sustainable land use manual.

Mango rootstock and parent tree orchard walk - This activity included an orchard walk with three growers at KRS on 9 November 2006, where a number of suitable mango rootstocks and parent trees for both domestic and international markets were shown.

Mango pruning and orchard rehabilitation - On 6 December 2006, the Senior Extension Officer conducted a practical demonstration of mechanical and structural mango tree pruning at a grower’s property, attended by 12 growers.

Mango IPM workshop - On 28 June 2007, Darwin Entomology staff conducted a mango IPM workshop at KRS on mango flower insects and their effect on fruit quality, attended by eight growers. Growers requested property visits once mango flowering was in full swing. Growers were very interested in the damage caused by insects and the research that could reduce it.
Results:

The local best practice group activities are still as successful as in previous years. These activities are providing a level of learning and group interactions that help growers to continue to improve farm management practices in the Katherine region.

PROJECT: Developing a Crop Forecasting System for the Australian Mango Industry

Project Officers: G. Owens, J. Thomas and D. Rock

Division: Plant Industries
Location: NT-wide
Keyword(s): mango, supply chain, crop forecasting, marketing
Project Type: Technical

Objectives:

To ground truth the heat sums theory in other production regions and introduce flowering surveys as a method of collecting data to compile an Australian mango season forecast.

To identify a reliable method to predict likely volumes for each production region.

To provide industry with a successful system by 2009.

Background:

In conjunction with the Mango Industry Association, DPIFM has published an NT mango seasonal forecast that shows the predicted time for the harvest peaks of the two main production regions of the Darwin rural and Katherine areas. This prediction is based on flowering surveys and the application of heat sum calculations to convert this flowering data into a harvest pattern. The forecast is widely used by the NT industry to better plan for each harvest. Each year the forecast is checked against the actual production pattern for the season by collecting weekly dispatch information from the major packing sheds and consolidators. Mangoes are highly seasonal and the periods of heavy and light supply fluctuate greatly throughout the mango season and from one year to the next. Mangoes are also extremely perishable and need to be moved quickly through the supply chain to achieve acceptable shelf life and best eating quality. Most production is in subtropical and tropical areas, often very far from the major markets of east coast cities. These factors cause problems for harvest labour, transport logistics, cooling and ripening, infrastructure, quality outturns, marketing and ultimately returns to all members of the supply chain.

Growers have often “jumped the gun” through fear of being swamped by other local or interstate growers. They harvest immature fruit which results in plummeting prices.

Method:

The heat unit system works on the basis that fruit needs a certain amount of heat to enable it to mature. By finding out the amount of heat (daily maximum and minimum temperatures) the developing fruit has been exposed to and by applying the correct formula, it is possible to predict when mangoes are ready for harvest.

Predicted heat units use the historical mean monthly averages (that have been collected over several decades) to calculate when dry matter testing should commence. As this is a large database over several
years, it is a fairly good indicator for growers. Real date values replace historical values as the current season’s temperatures are recorded, which may change harvest times slightly.

Information from flowering surveys is fed into heat sum formulas, generating a harvest pattern for the season. As this information changes with each year’s actual temperatures, fortnightly updates are published. The major flowering in Australia can be picked up in two consecutive flowering surveys that can be filled out by growers and faxed, emailed or completed on line. Volume forecasts are generated from a model that looks at flowering percentages, fruit-set and retention, industry weekly capacity and packing shed and allied industry estimates.

Results:

The 2006 mango crop forecast accurately predicted the timing and volume of the Darwin and Katherine mango production seasons. The forecast was updated fortnightly and demonstrated the important place of the updates as the timing of the Katherine peak harvest pushed back almost two weeks from the earliest predictions in August, from mid October to early November.

The forecasts and the analysis of their accuracy were presented to growers at the timely pre and post season seminars in Darwin and Katherine. The information was also used by the NT Horticulture Association (NTHA) in pre season forums with the transport industry and the harvest labour suppliers. The feedback from industry groups was that the information was very useful for their seasonal preparations.

Figure 1. Actual mango production compared with prediction

The full set of 2006 NT mango crop forecasts are available on the DPIFM website, www.horticulture.nt.gov.au, on the 2006 mango season page.

A report of the use of the crop forecasting system in planning the harvest labour requirements is available at the NTHA website, www.ntha.com.au in the document section.

Cooperating growers in the Dimbullah/Mutchilba area assisted in the set-up of temperature data loggers and tagging early and late flowering of KP, R2E2 and Keitt trees for harvest maturity assessments. The maturity assessment of the fruit was carried out in Mareeba in December and the results fit the same maturity
relationships as experienced in the NT. This is the third climatically different area in which the relationships between heat sums and harvest maturity have remained consistent, providing further evidence that a reliable national forecasting system based on this model is possible.

Crop forecasts for each business were prepared from temperature and flowering information and updated through the season with new temperature data. These forecasts remained ‘commercial in confidence’ for each farm. The forecasts are being analysed to compare with actual production patterns on these properties.

The theory behind the forecast models is proving to be sound. Growers associated with the project can see the benefits of contributing individual information to create the bigger regional and industry picture. Growers outside the project in various locations remain to be convinced.

The project moves into a larger mode for the 2007-08 season and will plan to publish forecasts for the Dimbulah/Mutchilba area from the Mareeba region and from an increased number of farms from Burdekin. Kununurra growers will be included in preliminary data collection and analysis this season.

Acknowledgements

This project was supported by HAL in partnership with the Australian Mango Industry Association. It was funded by the mango industry levy and the NT Government. The Australian Government provides matched funding for all HAL R&D activities.

PROJECT: Implementing a Top End Better Mangoes Project

Project Officers: G. Owens and R. Renfree

Division: Plant Industries
Location: NT-wide
Keyword(s): mango supply chain
Project Type: Technical

Objectives:

To use the techniques developed by the Queensland Better Mangoes team to map the performance of selected examples of existing Top End supply chains.

To establish the saleable life index (SLI) performance of Top End fruit and use it as a benchmark to evaluate other systems.

Background:

Top End supply chains are predominantly based on sending mature unripe mangoes to markets and either gas or naturally ripening them at destination.

The main mango producing areas in the Top End - Darwin rural and Katherine - and Kununurra in WA, are very far from the major markets on the east coast cities and from Perth in the west. The minimum time in transit is four days, while six to 10 days is the norm. Some fruit takes up to 14 days to get to market.

Consignments from the north, which leave in triple trailer road-trains, are routinely broken up for transport into southern markets. The new rail line to Darwin provides containerised freight as an option.

QDPI&F showed in its better mangoes project that the way the fruit was treated in the cool chain was crucial to its market outcome.
The Queensland Better Mangoes Project also developed the concept of SLI which allowed for the quality of the fruit in the market to be objectively benchmarked. By working with growers the Better Mangoes team was able to recommend two viable fruit transport and ripening systems for maximum SLI outcomes.

**Method:**

The target was to monitor four consignments per grower/packer for the five cooperating businesses, three from Katherine and two from Darwin, for temperature and outturn benchmarking against SLI.

A cooperating business was identified from Kununurra and initial logging of the supply chain was undertaken on an informal basis for the 2006 season.

All NT cooperating businesses had at least one of their consignments monitored and assessed. This target of four consignments per business was met by three enterprises. In addition, a sample from many of the consignments was kept back in Darwin, ripened and assessed as a static trial. SLI was established where possible and will form the basis of the benchmarking process of the combined seasonal report.

Some of the monitored consignments became part of export supply chain assessment for other developmental projects. The final outturn results and photos for these consignments are with QDPI&F.

**Results:**

In a number of cases it was difficult to establish an SLI, defined as the time between the fruit ripening to 60% and showing 10% post-harvest rots. This was because the season’s fruit development and harvest weather was exceptionally dry and the disease load of the fruit was low. Many trays of fruit collapsed from old age before demonstrating post-harvest rots. Most major growers also used Azoxystrobin pre-harvest.

The temperature information for the supply chain maps gave a clear history of the conditions faced by the fruit on its way to southern markets. Temperature management is well understood and these participants have developed strategies, infrastructure and alliances to maximize their success.

In 2006 these temperature systems were not challenged even though it was the second largest NT crop on record for a number of reasons:

1. The harvest was spread over 12 weeks instead of the usual eight weeks.
2. There was minimal overlap of the Darwin and Katherine seasons.
3. There was a large amount of banana cooling and ripening capacity available to the mango industry.

However, there is some evidence that the procedures normally used for ripening bananas resulted in high CO2 levels in the ripening process and subsequent green-skinned or blotchy coloured ripe mangoes.

There were some issues especially with rail freight, from a number of derailments and rail stoppages. This impacted mainly on the Katherine crop.

**Acknowledgements**

This project was supported by HAL in partnership with the Australian Mango Industry Association. It was funded by the mango industry levy and the NT Government. The Australian Government provides matched funding for all HAL R&D activities.
PROJECT: Management of Leaf Spot Disease of Peanuts

Project Officers: S. Bhuiyan, M. Bennett and M. Kahl

Division: Plant Industries
Location: Katherine
Keyword(s): peanuts, fungicide spray model, leaf spot
Project Type: Technical

Objective:

To develop a fungicide spray model on the basis of weather variables for the management of leaf spot disease of peanut in the Katherine and Douglas Daly regions.

Background:

Peanuts (Arachis hypogaea) are becoming an important crop in Northern Territory (NT), where they are grown in winter. In contrast, peanuts are grown during the summer months in QLD and NSW. Therefore, NT peanuts will satisfy 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 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 days schedule until 14 days prior to harvest. Excessive use of chemical fungicide could hamper future peanut production by contributing to the development of resistant pathogens.

Method:

An experiment was conducted at the farm belonging to the Peanut Company of Australia (PCA), Katherine using a Latin square design with five treatments and five replications. Plot size was 18 m × 20 m. Peanut variety Menzies, which is highly susceptible to leaf spot, was sown on 13 April 2006 in twin rows (15 cm apart) at the rate of 140 kg/ha with a no till planter, to a depth of about 6 cm. The space between the twin rows was 0.9 m.

The five treatments were (i) Elect® 14-day spray schedule (spray every 14 days), (ii) Elect® Advisory (spray according to the Virginia model), (iii) First spray with Folicur®, then Elect® 14-day schedule, (iv) First spray with Folicur®, then Elect® Advisory, and (v) Unsprayed control. The fungicide products, active ingredients, rate of application and name of manufacturing company are given in Table 1. Agridex® (Bayer Crop Science), a surfactant, was mixed (1L/ha) with Folicur® before application.

Table 1. Chemical fungicides used in the peanut leaf spot trial at PCA, Katherine, 2006

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Active ingredient</th>
<th>Product application rate (L/ha)</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elect® 500</td>
<td>50% Chlorothalonil</td>
<td>1.6 L/ha</td>
<td>Nufarm Australia Ltd</td>
</tr>
<tr>
<td>Folicur® 430 SC</td>
<td>43% Tebuconazole</td>
<td>230 mL/ha</td>
<td>Bayer Crop Science</td>
</tr>
</tbody>
</table>

The fungicide was applied in 100 L water/ha with a tractor-mounted boom sprayer at a pressure of 350 kPa.
The temperature and the relative humidity at 20 cm, 50 cm and 1 m above the soil surface were recorded using sensors (TinyTag Plus®, Gemini Data Loggers (UK) Ltd.). Data from 20 cm-height sensors were used to decide on fungicide spray (Advisory).

Disease assessment was conducted weekly from 31 August to 27 October 2006. Randomly selected ten plants from each treatment plot were assessed using a standard leaf spot disease scale of 1 to 10, where 1 = 0%, 2 = 1-5%, 3 = 6—10%, 4 = 11-20%, 5 = 21-30%, 6 = 31-40%, 7 = 41-60%, 8 = 61-80%, 9 = 81-100% disease severity, and 10 = dead plant. Peanuts were harvested on 7 November 2006 from 8 m by two twin rows from the middle of each plot, thrashed and weighed. The raw peanuts were sent to PCA, Kingaroy for grading.

**Results:**

Leaf spot disease severity and yield data are being analysed. Temperature and relative humidity data is not presented.

No apparent differences in leaf spot severity were observed between sprayed and unsprayed plots until the second week of assessment. From the third week, disease severity in control plots was constantly higher than in Advisory plots, followed by the 14-day spray schedule plots from the second assessment period (Figure 1). No differences in disease severity were apparent between Elect® and Folicur®+Elect® Advisory. Similar results were observed between Elect® and Folicur®+Elect® 14-day schedule plots.

![Figure 1. Disease severity under different treatments](image)

Ten fungicide sprays were required for the 14-day schedule plots, whereas only three sprays, a 70% reduction in the number of sprays, were needed for the Advisory plots. The lowest mean production (2.46 tonnes/ha) was recorded in control plots and the highest in Folicur®+Elect® 14-day schedule plots (Table 2).
### Table 2. Peanut yield after sprays with fungicides using 14-day schedule and peanut Advisory at PCA, Katherine, 2006

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Spray schedule</th>
<th>Total number of spray</th>
<th>Yield/ha (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elect®</td>
<td>14-day schedule</td>
<td>10</td>
<td>2.66</td>
</tr>
<tr>
<td>Elect®</td>
<td>Advisory</td>
<td>3</td>
<td>2.61</td>
</tr>
<tr>
<td>Folicur®+Elect®</td>
<td>14-day schedule</td>
<td>10</td>
<td>3.23</td>
</tr>
<tr>
<td>Folicur®+Elect®</td>
<td>Advisory</td>
<td>3</td>
<td>3.03</td>
</tr>
<tr>
<td>Control (no spray)</td>
<td>-</td>
<td>-</td>
<td>2.46</td>
</tr>
</tbody>
</table>

Although average yield was lowest in unsprayed control plots and highest in Folicur®+Elect® 14-day scheduled plots, initial statistical analysis indicates that the differences are not significant. The peanut season in Katherine in 2006 was different from normal years. Peanuts were planted late in April instead of March due to local flooding and late rain. Below average temperatures during the growing season also affected growth and development of peanut plants. Disease started to appear only in the first week of September, which may not have had sufficient time to impact on yield.

**PROJECT:** Broadleaf Weed Control in Perennial Grass Pastures

**Project Officers:** N. Hartley, R. Eastick and B. Beumer

**Division:** Plant Industries

**Location:** Darwin

**Keyword(s):** weeds, broadleaf, perennial, pastures, Douglas Daly Research Farm

**Project Type:** Technical

**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. An experiment was initiated to examine weed control efficacy of a range of herbicides in jarra, sabi and Strickland pastures. The 2006-07 wet season coincided with the third year of this experiment. Results for the initial and second years were presented in the 2005-06 Technical Annual Report.

In the 2005-06 wet season, all herbicide treatments, at both low and high rates, applied early and late in the season, were effective at controlling broadleaf weeds in pastures. Due to the efficacy of all treatments at both times, we considered there may be scope to further reduce application rates, particularly early when weeds are small. The spray window can often be narrow at the start of the wet season (after initial weed emergence), so the opportunity for early herbicide application may be missed. We needed to also identify whether lower herbicide rates would be effective at a later application on larger weeds.

In the 2006-07 season, we intended to evaluate weed control at two application times (early and late, when weeds are up to 10 cm and more than 30 cm, respectively), consistent with the previous season, but using only a single herbicide rate equivalent to half the ‘low’ rate used last season.
Method:

Experimental design and site

Randomised split-split plot, Douglas Daly.

Treatments

Main plot: Pasture species: jarra, sabi and Strickland
Sub-plot: Herbicide; (details in Table 1)
Sub-sub-plot: Time of application; early (E) and late (L)

Table 1. Herbicide application rates

<table>
<thead>
<tr>
<th>Trade name</th>
<th>Active ingredient</th>
<th>Rate (product/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diuron (flowable) and Amicide 625</td>
<td>Diuron (500 g/L) &amp; 2,4-D amicide (625 g/L)</td>
<td>750 mL and 400 mL</td>
</tr>
<tr>
<td>Brush-off® &amp; Amicide 625</td>
<td>Metsulfuron (600 g/kg) &amp; 2,4-D amicide (625 g/L)</td>
<td>4 g and 400 mL</td>
</tr>
<tr>
<td>Amicide 625</td>
<td>2,4-D amicide (625 g/L)</td>
<td>400 mL</td>
</tr>
<tr>
<td>Nu-trazine (flowable) and Amicide 625</td>
<td>Atrazine (500 g/L) &amp; 2,4-D amicide (625 g/L)</td>
<td>750 mL and 400 mL</td>
</tr>
</tbody>
</table>

Measurements and sampling

Cattle grazed the site over the dry season, as indicated in Figure 1, but were removed prior to the start of the wet season to allow the pasture species and weeds to re-establish once it started raining. The early herbicide treatment was applied on 22 November 2006; pasture height was about 30 – 40 cm with mainly sickle pod (*Senna obtusifolia*) at cotyledon to three-leaf stage. The area was fertilised with 200 kg/ha of Rustica Pluss® (12-5-14 plus trace) on 30 November 2006. The control plots were split into fertilised and non-fertilised to provide a preliminary assessment of differences in weed dynamics. The site was again visited on 28 December with the intention to apply the late herbicide treatments. Grasses were up to 70 cm tall, had commenced seeding and were extremely vigorous. Weeds were at cotyledon stage, illustrated in Figure 2. It was decided not to apply the herbicides at this time, as it was unlikely the weed seedlings would intercept any herbicide due to the dense cover provided by the pasture species. We continued to monitor the plots with the intention to apply the late herbicide treatment when the weeds emerged above the grass canopy.

Results:

The late herbicide treatments were not applied, as there was very little establishment of either grass or broadleaf weeds as the season progressed, due to the excellent competitiveness of the pasture species. Figure 3 illustrates the pasture species growth on 17 January. There was no observable herbicide effect for the early application treatments as all treatments produced excellent weed control. At the end of the season, no weeds were observed even in the ‘no-herbicide’ control plots above the canopy of the jarra strips; only isolated broadleaf weeds were seen in the Strickland and small patches of weeds in the sabi. There was no observable difference in weed biomass in the plots where the herbicides had been applied early and where no herbicide had been applied in the ‘late’ treatment. This suggested that, even with no herbicide application, the pasture species were efficient competitors, particularly jarra, but sabi was relatively poor in suppressing weeds. In hindsight, the plots should have been grazed in early January. This would have allowed for better pasture utilisation as would occur in a commercial situation and would have also provided more opportunity for weed emergence. But this was difficult due to the surrounding maize crop. However, these results indicate that grazing management and maintaining a competitive grass sward at critical times in the season have a major role in weed control.
Figure 1. Cattle effectively reduced the grass biomass over the dry season

Figure 2. A dense grass sward had re-established by 28 December, inhibiting emergence of senna seedlings

Figure 3. No weeds had emerged through the thick grass canopy by the end of the wet season
PROJECT: The National Grapevine Leaf Rust Eradication Program (NGLREP)

Project Officers: G. Schultz, G. Hore, S. Hornby and C. Hennessey

Division: Plant Industries
Location: Darwin
Keyword(s): grapevine leaf rust
Project Type: Technical

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 monitoring for GLR outside QA.

To remove any grapevines diagnosed with GLR and achieve “area freedom” in July 2007.

To conduct surveillance for GLR on Ampelocissus acetosa and A. frutescens during the wet season.

Background:

The fungus Phakopsora euvitis Y Ono (2000) causes GLR. It was detected in a suburb of Darwin on 17 July 2001. The disease had not occurred previously in Australia and was regarded as an exotic incursion. Grapevines are used as ornamental plants or for culinary use in Darwin and nearby rural areas. Due to climatic conditions, grapevines grow continuously throughout the year. The nearest large-scale commercial plantings of grapevines are at Ti Tree, some 300 km south of Darwin.

Professor Yoshitaka Ono from Ibaraki University in Japan, a world authority on rust diseases, visited Darwin in January 2002 to confirm the identity of the infection in the field and provide advice on the current situation. There was no evidence at that time for the pathway for this P. euvitis incursion.

Having established that P. euvitis was confined to Darwin and the satellite city of Palmerston, the Primary Industries Ministerial Council approved, in October 2002 funding under the national cost sharing arrangement for the implementation of NGLREP.

Method:

Four phases were implemented to identify all properties with grapevines, sample and test the vines for GLR, remove infected plants until area freedom is achieved. This took four years.

Ongoing surveillance was conducted for all grapevines that tested negative for P. euvitis in the Darwin property-to-property survey. The sampling method used full sampling, symptom-based. From June 2003 surveillance occurred at least every 10-12 weeks and from January 2004 onwards this interval was reduced to every six to eight weeks, with some locations being sampled back to back to identify potential hot spots for P. euvitis.
Results:

During the four phases of NGLREP, 745 grapevines were located and 504 (67%) were removed.

For the 67% that were removed, the following results were recorded:

- 38% tested positive to \textit{P. euvitis}
- 15% tested healthy but were volunteered for removal by their custodians
- 8% were of unknown status as the custodian requested immediate removal and
- 6% were dead at the time of removal due to other factors, not related to \textit{P. euvitis}.

Out of 67% that were removed, 14% were grapevines that originally tested negative to \textit{P. euvitis} but in subsequent surveillance tested positive and were removed. Now only 33% of the original vines remain on 34% of the original properties.

Ongoing surveillance has not detected the presence of \textit{P. euvitis} in Palmerston since November 2003. This is a 28-month period, with the potential for at least 56 \textit{P. euvitis} life cycles. Fourteen surveillance rounds were conducted in this period, including March 2006.

Ongoing surveillance has not detected the presence of \textit{P. euvitis} in Darwin since April 2005. This is an 11-month period, with the potential for at least 22 \textit{P. euvitis} life cycles. Seven surveillance rounds were conducted in this period, including March 2006.

The Darwin QA area and the NT have been unilaterally declared as free of GLR as of 30 June 2007.

PROJECT: Coastal Plains Horticulture Research Farm

Project Officers: Research Farm Managers and Staff

Division: Plant Industries
Location: Darwin
Keyword(s): Coastal Plains Horticulture Research Farm, forestry
Project Type: Technical

Objective:

\textit{To conduct research, demonstration and extension programs for horticultural and forestry production suitable for the Top End of the NT.}

Background:

Coastal Plains Horticulture Research Farm (CPHRF) is the NT’s principal horticultural research farm on 140 hectares of land. It is located at Middle Point, near Fogg Dam in the Darwin rural area. It has national significance as a site for tropical horticultural research. It is part of the national mango research program and also tests new tropical horticultural crops.

Annual highlights

- CPHRF participated in the national mango breeding program and arboretum.
- It houses the banana Tropical Race 4 panama disease management quarantine station.
- It participates in the genetic improvement of African mahogany.
• It conducts trials on bamboo for timber and shoots, and collects germ plasm of rambutan, durian, sapodilla, logan, ornamental gingers and cupuacu.
• Katherine pearl millet seed was produced.
• Carrot seed was evaluated for South Pacific Seed.
• Hay was produced on 8 ha of Strickland paddock.
• At the completion of the commercial cocoa assessment, trees were removed.
• Charles Darwin University used the facility to conduct a Freshcare course for Vietnamese growers and a plant nutrition workshop in conjunction with DPIFM staff. A ‘Smart-Train’ chemical course and re-accreditation were also conducted.
• A Japanese research crew from Osaka University set up lightning monitoring sensors on the farm for the wet season.
• Facilities were used by growers for producing dried mangoes. Farm equipment was lent to support local growers.

PROJECT: Katherine Research Station

Project Officers: Research Farm Managers and Staff

Division: Plant Industries
Location: Katherine
Keyword(s): Katherine Research Station
Project Type: Technical

Objective:

To provide land, livestock and infrastructure to DPIFM staff to conduct research, demonstration and extension programs for pastoral, mixed-farming, horticultural, and forestry production systems suitable for the Katherine region.

Background:

Located on the outskirts of Katherine, Katherine Research Station (KRS) comprises 1240 hectares and is the headquarters for DPIFM in the Katherine region. KRS staff maintain centre pivot, lateral move and trickle irrigation systems, a dedicated horticulture research area and an improved pasture area for beef cattle production. Underground water usage is monitored as part of the irrigation program. Another 2000 hectares have been obtained from the owners of the adjacent "Old Kumbidgee Station" where 300 breeders are run to produce female crossbred Tuli, Belmont Red and Senepol cattle for breeder genotype comparison projects at Victoria River Research Station.

Annual highlights

• Investigating dry season irrigated crops that have potential for bio diesel or ethanol production. Crops include sunflower, linseed, soybeans, cassava and African palm oil.
• Collecting baseline soil health and insect populations/dynamics for sorghum, millet, lablab, sesame, sunflower, sabi pasture, mangoes and melons.
• 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 go to commercial propagation.
• The annual Farm and Garden Day was held in April when about 1700 people attended.
• KRS received 908 mm of rain in the 2006-7 wet season.
• A sentinel cattle herd is kept on the farm for virology work for the national arbovirus monitoring program.
KRS produced 200 tonnes of grass hay, 174 tones of Cavalcade hay, 24 tonnes of lucerne hay and 10 tonnes of forage Super Dan hay.

PROJECT: Ti Tree Research Farm

Project Officers: Research Farm Managers and Staff

Division: Plant Industries
Location: Alice Springs
Keyword(s): Ti Tree Research Farm, table grapes
Project Type: Technical

Objective:

To conduct research, demonstration and extension programs for the local Ti Tree horticultural industry.

Background:

Located about 190 km north of Alice Springs on the Stuart Highway, Ti Tree Research Farm (TTRF) is about 8 hectares in size. It is situated in the Ti Tree farms area which comprises eight properties of various sizes totaling 200 hectares. Ti Tree Township is situated about 14 km north of the farms on the Stuart Highway. TTRF is used for horticultural research and as a venue for grower meetings. It is also as a training facility mainly for indigenous economic development.

Annual highlights

- Ongoing evaluation is conducted on lemon, orange and Mandarin scion/rootstock combinations. The trial is in its sixth year and will continue for at least another two years. It will also be used for training purposes.
- The Queensland fruit fly (QFF) was first detected in early March 2006. As the Ti Tree farms region has area freedom status, every measure was taken to eradicate the fly. All host fruit was stripped and buried and Chlorpyrifos cover sprays were applied. Malathion and protein baits were also used on a weekly basis and supplementary traps were put in place to monitor the progress of the eradication program. The program was successful and area freedom was reinstated.
- Several QFF were detected in early February 2007. However, an outbreak was not declared due to the small number of flies detected. An eradication program was immediately put in to place as an outbreak was considered inevitable. The program was identical to the one carried out the previous year and was once again successful.
- A wide range of crops are grown with the assistance of Aboriginal apprentices and CDEP crew for training purposes. The workers also get the benefit of fresh fruit and vegetables which they take home to the community. The training has proved invaluable to the Anmatjere people to enable them to obtain skills identified by industry as necessary for obtaining employment. Kim Brown, our indigenous apprentice is progressing well and should obtain his Certificate 2 in horticulture next year.
- The perimeter of TTRF was fenced with cattle and kangaroo proof ring-lock fencing. The work was done with the assistance of our apprentice and CDEP crew to protect plantings at TTRF as well as provide training to the workers. A significant amount of damage has been inflicted by kangaroos in the past and measures needed to be taken to prevent this from recurring.
- Work has commenced on establishing a 1-hectare best practice grape block containing three scion/rootstock combinations. It is a joint project between industry and DPIFM. The purpose of the planting is to demonstrate best practice techniques to industry and trainees in establishing a
planting. The area has been deep-ripped using a bulldozer, disced and smudged. The posts and strainers have all been erected with the assistance of the trainees and industry. Irrigation was installed in the next fortnight. The vines should be arriving shortly and once planted, work will begin on the various selected trellis configurations to be used.

- A mango planting of about 60 trees containing three different scion/rootstock combinations has been established. The plantings will be utilised for training purposes and to refine crop water use and management techniques.

**PROJECT:** The Arid Zone Research Institute and the Old Man Plains Research Station

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

| Division: | Plant Industries |
| Location: | Alice Springs |
| Keyword(s): | Arid Zone Research Institute, Old Man Plains Research Station, rangelands |
| Project Type: | Technical |

**Objective:**

*To conduct research, demonstration and extension programs for pastoral and horticultural production systems for Central Australia.*

**Background:**

The Arid Zone Research Institute (AZRI) is the headquarters for DPIFM in the southern region of the NT, 10 km south of Alice Springs. The total area of the two research stations is 557.5 km² dedicated to research and demonstration and as a training facility. This research facility provides the pastoral industry with sound guidelines in arid area long-term viability and preservation of the health and diversity of rangeland ecosystems. Research and development programs are progressing with industry participation.

**Annual highlights**

- The grazing systems partnerships four paddock rotation trial, funded by the NHT.
- GRASP pasture growth model collaboration.
- The 2000-02 fire period analysis.
- The Water Smart pastoral production trial plan (a combination of best technologies in stock water storage and delivery on pastoral properties) progressed.
- Sentinel animals were maintained for Virology and the national arbovirus monitoring program.
- A breeding program was developed for the Droughtmaster herd (artificial insemination and controlled breeding).
- Reducing the impact on weaner weight gain (in partnership with MLA).
- Monitoring of wildlife that affect pastoralism (dingo control).
- Demonstrating the benefits of forage budgeting and rotational rest grazing.
- Firebreak maintenance using plough technology and grader.
- 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 using Estimated Breeding Value.
• About 26 km of new fencing at Old Man Plains Research Farm.
• Visitors included delegates from Japan, interstate and NT organisations.
Animal Industries Scientific projects conduct applied research in controlled trials to discover solutions to problems that affect the productivity and profitability of the industry and, where possible, to protect the environment and human health.

**PROJECT:** Riverine Buffalo and Crossbreeding

**Project Officers:** B. Lemcke, E. Cox, L. Huth, A. Turner, G. Jayawardhana and Beatrice Hill Staff

- **Division:** Animal Industries
- **Location:** Darwin
- **Keyword(s):** buffalo breeding, Beatrice Hill Farm
- **Project Type:** Scientific

**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 to supply 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 NT Buffalo Industry Council (NTBIC) to introduce riverine buffalo blood into the Australian swamp buffalo population. The dream became reality in 1994 with surplus Buffalo Development Scheme money by importing two bulls, followed over the next three years by four heifers and two more bulls. Two of the heifers were purchased by a private producer and left at Beatrice Hill Farm (BHF) for mating. A crossbreeding program was started and progeny performance is monitored. Progeny are also sent to supply TenderBuff. The purebred number has now reached 70 at BHF, a big increase from the previous year due to good calving. Two of the original imported bulls have died; one accidentally whilst on loan to a local producer and the other from TB de-stocking nine years ago.

The aim is to produce purebred riverine buffalo from two directions: by using purebred cows to increase numbers from within and by crossbreeding then backcrossing to purebred through $\frac{3}{4}$, $\frac{7}{8}$ and $\frac{15}{16}$ generations back to purebred riverine.

It is expected that during this project we will be able to identify all mixtures of the two breeds that will best suit the various meat, export and dairy produce markets in Australia and overseas.

A four-year cooperative agreement with the Australian Dairy Buffalo Co in Millaa Millaa (North Queensland) to supply quantitative and qualitative data on the milk producing potential of the various crosses compared with the pure riverine buffalo was terminated in early 2007. This dairy supplies milk to the Vanella Cheese Factory in Cairns, which is producing mozzarella, feta, yoghurt, and other products through its own shop outlet.
BHF has also supplied stock to a dairy farmer in Maleny (Qld) in 2004 and 2005. This farm is now supplying milk to the local Maleny Cheese Factory, which is selling a new range of products.

**Method:**

All stock is held at BHF. Half-bred cows and heifers are mated to the imported bull “OJ” from the US, to produce \( \frac{3}{4} \) calves. Locally-bred bull 5775 sired the \( \frac{7}{8} \) calf group whilst a half-Italian AI-produced bull 5796 sired all the \( \frac{15}{16} \) calves. Some semen of Italian milking buffalo was imported into Australia. Semen from six Italian bulls is used in AI projects. Some of the purebred cows and some crossbreds have been inseminated with this Italian semen and others with semen from US import “Bill”. US import Hillary has been used to produce this year’s F1 calves. It mated with the swamp group this wet.

**Results:**

Table 1. The composition of riverine and crossbred buffalo groups at BHF, June 2007

<table>
<thead>
<tr>
<th></th>
<th>Imported bulls</th>
<th>Local bulls</th>
<th>Breeder cows</th>
<th>Yearling bulls</th>
<th>Yearling heifers</th>
<th>Male calves live</th>
<th>Female calves live</th>
<th>Calf deaths</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purebred Riverine</td>
<td>2</td>
<td>6</td>
<td>26</td>
<td>7</td>
<td>7</td>
<td>14</td>
<td>8</td>
<td>2</td>
<td>70</td>
</tr>
<tr>
<td>Swamp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>F1</td>
<td>38</td>
<td></td>
<td></td>
<td>6</td>
<td>6</td>
<td>11</td>
<td>2</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>3/4</td>
<td>34</td>
<td></td>
<td></td>
<td>16</td>
<td>11</td>
<td>12</td>
<td>1</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>7/8</td>
<td>4</td>
<td>25</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>9</td>
<td>5</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>15/16</td>
<td>2</td>
<td>7</td>
<td>5</td>
<td>9</td>
<td>5</td>
<td>4</td>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>2</td>
<td>10</td>
<td>151</td>
<td>24</td>
<td>44</td>
<td>50</td>
<td>45</td>
<td>14</td>
<td>326</td>
</tr>
</tbody>
</table>

Table 2. Calving results for 2006-07 and pregnancy diagnosis (June 2007) for next season’s calves

<table>
<thead>
<tr>
<th>Breeder Group</th>
<th>Calves born/cows mated = Calving rate (%) 06-07 calves</th>
<th>No. pregnant June 2007/ cows mated Dec. 2006</th>
<th>Pregnancy (%)</th>
<th>No. preg+wet cows/ total wet cows = (%) wet cows pregnant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swamp cows</td>
<td>19 / 26 = 73</td>
<td>14 / 26</td>
<td>54</td>
<td>8/17 = 47</td>
</tr>
<tr>
<td>F1 cows</td>
<td>24 / 38 = 69</td>
<td>28 / 38</td>
<td>74</td>
<td>16/22 = 73</td>
</tr>
<tr>
<td>3/4 cows</td>
<td>24 / 34 = 71</td>
<td>30 / 33</td>
<td>91</td>
<td>15/17 = 88</td>
</tr>
<tr>
<td>7/8 cows</td>
<td>19 / 25 = 76</td>
<td>11 / 25</td>
<td>44</td>
<td>2/11 = 18</td>
</tr>
<tr>
<td>15/16 cows</td>
<td>2 / 2</td>
<td>100</td>
<td>Both heifers</td>
<td></td>
</tr>
<tr>
<td>Riverine cows</td>
<td>21 / 26 = 81% AI plus F/U Bull</td>
<td>0 / 5 Feb 07 AI</td>
<td>0</td>
<td>41/67 = 62</td>
</tr>
<tr>
<td>Total</td>
<td>107 /149 = 72%</td>
<td>85 / 129</td>
<td>65.9%</td>
<td></td>
</tr>
</tbody>
</table>

Calf mortality is escalating and has reached 12.8% this year. This is up from 8% last year. Dingo predation appears to be higher and baiting, which has been used previously to control them and wild dogs, is not a legal option at this stage due to local government regulations.

The purebred riverine herd has not been mated since an attempt to use AI on five animals in February 2007. This was due to the large number of calves born over the latter part of the year, resulting from a July 2006 AI session followed by two months of bull mating. Twenty one calves were born. DNA testing will determine sires. Once calves are weaned, the cows will be inseminated at the start of the wet season to better synchronise the calving period.

We now have enough bulls after the AI program to be able to service all the crossbred breeder groups with different genetic material. A change in bull mating procedures will commence in 2007-08, which was not practically possible until now.
The \( \frac{7}{8} \) cow group had very disappointing pregnancy results this year and unacceptably high calf mortalities. Another bull will be used to resolve the problem.

The coming calving season will be a milestone as the first purebred riverine buffalo calves to be produced through the five generation crossbreeding and upgrading route will be born.

Sales

After two months at a quarantine farm in Wildwood, Victoria 17 heifers and one bull were exported to New Zealand in February 2007. Four of the heifers were from a private herd. Another 40 have been ordered for 2007-08.

Five riverine cross bulls were exported to the Sabah government farm at Telupid in 2005-06. Three crossbred bulls were sold to a Top End buffalo producer in August 2006.

It is hoped that a dairy will be established in the Top End in the near future. The experience at Millaa Millaa suggests that buffalo dairying is feasible in the Top End.

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**PROJECT: Improving Herd Profitability**

**Project Officer:** T. Oxley

**Division:** Animal Industries

**Location:** Katherine

**Keyword(s):** cattle, cattle profitability, Victoria River Research Station

**Project Type:** Scientific

**Objectives:**

*To measure the cost and returns of each management package in terms of gross margin per animal equivalent (AE) after interest.*

*To measure production differences between each management package in terms of kg of calf weaned per 100 kg of cow mated.*

*To measure the differences in labour requirements between the management packages in terms of full time equivalents.*

**Background:**

In 1990 the best bet management package was prepared for Kidman Springs (Victoria River Research Station) and was described in previous project reports.

As a result of the implementation of the package, performance of the herd at Kidman Springs greatly improved and mortality declined from 12% to less than 2%. Weaning rates increased from 50% to over 80%. In view of an ever-increasing cost of production, pastoralists have requested for research to improve or maintain performance at a reduced cost.

**Method:**

- Maintain one paddock at Kidman Springs based on the improved profit package.
- Maintain two control paddocks at Kidman Springs, one with high nutrition and one with low nutrition based on the best bet package.
• Maintain a commercial paddock ‘Rifts Yard’ on Victoria River Downs based on the improved profit package.

The improved profit part of the project commenced in May 2003 and data collection is expected to be completed by October 2007. Data collection from the commercial scale paddock was completed at the second round in 2006.

Results:

**Table 1.** Weaning percentage as an indicator of herd performance for three years, comparing the control (best bet management) and the improved profit package

<table>
<thead>
<tr>
<th>Year</th>
<th>Control</th>
<th>Improved profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>91</td>
<td>83</td>
</tr>
<tr>
<td>2004</td>
<td>71</td>
<td>62</td>
</tr>
<tr>
<td>2005</td>
<td>72</td>
<td>75</td>
</tr>
<tr>
<td>Average</td>
<td>78</td>
<td>73</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>13</td>
<td>12</td>
</tr>
</tbody>
</table>

Table 1 indicates a consistently higher weaning rate of 5% on average under the best bet management system. However, whether there is sufficient benefit from this increase given the larger cost of implementing the best bet system over the improved profit system will be determined by an economic analysis by the end of 2008.

**PROJECT:** Industry Initiatives to Improve Heifer Performance in the NT

**Project Officers:** T. Schatz, S. Leigo and H. James

**Division:** Animal Industries
**Location:** NT-wide
**Keyword(s):** cattle, fertility
**Project Type:** Scientific

**Objectives:**

*To establish current levels of fertility in heifers on commercial properties in the NT.*

*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 these systems.*

*To prepare a best practice manual for heifer management.*

**Background:**

The research work of this project is conducted entirely on commercial properties and decisions about what is studied are made by producers through producer groups (the Katherine Pastoral Industry Advisory Committee, the Barkly Region Advisory Committee and the Alice Springs Pastoral Industry Advisory Committee) and managers of properties.
Part of the project is to establish what the current levels of fertility are 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 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 body of research in each region will be a demonstration site on a commercial property that is selected by the producer management group (PMG). Management practices that are selected by the 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 do them by themselves. The demonstration sites will be run for five years.

Method:

The managers of most of the 169 commercial pastoral properties in the NT were surveyed in “one to one” interviews. They were asked a number of questions regarding the management of their heifers and their estimates of heifer performance.

Results:

Survey
The results of the survey are presented in the Pastoral Industry Survey NT 2004 (Oxley et al. 2006) publications which are available from DPIFM Publications.

Some of the main findings from the survey included the following:

- Most stations join their heifers for the first time at two years of age.
- Most try to segregate them at least until their first joining.
- Few properties practise controlled mating.
- Few properties (< 20%) vaccinate for any diseases other than botulism.

Table 1 summarises estimates of various production parameters from all property managers surveyed.

Table 1. Average of manager estimates

<table>
<thead>
<tr>
<th></th>
<th>Estimated branding (%)</th>
<th>Estimated mortality rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maiden heifers</td>
<td>Lactating 1st calf heifers</td>
</tr>
<tr>
<td></td>
<td>Maiden heifers</td>
<td>Lactating 1st calf heifers</td>
</tr>
<tr>
<td></td>
<td>67</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>3.5</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Performance recording

Commercial performance recording is being conducted on properties in the Katherine/VRD, Barkly and Alice Springs regions. Results to date reflect the effect of joining weight on fertility and highlight the fact that the problem of low fertility in lactating first calf heifers is much greater than many people realise. This can be seen from the fact that average of manager estimates of re-conception rates in lactating 1st calf heifers was 63 % while performance recording has shown that it is often less than 10% (see Tables 1 and 2).
### Table 2. Summary of performance recording on NT commercial properties

<table>
<thead>
<tr>
<th>Property location</th>
<th>Breed</th>
<th>Maiden heifer conception rates (%)</th>
<th>Lactating 1st calf heifer re-conception rates (%)</th>
<th>Calf loss (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central VRD</td>
<td>Brahman</td>
<td>84</td>
<td>1 (2006)</td>
<td>14</td>
</tr>
<tr>
<td>Southern VRD</td>
<td>Brahman &amp; Bra x</td>
<td>72</td>
<td>19 (2006)</td>
<td>11</td>
</tr>
<tr>
<td>Sturt Plateau</td>
<td>Brahman &amp; Bra x</td>
<td>51 (yearlings)</td>
<td>30 (2007)</td>
<td>25</td>
</tr>
<tr>
<td>North east Barkly</td>
<td>Brahman &amp; Bra x</td>
<td>85</td>
<td>3 (2006)</td>
<td>31</td>
</tr>
<tr>
<td>Western Barkly</td>
<td>Santa</td>
<td>7* (2005)</td>
<td>76 (2007)</td>
<td>30</td>
</tr>
<tr>
<td>Barkly East</td>
<td>Composite</td>
<td></td>
<td>86 (2007)</td>
<td>10</td>
</tr>
<tr>
<td>Barkly (stud herd)</td>
<td>Composite</td>
<td></td>
<td>86 (2007)</td>
<td>10</td>
</tr>
<tr>
<td>Alice Springs - Nth</td>
<td>Shorthorn</td>
<td>84</td>
<td>Not available yet</td>
<td></td>
</tr>
<tr>
<td>Alice Springs - Sth</td>
<td>Angus</td>
<td>81</td>
<td>17 (2005)</td>
<td>4</td>
</tr>
</tbody>
</table>

As Table 2 shows, there is a very large variation in the re-conception rates recorded on commercial properties, from 1% to 88%. This variation is due to the condition of cows. Re-conception rates were quite high where heifers were in good condition during the period when they were calving and lactating due to the effects of good country, good seasonal conditions, low stocking rates and supplementation. However, these were the exception and re-conception rates were generally much lower on most NT properties.

In summary, the collected raw data shows the following trends:

- Where heifer management is a priority and animals are run at moderate stocking rates, re-conception rates in lactating animals are usually between 30% and 40%; heifer weight at weaning in these cases is usually around 350 kg.
- If stocking rates are too high and pre-calving weights are too low, re-conception rates are often below 10%; heifer weight at weaning in these cases is usually less than 300 kg.
- Under special nutritional conditions, for example the Barkly in good seasons, improved pasture in the Douglas Daly region and the use of protein and energy supplements, high re-conception rates such as 80% are achievable; heifer weight at weaning in these cases is usually over 400 kg.

**Demonstration sites**

Demonstration sites were set up at Newry in the Katherine/VRD region and Tieyon in the Alice Springs region. Trial work is progressing well. Field days were held at both sites in 2006 to present preliminary findings. Copies of reports from these field days are available from Tim Schatz (tim.schatz@nt.gov.au or by telephoning 8999 2332.

**Best practice manual**

A best practice manual on heifer management will be produced at the end of the project in 2009.

**Reference:**

PROJECT: Multi-breed Composite Assessment and Brahman Improvement


Division: Animal Industries
Location: NT-wide
Keyword(s): cattle multi-breed, fertility, Brahman
Project Type: Scientific

Objectives:

To measure the relative growth, reproductive performance and carcase characteristics of interbred progeny of some tropically-adapted multi-breed crossbred bulls mated to Brahman cows, compared with progeny of Brahman bulls mated to Brahman cows.

To maximise Brahman performance in reproduction and growth while minimising 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. Multi-breed composites also combine the good characteristics of different cattle types more. They are also more suitable for meat quality-based markets than Brahmans and are being explored as a possible alternative to the Brahman in case of a downturn in live exports. Most of the large cattle companies such as NAPCO and AA Company 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% un-adapted Bos taurus and can be expected to retain about 64% of heterosis in the second generation onwards. Crossing half Belmont Red, quarter Tuli, and quarter Charbray bulls (from Geoff Maynard’s “Mt Eugene” stud in Queensland) with Brahman cows created the composite. The cows are run at Victoria River Research Station (VRRS) and steers and heifers up to three years of age are run at Douglas Daly Research Farm (DDRF). None of the animals are treated for worms, ticks or flies. Both the composites and comparison Brahman bulls are selected on weight, testicle size and percentage normal sperm at yearling and are used for a maximum of three years. The females are selected on pregnancy and rearing a calf. Empty animals are culled except, if necessary, when 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 Australia-wide genetic evaluation system. Breedplan is used to assess genetic progress, rather than as a within herd selection tool, which allows this program to be replicated in more extensive herds.

Results:

The success of the Brahman improvement program is shown by the average days to calving and scrotal circumference - reproduction traits – and estimated breeding values (EBV). The DDRF Brahman herd is the best of all the herds on the Brahman group Breedplan.
Figure 1. A comparison of reproductive parameters

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 being kept relatively low, as large cows require more feed. The Brahman breed average has significantly improved for weight but at the expense of increased mature cow weight and days to calving and no improvement in scrotal circumference. This is a worrying trend for the Brahman breed as reproduction has been shown to be more economically important than growth and large mature cows will not re-breed in harsh environments.

The success of this program in a small herd of 250 females over a 12-year period shows that very rapid improvement will be possible in the large NT herds if these methods are followed. Work done in Brazil by Eler et al. (2004), indicates that the heritability of reproduction is a lot higher than has been generally accepted in Australia (69% heritability for yearling pregnancy in Nellore cattle compared to Australian estimates of 7% to 15%). Current data from the Beef CRC in Queensland indicates a heritability of 50% for yearling pregnancy (Geoff Fordyce pers. com.)
<table>
<thead>
<tr>
<th></th>
<th>Brahmans (no.)</th>
<th>Composites (no.)</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight</td>
<td>28.4 kg (259)</td>
<td>1st cross - 27.9kg (233)</td>
<td>-0.5 kg</td>
</tr>
<tr>
<td></td>
<td>26.4 kg (113)</td>
<td>2nd cross - 27.0kg (173)</td>
<td>0.6 kg</td>
</tr>
<tr>
<td>Weaning weight</td>
<td>188.1 kg (316)</td>
<td>1st cross - 195.8 kg (329)</td>
<td>7.7 kg</td>
</tr>
<tr>
<td></td>
<td>185.9 kg (241)</td>
<td>2nd cross - 192.1kg (258)</td>
<td>3.8 kg</td>
</tr>
<tr>
<td>Yearling (400 day) weight</td>
<td>199.0 kg (317)</td>
<td>1st cross - 208.1 kg (327)</td>
<td>9.1 kg</td>
</tr>
<tr>
<td></td>
<td>219.3 kg (245)</td>
<td>2nd cross - 228.2 kg (219)</td>
<td>8.9 kg</td>
</tr>
<tr>
<td>Yearling (400 day) testicle size</td>
<td>23.1 cm (107)</td>
<td>1st cross - 26.1 cm (109)</td>
<td>3.0 cm</td>
</tr>
<tr>
<td></td>
<td>22.3 cm (65)</td>
<td>2nd cross - 24.6 cm (54)</td>
<td>2.2 cm</td>
</tr>
<tr>
<td>Normal sperm (%)yearling</td>
<td>7.7 (107)</td>
<td>1st cross - 25.2 (109)</td>
<td>17.5% (3 X Brahmans)</td>
</tr>
<tr>
<td></td>
<td>8.6(83)</td>
<td>2ndCross – 23.4 (74)</td>
<td>14.8% (3 X Brahmans)</td>
</tr>
<tr>
<td>Yearling pregnancy</td>
<td>29.9 % (40/134)</td>
<td>1stCross – 57.0 % (86/151)</td>
<td>27.1% (almost 2xBrahmans)</td>
</tr>
<tr>
<td></td>
<td>47.6% (70/147)</td>
<td>2ndCross – 65.4% (106/162)</td>
<td>17.8%</td>
</tr>
<tr>
<td>Av. joining weight</td>
<td>223.6 kg (134)</td>
<td>1stCross – 231.5 kg (151)</td>
<td>7.9 kg</td>
</tr>
<tr>
<td></td>
<td>224.4 kg (89)</td>
<td>2ndCross – 222.2 kg (92)</td>
<td>-2.4 kg</td>
</tr>
<tr>
<td>Av. joining weight</td>
<td>240.0 kg (163 to 293kg)</td>
<td>1stCross-240.5kg (186-306kg)</td>
<td>0.5 kg</td>
</tr>
<tr>
<td>Pregnant (range)</td>
<td>249.1 kg (191 to 297kg)</td>
<td>2ndCross-237 kg (166-285 kg)</td>
<td>-12.1 kg</td>
</tr>
<tr>
<td>Av. Joining weight</td>
<td>216.7 kg (153 to 279kg)</td>
<td>1stCross-219.7kg (144-281kg)</td>
<td>3 kg</td>
</tr>
<tr>
<td>Empty (range)</td>
<td>206.1 kg (151 to 288kg)</td>
<td>2ndCross-210.6kg (164-254kg)</td>
<td>4.5 kg</td>
</tr>
<tr>
<td>Pregnancy rate of lactating 2 year-old animals</td>
<td>30.6 % (11/36)</td>
<td>1stCross - 61.5 % (48/78)</td>
<td>31.7 % (2 X Brahmans)</td>
</tr>
<tr>
<td></td>
<td>58.8% (20/34)</td>
<td>2ndCross – 67.3% (33/49)</td>
<td>8.5%</td>
</tr>
<tr>
<td>Pregnancy rate of lactating 3 year-old animals*</td>
<td>74.5 % (76/102)</td>
<td>1stCross - 79.5 % (89/112)</td>
<td>5.0%</td>
</tr>
<tr>
<td></td>
<td>100% (11/11)</td>
<td>2ndCross- 88.9% (24/27)</td>
<td>-11.1%</td>
</tr>
<tr>
<td>Pregnancy rate of lactating adults</td>
<td>78.8% (112/142)</td>
<td>1stCross - 90.2% (130/144)</td>
<td>11.4%</td>
</tr>
<tr>
<td></td>
<td>nil</td>
<td>2nd Cross – 77.8% (7/9)</td>
<td>-</td>
</tr>
<tr>
<td>Two year-old steer weight</td>
<td>390.0 kg (54)</td>
<td>415.9 kg (51)</td>
<td>25.9 kg</td>
</tr>
<tr>
<td>Carcass weight</td>
<td>227.8 kg (27)</td>
<td>237.2 kg (25)</td>
<td>9.4 kg</td>
</tr>
<tr>
<td>Eye muscle area</td>
<td>73.3 cm² (27)</td>
<td>78.4 cm² (25)</td>
<td>5.1 cm²</td>
</tr>
</tbody>
</table>

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

The second-generation data indicates second cross composites consistently heavier. They are mostly showing 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 empty animals could be due to the same reason (character of later-maturing European). This second-generation performance is more important than that of the first cross as heterosis loss in a composite occurs between first and second generations. Figure 2 shows a comparison between pregnancy and joining weight for the original DDRF Brahmans (1994 to 1996 drops), the current DDRF Brahmans and the second cross composites.
Figure 2. Joining weight and pregnancy relationships

The composites achieve high pregnancy rates at very light weight ranges. The newer Brahmanes also seem capable of becoming pregnant at lighter weights than the original Brahmanes as a result of selection for fertility.

Reference:
PROJECT: Reproduction Management on Commercial Properties - Florina/Camp Creek Wet Season Weaning Trial

Project Officers: G. Jayawardhana and Staff of Florina/Camp Creek Stations

Division: Animal Industries
Location: NT-wide
Keyword(s): cattle, weaner production, wet season weaning, reproduction management, productivity
Project Type: Scientific

Objectives:

To record the results of innovative programs on private properties which may be relevant to the rest of the industry.

To examine the effects of a modified weaning and joining program on cow reproduction, calf growth and mortality.

Background:

A number of innovative cattle management programs conducted in Queensland have advocated a weaning and joining system that is significantly different from general industry practice. Cows are joined to bulls from October to January, have their calves in the dry season from July to October, and weaning is from November to February. The intention is to encourage early rumen development in weaners during the time of best feed availability in the wet season. Cows go through the wet season without calves suckling them and are thus dry and in good condition at pregnancy testing. This makes it easy to detect and sell empty cows at that time.

The program started at Florina in the 2003-04 wet season, but no data was recorded until April 2004 when cows were pregnancy tested and empty or under two and a half months pregnant animals were culled. Cow mortality between pregnancy testing and weaning was 7%. Florina was sold and the cattle were moved to Camp Creek in July 2005.

Method:

Calving started in December 2004 at Florina. All calves were kept in the yards for three days and handled using Bud Williams’ low stress stock handling methods. Heavy rains occurred over this period and there was very limited shelter. A tarpaulin kept weaner pellets dry. Encouraged by proper handling, all calves began eating hay and pellets during that period. They were then divided into two groups by weight. One group consisted of animals over 80kg and the other under 80kg. They were all grazed on improved pasture and larger weaners were given a monensin molasses mix and a pure kynophos loose-mix in the open. The smaller weaners were given weaner pellets containing monensin, the monensin molasses mix and kynophos under shelter in the paddock. In total 3360 kg of calf pellets, 0.5 kg of Rumensin (monensin) and 600 L of molasses were fed costing $2493 ($10 per animal). The cows were put on native pasture with pure kynophos as a loose mix.
Results:

Table 1. Details of live-weight gains in 249 weaners

<table>
<thead>
<tr>
<th></th>
<th>Average weight (kg)</th>
<th>Minimum weight (kg)</th>
<th>Maximum weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaning 30/12/04</td>
<td>87</td>
<td>46</td>
<td>155</td>
</tr>
<tr>
<td>Marking and dehorning 1/8/05</td>
<td>147</td>
<td>77</td>
<td>258</td>
</tr>
<tr>
<td>after trucking to Camp Creek</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain</td>
<td>60</td>
<td>24.5</td>
<td>103</td>
</tr>
</tbody>
</table>

Three weaners out of 249 died between weaning and 01/08/2005 (1.2%). The average weaning weight of calves that died was 62 kg, which was at the lighter end of the spectrum. Nonetheless, the mortality rate was very low for calves weaned at these weights. The figure does not include mortality due to dehorning and castration which were done in August, 2005. The late marking was due to logistics at Florina as branding should have been done in the first dry period after weaning.

The pregnancy rate in cows that were dry at pregnancy testing in June 2005 (most of whom had their weaners removed in December) was 94%. The first calf heifer pregnancy rate was 77%. Three out of six wet adult cows that were not mustered during the December wean were pregnant. None of the three wet first calf heifers was pregnant. Though this is a small number, it indicates the effect of early wean.

Another source of comparison for this trial are the cattle at Camp Creek when it was purchased. At the weaning muster in July 2005 there were 267 lactating cows with a 6% pregnancy rate (15 pregnant and wet) and 279 dry cows with a 76% pregnancy rate (211 pregnant and dry). This extremely low wet cow pregnancy rate was due to poor conditions during the 2004 dry season. All empty cows were sold at that weaning muster.

The Camp Creek weaners averaged 127 kg, a ranging from 45 kg to 192 kg. Their mortality rate from weaning to the 2006 muster was 19.4% compared to 3.6% in Florina early weaners. These groups were run together after the Florina weaners were branded at Camp Creek in August 2005. The mortalities at different weight ranges for the two groups are shown in Figure 1.

![Mortalities and Numbers by Weight Range for Florina and Camp Ck Weaners](image_url)

**Figure 1.** The effect of weaning weight on mortality
The very high mortality rate in the light Camp Creek weaners highlights the need for a high level of care for light animals, particularly during the dry season. This group had a far higher mortality rate than Florina early weaners, which had a 3.6% mortality rate from early weaning to the 2006 muster. It appears that weaning on to green feed, even at light weights, is better for weaners than weaning on to rank dry season feed as their rumens develop before the time of maximum stress.

Comparative weights at different ages are shown in Figure 2.

![Weight for Age Early and Normal Weaners](image)

**Figure 2.** Weight comparisons at different ages

The Two-year pregnancy rate in Florina early weaners was 29% compared to 33% in Camp Creek late weaners. At two years both groups had very similar and low pregnancy rates.

Based on initial results, this weaning method appears quite promising where wet season mustering is possible. The pregnancy rate of 94% was very high for a property in the Katherine region. Weaner mortality was low at 3.6% and weaner performance was acceptable.

However, in the opinion of project officers, low stress stock handling was the main reason that kept weaner mortalities low, particularly in early weaners. Weaning light calves in the middle of a monsoon without shelter would be a recipe for disaster, if the animals were not properly cared for, which encouraged them to eat.

The low annual weight gains and low heifer pregnancy rates in both groups highlight the effect of an inadequate nutritional regime for young cattle generally. This needs to be addressed, by a supplementation program and improved feeding in paddocks, to reap the benefits of a breeding program.

**Assessment of weaning by using nose rings**

In 2006 a weaning nose ring was tried to dry off cows while running with their calves. Nose rings were produced by Eaziwean Company. In March 2006, 444 calves were nose-ringed and returned to their mothers. They were mustered in July 2006 and the effectiveness of the nose ring was assessed. The nose ring had stopped 74% of the cows from lactating; 6.3% (27 out of 429) of calves lost the nose ring. Another 19.6% (84 out of 429) had learnt to suckle while the nose ring was present. However, it appeared that there was less udder development in many of the cows, perhaps indicating reduced lactation.
PROJECT: Northern Australia Beef Fertility Project

Project Officer: K. McCosker

Division: Animal Industries
Location: Katherine
Keyword(s): cattle, reproduction management
Project Type: Scientific

Objectives:

To define reproductive performance in a selected population of northern Australian commercial properties (study population) over three consecutive years using a range of measures. Primary selection will be at the property level and the main unit of analysis will be the ‘mob’.

To establish outcome measures for monitoring and comparing reproductive performance of breeding mobs and properties in northern Australia.

To define typical and achievable performance using the above method in the study population.

To estimate variation in reproductive performance at the animal, ‘mob’, property and region level.

To identify causes of variation in reproductive performance between animals, ‘mobs’, properties and regions.

To quantify the proportion of variation explained by identified risk factors.

To identify those risk factors which explain the greatest amount of variation between ‘mobs’, properties and regions.

To develop a cost benefit framework to estimate the economics of changing the major ‘mob’ level factors affecting reproductive performance.

This will lead to recommendations on:

- A benefit cost study to assess the production and economic impact of changing well defined inputs and management practices that affect key risk factors.
- Extension priorities for changing well defined inputs and management practices that affect key risk factors
- Research priorities for inputs and management practices that affect key risk factors for which the impacts are not well defined.
- The feasibility of establishing strategic ongoing reproductive performance monitoring ‘systems’ to enable a longitudinal evaluation of the impact of implemented changes in management practices and inputs.

Background:

This is a Meat and Livestock Australia funded collaborative project between The University of Queensland, QDPI&F and DPIFM to be conducted from 2007 to 2012.

No systematic study of the reproductive performance of breeding herds or of the factors affecting performance has been conducted in northern Australia. There have been a number of case studies and
producer surveys which, although providing some very useful data are limited in their application to the industry as a whole. Further the current lack of a common ‘language’ to describe performance of breeding mobs prevents accurate comparisons between mobs, properties and regions.

The causes of sub-optimal reproductive performance in northern Australian beef herds are multi-factorial. However, although our knowledge of specific causes of lower than expected/predicted performance has improved considerably, quantification of the contribution of each to the overall performance of breeding mobs and herds is lacking. The latter information is critical to enable producers to focus management changes and investment on those factors which have been shown to be contributing most to mob/herd reproductive outcomes. This information is also needed to guide investment by research funding agencies. For example, if 75% of the difference between mobs/herds can be explained by known factors, then investment should target technology transfer or development of improved approaches to manage these factors; however, if only 30% of the difference can be explained, then investment should target further research to define the causes and factors associated with sub-optimal performance.

Over the past 25 years, there have been considerable improvements in nutritional and herd management practices in northern Australia, which resulted in improvements in branding rates to the order of 15%. The results of a recently completed MLA study (NBP.336) of a sample of commercial and research station herds found that the established pregnancy rates per cycle ranged from 40% to 70% indicating some herds are achieving physiological targets of performance. However, the economic benefits of improved conception rates can only be realised if there are minimal losses between confirmed pregnancy and weaning. Data from case studies conducted in northern Australia indicates that losses between confirmed pregnancy and weaning in heifer herds are 15% to 20%, while 5% to 10% losses in cow herds are not uncommon. Although in some cases the causes of these losses have been determined, the relative contribution of each cause to overall loss at an industry level has not been defined. A recent study by Brown et al. (2002) found that only 79.2% of Brahman heifers (n=207) on a pastoral company property on the Barkly Tableland successfully raised a calf, with 63% of the losses being peri-natal, primarily due to dystocia, mis-mothering and unknown causes. Even when appropriate good quality foetal and maternal samples were submitted for comprehensive pathological and microbiological investigations, a definitive diagnosis of the cause of perinatal mortality could only be obtained in about 50% of cases. This project will use epidemiological analyses to identify the risk factors significantly associated with peri-natal mortality. The findings will then be used to design studies to improve our ability to define the causes of these unexplained losses.
PROJECT: Productivity Consequences of Incorporating Tropically-adapted Taurus Breeds into a Breeding Herd in the VRD

Project Officers: A. Huey and K. McCosker

Division: Animal Industries
Location: Katherine
Keyword(s): cattle, Brahman, productivity, Douglas Daly Research Farm, Victoria River Research Station
Project Type: Scientific

Objective:

To measure and report the relative breeding herd efficiency ($\frac{\text{kg calf weaned}}{100 \text{ kg cow mated}}$ and $\frac{\text{kg calf weaned}}{\text{AE cow mated}}$) of adult

F1 Belmont Red-Brahman and F1 Tuli-Brahman breeders, compared to purebred Brahman breeders by 2011.

Method:

The trial will be conducted in Boab, Coolibah, Supple jack and Nutwood Paddocks at Victoria River Research Station from 2007 to 2011.

Breeder herd

Breeders will be kept at a stocking rate similar to the safe carrying capacity calculated from long term median pasture growth and estimated safe utilisation rates. They will be joined on a continuous basis at 4%.

Mustering and weaning will occur twice a year in May and October. Calves will be weaned at 100 kg live-weight. At each weaning, live-weight, body condition score, P8 fat depth, hip height, pregnancy and lactation status will be recorded.

All weaners will be mothered-up to identify dams. Sires will be identified using DNA analysis. Calves will be left entire until weaning. Weaned progeny will be trucked to Douglas Daly Research Farm after being tailed at Victoria River Research Station.

Bulls will be fertility-tested annually and will be culled for sub-fertility on the BBSE score, injury, temperament, or for being with the herd for two years. A two-year maximum joining period ensures a breed effect rather than a bull effect.

Breeders will be culled for being barren, temperamental, injured, or older than 10 years.

Heifers will be selected at two years of age for temperament, live-weight of 280 kg or over and general appearance. Heifers will be mated in January each year and run separately until they wean their first calf.

Supplementation will be provided to all breeder herds year round. During the dry season (April-November), a loose supplement will be provided consisting of 20-25% urea, 20% kynophos, 10% sulphate of ammonia and 40-45% salt. In the wet season a loose mix of 35% kynophos, 10% sulphate of ammonia and 55% salt will be provided. Supplements will be distributed weekly at 100 g/animal/day.
All cattle will be vaccinated for C and D botulism stains during the May muster. In addition, bulls will be annually vaccinated for vibriosis during the October muster.

Fire will be used to maintain pasture condition. Paddocks will be burnt every four years, with a quarter of each paddock being burnt annually during the late dry season after first rains.

**Indicator steers**

Indicator steers will be allocated by using animals from weaning round 1. Brahman steers will be used where possible. Ten indicator steers of a consistent age, genotype and weight (>150 kg) will be included annually in each paddock at weaning round 1 and replaced at weaning round 1 of the following year, in consultation with the department's biometrician.

**Faecal sample collection for NIRS analysis**

Bulked faecal samples will be collected monthly from each paddock to monitor pasture quality and to determine faecal nitrogen, dietary crude protein and digestibility.

**Results:**

During 2006-07 breeding females were stratified for age, pregnancy, lactation and live-weight in preparation for the trial.

### 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

**Division:** Animal Industries

**Location:** Katherine

**Keyword(s):** cattle, productivity, Brahman, native grasses, Victoria River Research Station

**Project Type:** Scientific

**Objective:**

*To measure and report 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 to purebred Brahma, by 2007.*

**Background:**

Feedback from SE Asian feedlots in the early 1990s indicated that there was an increasing problem of over-fattening at the completion of the feeding phase in young Brahman cattle sourced from northern Australia. SE Asian feedlots usually supply the SE Asian ‘wet’ market, which has a low value for fat and considers it a less-desirable component of the carcass.

A way to overcome this problem of over-fattening is to include later-maturing genes. However, history shows that animals containing a high proportion of later-maturing genes are not productive in northern Australia. To investigate the productivity of breeders containing later-maturing genes and to demonstrate a method to
introduce later-maturing genes into a high grade Brahman herd, a two-way criss-cross crossbreeding program was established at Victoria River Research Station using Charbray and Brahman (Figure 1).

![Figure 1](image-url) Development of a two-way criss-cross crossbreeding system at Victoria River Research Station.

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

### Method:

The method was described in the 2005-06 Technical Annual Report.

### Results:

**Table 1. Summary of productivity measures for each of the breeding herds at VRRL during 2003-06**

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Brahman</th>
<th>Bra x ¼ Cha, ¾ Bra</th>
<th>¼ Cha, ½ Bra x ¾ Brahman</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean empty live-weight in May (kg/animal)</td>
<td>443</td>
<td>483</td>
<td>480</td>
</tr>
<tr>
<td>Mean empty live-weight of breeders in October (kg/animal)</td>
<td>406</td>
<td>434</td>
<td>424</td>
</tr>
<tr>
<td>Mean wet season pre-weaning ADG (kg/animal/d)</td>
<td>0.78</td>
<td>0.78</td>
<td>0.90</td>
</tr>
<tr>
<td>Mean dry season pre-weaning ADG (kg/animal/d)</td>
<td>0.64</td>
<td>0.45</td>
<td>0.59</td>
</tr>
<tr>
<td>Mean weaning weight (kg)</td>
<td>174</td>
<td>168</td>
<td>185</td>
</tr>
<tr>
<td>Mean weaning rate (%)</td>
<td>77.8</td>
<td>79.8</td>
<td>71.5</td>
</tr>
<tr>
<td>Mean inter-calving interval (m)</td>
<td>14.6</td>
<td>13.9</td>
<td>14.7</td>
</tr>
<tr>
<td>Breeding herd efficiency (kg weaned/AE*)</td>
<td>153.2</td>
<td>137.5</td>
<td>157.6</td>
</tr>
</tbody>
</table>

*AE calculated on 450 kg dry cow

### Conclusions:

¼ Charolais, ¾ Brahman breeders are substantially heavier than purebred Bra at both WR1 and WR2. ¼ Charolais, ¾ Brahman breeders tended to perform similar to the Bra herd reproductively.

This project has been completed.
PROJECT: Understanding and Improving Heifer Fertility in the NT

Project Officer: T. Schatz

Division: Animal Industries
Location: NT-wide
Keyword(s): cattle, fertility, Victoria River Research Station, Douglas Daly Research Farm
Project Type: Scientific

Objectives:

To establish the relationship between body weight/condition and conception rates for the first two joinings of Brahman heifers (joined first as yearlings and as two year-olds) in northern Australia.

To produce simple charts showing the conception rates that can be expected from mating heifers at different weights/conditions at their first two joinings.

To demonstrate and document target weights and subsequent fertility that can be achieved under high and low input management systems and its cost in different pastoral zones of the NT.

Background:

The low re-mating conception rates in lactating first calf heifers has long been recognised as the biggest area of inefficiency in northern Australian breeding herds. The main reason for this is that the condition of first calf heifers often slips while they are lactating (and growing at the same time). As a result, they do not resume cycling shortly after calving.

This project aims to establish the exact relationship between body weight and/or condition and re-mating conception rates in Brahman heifers at their first two joinings in northern Australia. From this it will be possible to produce a simple chart showing the conception rates that would be expected from mating first calf heifers at different weights. This would allow producers to determine the most cost-effective way to manage replacement breeders.

Note: In this report the term “yearling” describes heifers that were joined at the end of the year in which they were weaned. Some heifers were purchased from continuously-mated herds and so may have been slightly older than 12 months at joining.

Method:

The method has been described in detail in previous Technical Annual Reports.

Brief outline

Each year at least 100 maiden Brahman heifers will be joined at Victoria River Research Station (VRRS) (joined first at two years of age) and at Douglas Daly Research Farm (DDRF) (joined first as yearlings). At both sites, pregnant heifers with their first calf will be split into two treatment groups. One group (control) will graze pasture as normal in the pre-calving dry season, while the other group (high nutrition) will be managed to gain an extra 50 kg before calving. This will result in heifers having a range of weights/body conditions at their second joining. The data from this joining (over several years) will generate a model that will predict the likely pregnancy rates 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 will 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 (mated first as yearlings and at two years of age).

**Results:**

1. **DDRF – first joined as “yearlings”**

Research at DDRF and VRRS has shown that growth in heifers was about 0.2 kg/day higher at DDRF than at VRRS over the wet season after they had been weaned. The question is whether it would be profitable to transport weaner heifers from large extensive properties to high production areas like Douglas Daly where they can grow faster, making yearling mating possible.

**Yearling mating (DDRF) – preliminary results**

The results from the yearling mating of three-year groups of heifers are now available. Data on their re-conception rates as lactating first calf heifers is currently available for two of these groups as the 3rd group is due to start calving later this year.

Figure 1 shows the effect of joining weight on the subsequent fertility of yearling mated Brahman heifers that were purchased from commercial properties (data from the three-year groups was bulked together). As expected conception rates are higher as joining weight increases.

![Figure 1. The effect of joining weight on conception rates of yearling mated Brahman heifers (three-year groups combined n=300)](image)

In practice, managers are likely to want to know which heifers may be suitable for yearling mating at weaning so that they could be drafted for different purposes at that time. Figure 2 shows the relationship between post weaning weight (a weight recorded after the weaning process) and subsequent fertility. The chances of a heifer getting pregnant from mating as a yearling increase with weaning weight.
These results suggest that while fertility of high grade Brahman heifers increases with increasing weight at joining, it is not high enough at this age to justify the expense of transporting animals from other regions of the NT for the purpose of yearling mating. Table 1 shows the pregnancy rates achieved by each year group, which suggests that high grade Brahman heifers are just too late-maturing to achieve good results from mating as yearlings. This was indicated when ovaries of all heifers that failed to conceive were examined twice, 10 days apart (using real time ultrasound) at the end of joining. Very few had a corpus luteum present, indicating that they were not cycling because they had not reached puberty.

Table 1. Conception rates and joining weight data for each year group of heifers joined as yearlings

<table>
<thead>
<tr>
<th>Year weaned</th>
<th>Pregnant (%)</th>
<th>Average joining weight (kg)</th>
<th>Average weight at 1st conception (kg)</th>
<th>Pregnant average weight</th>
<th>Empty average weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>27*</td>
<td>259</td>
<td>294</td>
<td>323 kg</td>
<td>318</td>
</tr>
<tr>
<td>2005</td>
<td>36</td>
<td>252</td>
<td>320</td>
<td>334 kg</td>
<td>326</td>
</tr>
<tr>
<td>2006</td>
<td>36</td>
<td>264</td>
<td>299</td>
<td>356 kg</td>
<td>347</td>
</tr>
</tbody>
</table>

*Note that the 2004 heifers were from a control mated herd and so were slightly younger on average than the heifers from the other year groups which came from continuously-mated herds. The heifers from the continuously-mated herds were weaned at the first round but some that had been branded as small calves at the second round the previous year were retuned to their mothers and were slightly older.

The weight at conception was estimated for each heifer from the pregnancy diagnosis and weights recorded around the time of conception. On average most heifers conceived at around 300 kg. The average weight was higher for the 2005 year group because probably they did not have access to as good nutrition after weaning and before being transported to DDRF as the other two-year groups. They grew faster than the other year groups over the wet season months at DDRF possibly through compensatory gain, but possibly took longer to pick up in condition to the point where they were fat enough to start cycling.

First calf heifers at DDRF

At this stage, only data from two-year groups is available and as a result the number of observations is quite low (N=99) especially where heifers have been divided into subsets such as weight ranges. Apart from the fact that the conception rates from yearling mating were quite low, one of the main reasons that numbers
were low is that calf losses in the first year were quite high (33% in the first year group compared to 8% in the second year).

In general re-conception rates in lactating first calf heifers at DDRF were very high (year 1, 66% and year 2, 72%). It seems that the reliable wet seasons and the improved fertilised pasture at DDRF provide adequate nutrition for most lactating heifers to maintain good enough condition to resume cycling in time to re-conceive before weaning in early May. It should be noted that these re-conception rates are much higher than has been recorded in recent years on most commercial NT properties (average re-conception rate, 8.5%).

The fact that re-conception rates in the “low” nutrition groups were actually higher than in the “high” nutrition groups (where heifers were put on a higher plane of nutrition through the dry season prior to calving) indicates that the so called “low” nutrition group actually received quite good nutrition through the period where they were calving and lactating. This is supported by the fact that average weights of both groups of heifers were about the same at weaning and that the average weights at weaning were quite high at over 360 kg (Table 2).

Table 2. The effect of plane of nutrition prior to calving on re-conception rates and weights at various times

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Re-conceived while wet (%)</th>
<th>Average weight at end of 1st joining (kg)</th>
<th>Average weight pre-calving (Sep.) (kg)</th>
<th>Average weight at weaning (May) (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st year High nutrition</td>
<td>62</td>
<td>338</td>
<td>404</td>
<td>368</td>
</tr>
<tr>
<td>Low nutrition</td>
<td>71</td>
<td>341</td>
<td>395</td>
<td>366</td>
</tr>
<tr>
<td>2nd year High nutrition</td>
<td>66</td>
<td>348</td>
<td>440</td>
<td>401</td>
</tr>
<tr>
<td>Low nutrition</td>
<td>78</td>
<td>352</td>
<td>407</td>
<td>395</td>
</tr>
</tbody>
</table>

The fact that nutrition seems to have been so good over the period when heifers were calving and lactating has resulted in data where the relationship between pre-calving weight and fatness has not been as strong as would have been expected. Figure 3 shows that there is no marked increase in re-conception rates with increasing pre-calving weight.

Figure 3. The effect of pre-calving weight range on re-conception rates by weaning in first calf heifers at DDRF (both years’ data except for heifers that calved after 1 January n=90)

While pre-calving weight seems to have little effect on re-conception rates at DDRF, measuring fat depth (ultrasonically at the P8 site) is a better way of measuring the (body reserves) condition of heifers since it is not affected by frame size. However, weight is affected by frame size. For example a large framed (tall) thin heifer might weigh the same as a small framed (short) fat heifer. Figure 4 shows that re-conception rates
increased as pre-calving fatness increased, although the re-conception rates at the lower fat depths are higher than what would be expected on most NT properties where the nutrition is not as good as at DDRF.

![Figure 4](image)

**Figure 4.** The effect of pre-calving fatness range on re-conception rates by weaning in 1st calf heifers at DDRF (both years data [except for heifers that calved after 1 January] n=90)

Date of calving strongly influences the chances of re-conception and heifers which calved before January had a much higher chance of re-conceiving than heifers that calved after January (see Figure 5). This is mostly due to the fact that they had less time between calving and weaning to re-conceive. (Note that most heifers that had not re-conceived by weaning did so shortly afterwards). As a result the heifers which calved after January were not included in the above analysis.

![Figure 5](image)

**Figure 5.** The effect of month of calving on re-conception rates by weaning time in lactating first calf heifers at DDRF (both years data n=99)

2. VRRS – first joined at two years of age

So far no reproductive data is available for the third year group as they will be joined for the first time from December 2007. Data from the first joining is available for the number 4 and 5 heifers and data from the second joining is only available for the number 4 heifers.
Figure 6 shows the large effect of joining weight (recorded in October/November) on conception rates in heifers joined first at 2 years of age at VRRS. Conception rates increase with joining weight until they are close to 100% at around 280 kg.

![Figure 6](image)

**Figure 6.** The effect of joining weight on conception rate at VRRS (both years data combined n = 177)

The effect of fat depth on conception rates at the maiden joining was even more marked with conception rates increasing until they reach 100% at 5 mm (see Figure 7). As mentioned earlier, measuring fat depth is a better way of measuring the (body reserves) condition of heifers since it is not affected by frame size as by weight.

![Figure 7](image)

**Figure 7.** Effect of pre-joining fat depth on conception rates in maiden two-year-old heifers (both years data combined n = 177)

*First calf heifers at VRRS*

Only data from first year group is available at this stage and as a result the number of observations is quite low especially where the heifers have been divided into subsets (weight ranges). There were 83 pregnant heifers prior to calving. Due to some losses and calf loss of 8%, there were 76 lactating heifers at weaning on 01/05/2007.
Following their first joining the pregnant heifers are allocated to either a high nutrition (HN) or low nutrition (LN) group. Each group grazes in a similar paddock with access to dry lick mineral supplement but the HN group is also given some protein and energy supplement in troughs in the paddock during the dry season until the season breaks.

In 2006 the HN group was given 2.3 kg/animal/day AustAsia Hi-Pro live export pellets (28% crude protein [14% minimum true CP] and 11.5 MJ/kg ME) from 14/07/2006 to 18/12/2006. Originally it was planned to finish feeding earlier but no substantial rain was received until 22/12/2006.

It was difficult to measure the full extent of the HN treatment in terms of weight gain since feeding continued after the heifers had started calving (due to the late break in the season) and we did not want to muster them during the calving period. As a result the pre-calving weight was recorded on 03/10/2006 and feeding continued for 76 days afterwards. However, during the period when it was possible to measure the difference in weight gain between the HN and LN treatments, the HN treatment animals had on average gained 33 kg more and were 3 mm fatter by 03/10/06.

The benefit from supplementary feeding continued through the period when heifers were lactating and by the weaning muster at 01/05/2007, the HN heifers were still 22 kg heavier and 1.2 mm fatter than the LN heifers. As a result re-conception rates in the HN heifers were 42% higher (see Table 3). The re-conception rate of 82% in the HN group is extremely high for high grade Brahman heifers in the NT and shows the large effect of good body condition through improved nutrition during the lactation period.

Table 3. Comparison of the performance of the HN and LN treatment groups

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average weight (kg) 6/6/06</th>
<th>Average weight (kg) 3/10/06</th>
<th>Average fat (mm) 3/10/06</th>
<th>*Average weight (kg) 1/5/07</th>
<th>*Average fat (mm) 1/5/07</th>
<th>Pregnant (%) 1/5/07</th>
</tr>
</thead>
<tbody>
<tr>
<td>HN</td>
<td>397</td>
<td>458</td>
<td>9.7</td>
<td>387</td>
<td>2.2</td>
<td>82</td>
</tr>
<tr>
<td>LN</td>
<td>400</td>
<td>428</td>
<td>6.7</td>
<td>365</td>
<td>1.0</td>
<td>39</td>
</tr>
<tr>
<td>difference</td>
<td>-3</td>
<td>30</td>
<td>3.1</td>
<td>22</td>
<td>1.2</td>
<td>42</td>
</tr>
</tbody>
</table>

* Denotes that only data from heifers that were lactating at this time was included (those that had lost calves and were dry were not included).

Re-conception rates increased with pre-calving weight (see Figure 8). There are some large fluctuations in the trend lines in Figure 8 due to the fact that numbers in each weight category are low at this stage.

Figure 8. The effect of pre-calving weight range (corrected for stage of pregnancy) on re-conception rates in lactating first calf heifers (only one year’s data, n = 76)
The effect of pre-calving fatness on re-conception rates was even more marked than the effect of pre-calving weight (see Figure 9).

![Figure 9](image_url)

**Figure 9.** The effect of pre-calving fatness on re-conception rates in number 4 lactating first calf heifers

**Summary**

This project is well on the way to produce the data required to generate equations (and then tables) that predict conception rates from pre-joining weights and fatnesses for Brahman heifers at their first two joinings in the NT.

**PROJECT: 21st Century Pastoralism**

**Project Officers:** M. Ashley, A. Bubb and A. James

**Division:** Animal Industries

**Location:** Alice Springs

**Keyword(s):** desert pastoralism, telemetry, indigenous pastoralism, indigenous development

**Project Type:** Scientific

**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.*

**Background:**

The project aims to increase the economic viability of desert pastoral enterprises. The project is analysing the cost benefit of labour-saving devices including telemetry systems and creating exciting new remote pastoral management tools like ‘walk over weighing’ and automatic drafting. The research also includes incorporating SANDS network technologies that allow high-width data transfer across UHF radio systems that dramatically improve the capacity of commercially-available telemetry systems.
Participatory evaluation of indigenous pastoral programs continues and the findings will be report in 2008.

Method:

As part of the Utilizing Technology Project Monitoring, the cost of bore runs has been assessed at the three stations and telemetry systems have been installed on all of them. Early indications are that a modest investment in telemetry can reduce bore run costs by 30% for a desert property.

A beef cattle WOW prototype was installed at Napperby Station in April. Initial setup problems have now been resolved. This system will be linked to an automatic drafting system that will enable remote management of stock based on individual animal performance. Construction of a remote cattle drafting prototype has commenced and was planned for completion by September, for a field day demonstration at Napperby Station in October 2007. Further external funding will be sought in 2007-08 to continue the development of the system.

Preliminary testing of the SAND communication technology is complete. The tests were successful and units will be ready for a long-term field test with some modification. This will be demonstrated at Napperby Station in conjunction with the WOW and automatic drafting.

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

Results:

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 cattle and country project has conducted research at indigenous operated stations including Amanbidji, Elsey and Mungluwurru.

The indigenous pastoral employment review has conducted over 70 interviews with stakeholders across the northern Australian pastoral industry. The report was planned to be published in September 2007, to be followed by reports for the Indigenous Pastoral Program and the Kimberly Indigenous Management Support Service.

The ‘Managing for Variability’ and ‘Improving Economic Sustainability’ research areas will be developed in 2008 following further stakeholder consultations and establishment of multi-agency research teams.
PROJECT: Identifying Optimum Levels of Pasture Utilisation at Pigeon Hole and Mt Sanford

Project Officers: R. Cowley, K. McCosker, C. Smith and T. Cowley

Division: Animal Industries
Location: Katherine
Keyword(s): cattle, pasture utilisation, watering points, Mt Sanford
Project Type: Scientific

Objective:

To identify optimal levels of pasture utilisation.

Background:

A survey of 134 paddocks in the VRD in 1997 found that paddock stocking rates averaged 11 animal equivalents (AE)/km$^2$, ranging from 5 to 35 AE/km$^2$. Among surveyed paddocks, 40% stocked less than 10 AE/km$^2$. Based on modelled pasture growth, 11 AE/km$^2$ is equivalent to 25% utilisation on red soils 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. A study of utilisation rates in the VRD in 2006 found that average rates of utilisation were 16%.

Although average utilisation rates were low to moderate, paddock sizes are large and 40% of VRD paddocks are more than 4km from water, resulting in areas close to water being overgrazed, while in areas far from water utilisation is very low. Cattle producers in the region recognise the potential for further development and in a recent survey 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 develop further water points and subdivide paddocks.

Prior to this study, there was little local information on sustainable carrying capacity in 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 over-development of rangeland that has occurred in eastern savannas.

Method:

Utilisation was tested at two sites.

At a research level (Mt Sanford), utilisation was trialled from 2001 to 2006. Paddocks were stocked for six years at six utilisation rates ranging between 12% and 43% (4-12 sq km).

At a commercial level, paddocks were stocked for five years at five utilisation rates ranging between 15% and 44% (20-22 sq km) at Pigeon Hole. The trial will conclude in October 2007.

At both sites animal numbers were adjusted each May according to the amount of pasture available to achieve the target utilisation rate for the paddock (Table 1).
Table 1. Stocking rates and utilisation

<table>
<thead>
<tr>
<th></th>
<th>Average utilisation rate (%)</th>
<th>Average stocking rate (AE / sq km)</th>
<th></th>
<th>Average utilisation rate (%)</th>
<th>Average stocking rate (AE / sq km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mt Sanford</td>
<td>12</td>
<td>12</td>
<td>Pigeon Hole</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>17</td>
<td></td>
<td>20</td>
<td>16</td>
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<td>24</td>
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<td></td>
<td>43</td>
<td>38</td>
<td></td>
<td></td>
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</tbody>
</table>

Results:

*Mt Sanford research level utilisation 2001-06*

Land condition and biodiversity:

Above 21%

- Bare ground levels in October were unsustainable (greater than 60%) (Figure 1).
- Bird abundance declined.
- Some palatable plant species declined.

*Figure 1. Effect of utilisation on % bare ground in October at Mt Sanford 2001-2006*

Values above 60% bare ground are above the red line, and occurred at utilisation rates 28% to 43% from 2003 to 2005.
Animal production:

Above 21% utilisation

- Individual weight gain was reduced by 10 kg.
- Breeders took 1.5 months longer to re-conceive.
- Weaning rate was nearly 10% lower.

Animal production per area was highest at highest utilisation rates on average, but it was much more variable through time, as animals took longer to get over dry periods at higher utilisations (Figure 2).

![Figure 2. Weaner production per unit area through time at Mt Sanford](image-url)

_Pigeon Hole commercial level utilisation 2003-07_

Unlike at the Mt Sanford site, there were large fires at the Pigeon Hole site during the trial. These occurred in different paddocks at different times. The effect of fires on vegetation and hence animal production (through removal of poor quality dry forage) often overrides other treatment and sometimes seasonal effects.

There was no effect of utilisation on land condition through time at the commercial level.

Initially there was little effect of utilisation rate on weight gains, partly because of the overriding effect of fire in some paddocks. However, since 2006 (less fire influenced and more time for treatments to take effect) there was consistently higher weight gain in the lower utilisation paddocks (Figure 3). This effect was greatest during the wet season.
The effect of utilisation on branding percentage varied through time. In 2004 branding percentage was highest at lower utilisations. This pattern disappeared in 2005 and 2006 after fires in some of the paddocks in 2005 started to have a greater effect on animal production. At high utilisation rates there are large fluctuations in branding percentage through time (Figure 4).

**Figure 3.** Effect of utilisation on weight gain of indicator steers at Pigeon Hole in 2006 and 2007

**Figure 4.** Effect of utilisation rate on branding % through time at Pigeon Hole Station
Conclusions

Large paddocks may already have average utilisation rates at around 20% but where water is sparsely distributed, actual utilisation around water is likely to be much higher, but very low beyond 3 km from water. By adding watering points to large sparsely watered paddocks, actual utilisation may decrease, by making utilisation more even across the landscape, which can significantly increase animal production.

Future research

Regional implications of the trial recommendations are being studied. This will include the potential for future adoption in the Top End of the NT and how this may affect infrastructure, staffing, cattle turnoff and the NT economy.

Recommendations

20% utilisation.

For red soil areas this may be lower. DPIFM currently recommends 15% utilisation for red soils, as they are less resilient.

Producers looking for development opportunities should analyse current utilisation rates to identify potential gains in animal production and land condition through infrastructure development.

The MLA Grazing Land Management course run by DPIFM can assist producers to identify their current utilisation rates and plan property development and management strategies to provide sustainable improvements in animal production and land condition.

PROJECT: Newcastle Waters Cell Grazing

Project Officers: R. Cowley and P. Krafft

Division: Animal Industries
Location: Barkly
Keyword(s): cattle, grazing, pasture, rangelands
Project Type: Scientific

Objective:

To compare rotational and continuous grazing systems in northern Australia.

Background:

As demand for cattle grows in northern Australia, particularly in the live export market, cattle producers are looking to increase production whilst maintaining or improving ecosystem health. Cell grazing and rotational grazing are systems that promise to allow greater carrying capacity through monitoring and rest of pastures. As cell grazing is a relatively new phenomenon in the Northern Territory cattle industry, there is great interest in the workability of such a system in local land systems.

In 2000, Newcastle Waters Station began to set up cell grazing in two paddocks. This was in response to a perceived need for more intensive handling of stud weaners, and better utilisation of pastures. The sites were old holding paddocks on the Barkly Stock Route, and have since been used by Newcastle Waters as stud paddocks.
Method:
Baseline vegetation data was collected prior to cattle entering the cell. DPIFM staff assisted with continued monitoring of pastures within the cell and a control area from May 2003 to May 2005. Both land condition and cattle live-weight gains were monitored. Data was also collected on stock numbers held in the cell and control paddocks, as well as the management inputs for each system.

Live-weight gain was analysed using one-way ANOVA. Land condition variables were analysed using the Kolmogorov Smirnov test.

Results:

Cattle live-weight gain

In 2003-04 and 2004-05 live-weight gains in indicator steers were around 15 kg/year lower in the cells, but were significant only in 2004-05 (P=0.008) (Figure 1). An analysis of the different carrying capacities of the two systems will allow the relative production in kg/ha to be compared.

Land condition

Generally land condition variables fluctuated seasonally, but there was little consistent divergence between the treatments. Ground cover and total yield were similar between treatments except for May 2005 following a fire in the control paddock which greatly reduced cover and yield (Figures 2 and 3). The proportion of perennials was initially higher in the cells, but in November 2004 was higher in the control paddock (Figure 4). The proportion of palatable yield was higher in cell paddocks in 2004 (Figure 5).

Figure 1. Live-weight gain in cattle in cells compared with that in the control paddock at Newcastle Waters
Figure 2. Ground cover through time in cells compared with the control paddock at Newcastle Waters

Figure 3. Yield through time in cells compared with the control paddock at Newcastle Waters
Figure 4. Proportion of palatable yield through time in cells compared with the control paddock at Newcastle Waters

The generally higher standard errors for the control paddock reflect the smaller sample number there. However, further analysis of within-paddock variation is warranted. Further analysis of individual species yield, frequency and defoliation is still to be done, as is a comparison of stock days/hectare for the two treatments. An estimate of turnoff and discussion of management implications of the two systems will be conducted later.

Figure 5. Proportion of palatable yield through time in cells compared with the control paddock at Newcastle Waters
PROJECT: Carrying Capacity – Testing Methods for Assessing Long Term Carrying Capacity at Kidman Springs

Project Officers: C. Smith

Division: Animal Industries
Location: Katherine
Keyword(s): rangelands, carrying capacity, pasture, Victoria River Research Station
Project Type: Scientific

Objective:

To assess the long term carrying capacity of Victoria River Research Station (VRRS) as a test case for the method of estimating long term carrying capacity using pasture growth models.

Background:

The grazing land management course recommends a method of determining carrying capacity based on the use of a predetermined safe utilisation of averaged modelled pasture growth. It is already possible to model pasture growth for many land types in the Victoria River Downs (VRD) and VRRS. Some estimates are available of safe utilisation rates based on grazing trials at Mt Sanford in the VRD and in north Queensland. This provides a unique opportunity to test the carrying capacity methodology at VRRS.

Method:

An initial assessment of carrying capacity was completed in June 2002. Stocking rates were then set according to this estimated long term carrying capacity in 2003. To assess the sustainability of the estimated carrying capacity, pasture is monitored every May; cattle are assessed in May and September.

By mid 2004 there were concerns about the sustainability of the implemented stocking rates due to poor or declining pasture and cattle condition. Based on this feedback, a re-evaluation of carrying capacity was conducted in November 2004, reviewing some of the previous assumptions and testing the sensitivity of the carrying capacity estimate to that suggested earlier.

Results:

Yield assessment was completed in June 2007. The data is presented in Table 1 and Figure 1. The low yields reflect the late start to the wet season.
Table 1. Average pasture growth in kg/ha in each paddock sampled

<table>
<thead>
<tr>
<th>Paddock</th>
<th>Average yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boab</td>
<td>643</td>
</tr>
<tr>
<td>Box</td>
<td>683</td>
</tr>
<tr>
<td>Bull</td>
<td>756</td>
</tr>
<tr>
<td>Conkerberry</td>
<td>1181</td>
</tr>
<tr>
<td>Coolibah</td>
<td>1106</td>
</tr>
<tr>
<td>Little Rosewood</td>
<td>802</td>
</tr>
<tr>
<td>Nutwood</td>
<td>1471</td>
</tr>
<tr>
<td>Rosewood East</td>
<td>1588</td>
</tr>
<tr>
<td>Rosewood West</td>
<td>1021</td>
</tr>
<tr>
<td>Supplejack</td>
<td>689</td>
</tr>
<tr>
<td>Weaner</td>
<td>1242</td>
</tr>
</tbody>
</table>

Figure 1. Undesirable and desirable annual and perennial pasture species as a proportion of total yield (kg/ha)
Animal Industries Technical projects use established scientific principles to solve problems that affect the productivity and profitability of the industry and, where possible, to protect the environment and human health.

**PROJECT:** Genetic and Reproductive Improvements in Australian Water Buffalo

**Project Officers:** B. Lemcke, E. Cox, A. Turner, G. Jayawardhana and Beatrice Hill Farm Staff

**Division:** Animal Industries

**Location:** NT-wide

**Keyword(s):** buffalo artificial insemination, Beatrice Hill Farm

**Project Type:** Technical

**Objectives:**

To develop an artificial insemination (AI) synchronisation protocol to deliver acceptable outcomes.

To establish a long-term database for the entire Australian buffalo industry.

To analyse and document the genetics of swamp buffalo from data held by DPIFM.

**Background:**

The Rural Industries Research and Development Corporation (RIRDC) collects levies from the buffalo industry (and many others) to support research and development programs in those sectors. DPIFM proposed a four-year project (DNT 33A), which started in 2003 and ends in 2007. Another application has been made to RIRDC for funding for the following four years.

**Method:**

As suitable females become available, drug protocols are used to synchronise the onset of oestrus for fixed time inseminations. Semen has been available from Italy and locally for producing suitable genetic lines to productivity. AI is necessary due to the limited number of imported breeding stock from the US. NT and interstate herds can participate in this project if they have suitable stock and facilities. So far Beatrice Hill Farm (BHF), Shaw River Buffalo Dairy, Yambuk Vic and the Australian Dairy Buffalo Company (ADBC) in Millaa Millaa, North Queensland, have participated in the project.

Arrangements have been made with the Agricultural Business Research Institute at the University of New England to provide technical advice, genetic analysis and registry facilities for this project. Data from the current riverine and crossbreeding herd and from the BHF Swamp herd of the 1980-90 period has been submitted.

Twenty five pure riverine and mixed crossbred heifers were artificially inseminated in July 2006 at BHF. This was immediately followed by the introduction of a bull into the group for two months. Twenty one calves were...
produced. The proportions of calves resulting from AI and from natural mating will be determined by DNA analyses.

In February 2007 a small number of empty purebred cows and heifers were inseminated. They included two dry cows, two lactating cows and one heifer. No conception was achieved.

In June 2007 a local inseminator inseminated 26 animals using the Brazilian protocol and 10 animals using CIDRs (intra-vaginal devices for hormone release) at ADBC. Two aborted. Early indications were good, but pregnancies have yet to be confirmed.

Calving results in the Yambuk (Vic) herd inseminated in March 2006 were six live calves from the 10 ultrasound-confirmed pregnancies out of 20 inseminated heifers. One pregnant heifer died during pregnancy whilst three other pregnancies failed to produce a calf.

**PROJECT: TenderBuff Development and Supply**

**Project Officers:** B. Lemcke, E. Cox, L. Huth and Beatrice Hill Farm Staff

**Division:** Animal Industries

**Location:** Darwin

**Keyword(s):** buffalo, TenderBuff, Beatrice Hill Farm

**Project Type:** Technical

**Objectives:**

*To supply, promote and implement the TenderBuff quality assurance program for local and interstate markets.*

*To ensure a year-round supply of TenderBuff in the Northern Territory.*

**Background:**

The TenderBuff program was initially started to provide higher returns to the buffalo producer whose animal numbers were now quite small, post-BTEC. TenderBuff was seen as a reasonable substitute for feral-derived eye fillet that was going to the restaurant trade. It was also an opportunity to supply a much wider range of high quality cuts.

The Livestock Management group at DPIFM runs the project in conjunction with the NT Buffalo Industry Council. It conducts quality assurance and brands carcasses at the abattoir. The producer receives $3.10/kg hot standard carcass weight (HSCW). The carcass must meet five specifications to receive the TenderBuff strip brand.

Supplies are now sourced mainly from commercial properties and fattened at Beatrice Hill Farm to maintain a steady year-round supply.

TenderBuff has lower cholesterol and fat than beef. These two factors can be used for positive marketing of the product as an alternative red meat. As riverine cross buffalo grow much faster than swamp buffalo, they can be turned-off at a much younger age and should therefore produce more tender meat.

The latest problem to affect local TenderBuff production is the closure of Litchfield abattoir in March 2007. There is no alternative abattoir in the NT at present with the necessary facilities on a year-round basis.
Method:

The current Tenderbuff specifications are:

- 150-300 kg HSCW.
- 3-12 mm fat at p8 site.
- No permanent teeth.
- Electrically stimulated carcass.
- Muscle pH below 5.8 after 18 hours.

DPIFM staff monitor TenderBuff animals through the abattoir on slaughter day and conduct chiller assessment on 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 specification. Discounts are multiplicative if more than one specification is not met.

Results:

Table 1. Carcass parameters for TenderBuff

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No of animals</td>
<td>45</td>
<td>46</td>
<td>36</td>
<td>43</td>
</tr>
<tr>
<td>Mean HSCW (kg)</td>
<td>235.6</td>
<td>244.8</td>
<td>227.3</td>
<td>244.6</td>
</tr>
<tr>
<td>Mean eye muscle area (cm2)</td>
<td>64.7</td>
<td>65.4</td>
<td>61.1</td>
<td>63.9</td>
</tr>
<tr>
<td>Mean pH</td>
<td>5.49</td>
<td>5.51</td>
<td>5.56</td>
<td>5.61</td>
</tr>
<tr>
<td>Mean carcass length (cm)</td>
<td>105.8</td>
<td>105.4</td>
<td>103.5</td>
<td>105.4</td>
</tr>
<tr>
<td>Mean gross ($)</td>
<td>720.01</td>
<td>732.85</td>
<td>700.30</td>
<td>739.17</td>
</tr>
<tr>
<td>Total gross value ($)</td>
<td>32 400</td>
<td>33 711</td>
<td>25 210</td>
<td>31 784</td>
</tr>
<tr>
<td>Mean grid $/kg</td>
<td>3.02</td>
<td>2.99</td>
<td>3.08</td>
<td>3.02</td>
</tr>
<tr>
<td>Mean p8 fat (mm)</td>
<td>10.5</td>
<td>8.3</td>
<td>7.5</td>
<td>9.4</td>
</tr>
<tr>
<td>Mean rib fat (mm)</td>
<td>10.1</td>
<td>9.9</td>
<td>7.9</td>
<td>11.1</td>
</tr>
<tr>
<td>Mean dressing %</td>
<td>53.3</td>
<td>53.2</td>
<td>51.06</td>
<td>51.37</td>
</tr>
<tr>
<td>Total carcass weight (kg)</td>
<td>10739</td>
<td>11261</td>
<td>8180</td>
<td>10516</td>
</tr>
<tr>
<td>Riverine cross stock (%)</td>
<td>43/45 = 95.6</td>
<td>38/46 = 82.6</td>
<td>34/36 = 94.4</td>
<td>42/43 = 97.7</td>
</tr>
</tbody>
</table>

In 2006-07 the number of animals slaughtered declined by 13%. Trade value declined by 14%. This was due to abattoir closure two months before the end on the financial year. Also wholesalers had limited capacity due to the shortage of skilled butchers.

Sabah in Malaysia is interested in slaughter-ready TenderBuff animals. This may be an outlet for industry expansion. Recent promotion in Sabah was very successful. Other possible outlets are Indonesia and other parts of Malaysia. However, both would likely need value-adding in feedlots before slaughter.
Table 2. Comparison between swamp and riverine crossbreds from July 2006 to June 2007

<table>
<thead>
<tr>
<th></th>
<th>Swamp</th>
<th>River crosses</th>
<th>Difference over swamp (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of animals</td>
<td>3</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>Mean HSCW (kg)</td>
<td>212.9</td>
<td>237.6</td>
<td>11.6</td>
</tr>
<tr>
<td>Eye muscle area (cm²)</td>
<td>57.3</td>
<td>66.0</td>
<td>15.2</td>
</tr>
<tr>
<td>Mean pH</td>
<td>5.63</td>
<td>5.59</td>
<td>-0.1</td>
</tr>
<tr>
<td>Mean carcass length (cm)</td>
<td>104.7</td>
<td>104.6</td>
<td>-0.1</td>
</tr>
<tr>
<td>Mean grid $/kg</td>
<td>3.10</td>
<td>3.05</td>
<td>-1.6</td>
</tr>
<tr>
<td>Mean P8 Fat (mm)</td>
<td>5.0</td>
<td>8.7</td>
<td>74</td>
</tr>
<tr>
<td>Mean dressing %</td>
<td>51.1</td>
<td>51.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Mean price ($/animal)</td>
<td>659.90</td>
<td>723.89</td>
<td>9.7</td>
</tr>
</tbody>
</table>

Comparisons (Table 2) are similar to those in other years. However, the very small number of swamp animals makes differences unreliable. The most important specifications of growth rate, tenderness, dressing %, eye-muscle area, fat % and price per animal improved with the use of riverine crossbreeding. The most significant was the higher growth rate which allows the slaughter of younger animals (which should be more tender) and thereby increases turnover and reduces stocking rates.

PROJECT: Increasing Market Share of NT Livestock Exports

Project Officer: D. Ffoulkes

Division: Animal Industries
Location: Darwin
Keyword(s): cattle, buffalo, live export, capacity building
Project Type: Technical

Objective:

To supports new and existing markets for NT pastoral and livestock export industries by providing technical assistance to importing countries.

Background:

The Livestock Exports Development Program provides technical support to governments and industry sectors of importing countries to strengthen trading links and increase the market share of NT livestock exports. Technical assistance is provided in the form of feasibility studies, and advice and training in best practice management of imported cattle.

The program is focused on providing technical support for offshore livestock industry development projects that are likely to seek imports of cattle and buffalo from northern Australia. In mid-2006, there were ongoing projects in the Philippines and Sabah, Malaysia. A new project was initiated in early 2007 in Sarawak, Malaysia.

Method:

The Negros Cattle Industry Development Project in the Philippines commenced in 2002 and a trial feedlot operation was successfully conducted with NT cattle to test the markets. Further shipments were planned for distribution to small holder farmers for growing out prior to finishing in small commercial feedlots. DPIFM officers from DPIFM have been providing technical support and training during the implementation of the project.
A Memorandum of Cooperation (MOC) between DPIFM and the Department of Veterinary Services and Animal Industries (DOVSAI) was signed in Sabah by respective Ministers in February 2005 for cattle industry development and trade. A working group representing each department meets annually to review collaborative activities aimed at capacity building of DOVSAI staff in tropical beef production, animal disease diagnostics and abattoir management.

The Sarawak Beef Development Support project was initiated in early 2007 as part of a collaborative effort by Meat and Livestock Australia and the Australian Brahman Breeders’ Association to assist the Sarawak Department of Agriculture (DOA) to establish a breeding herd to supply quality, locally-bred and adapted Brahman bulls to cattle herds. PIFM provides training in breeder herd management and development of herd management plans for the DOA Karabungan Livestock Centre (75 km from Miri) which will be evaluated over a period of 18 months.

Results:

The Philippines

A financial review of the project was conducted on behalf of investors in June 2006. It was decided to ship young cattle in early 2007. In preparation for the shipment, a two-day training course was delivered at the La Granja agricultural complex in Negros Occidental in November 2006 on receiving and raising Australian commercial cattle, to government and non-government trainers and extension officers (Ffoulkes, 2006a). A review in December 2006 determined that DPIFM would continue to support this project in view of commitments made by the investors and expected shipment of animals in early 2007. Up to now, the shipments have not materialised and the project is likely to be concluded when it is reviewed in December 2007.

Sabah

Most of the collaborative activities identified by the MOC working group for 2006 were completed, namely (a) evaluation of government farms and the TenderBuff program, (b) development of the Sabah Meat Training Centre (SMTC), and (c) feedlot study and management training program. The main exception was the postponement of the farm manager and veterinary laboratory staff work experience and training program in the NT.

In July 2006, DPIFM officers completed an evaluation of seven government farms, assessed the TenderBuff program and delivered a training course on feedlot management (Ffoulkes, 2006b).

In August 2006, the Livestock Exports Development program was part of the NT Stand at the Sabah International Expo to promote NT cattle and TenderBuff. In October 2006, SMTC was officially launched. Both events were attended by the Minister for Primary industry, Fisheries and Mines.

In March 2007, the MOC working group reviewed the 2006 program and developed an action plan for outputs in 2007. A three-month extension was given to the DPIFM Senior Meat Industry Officer to act as Development Manager at SMTC to establish accredited training courses in animal slaughter, butchery and quality assurance. By June 2007, the Development Manager and his counterparts had developed and delivered courses on meat cut techniques, abattoir management and meat inspection. Progress was made to obtain national accreditation for these courses.

In May 2007, two farm managers and two laboratory staff from DOVSAI spent two weeks in the NT for work experience and training. In June 2007, DPIFM officers conducted the final evaluation of government farms in Sabah and delivered a two-day training course on breeder herd management (Ffoulkes, 2007) to farmers. A senior staff member from Berrimah Veterinary Laboratories reviewed epidemiological control measures along the border with Indonesia and appraised progress in implementing quality management systems at the Sabah Government Animal Disease Research Centre and Tawau Veterinary Laboratory.
Successful outcomes were achieved for all MOC activities in cattle industry development. Most government farms are now demonstrating best practice management for the local industry and productivity in terms of lower mortalities and higher calving rates as farm managers realise the importance of sustainable stocking rates. The TenderBuff program cannot meet market demand and shipments of slaughter stock may need to be considered within a joint venture framework. Work experience programs in the NT for farm managers and veterinary laboratory staff have generated new ideas to improve workplace management practices. The placement of a DPIFM staff member as Development Manager at SMTC has resulted in a competent slaughterhouse operation and meat industry training program. Training in feedlot and breeder herd management has boosted the confidence of local farmers to invest in these production systems.

This project is due to be completed in February 2008 when a full report including training resources developed during the project, is scheduled to be handed to the Sabah Government. From July 2006 to June 2007, total exports of livestock to Sabah were 3860 breeder cattle, 660 buffalo and 6350 goats.

Sarawak

In June 2007, DPIFM Officers delivered a two-day training program (Ffoulkes, 2007) at Karabungan Livestock Centre on good animal handling practices and breeder herd management to 15 participants comprising government extension officers and private sector livestock managers. A key outcome of this training was an agreement that 65% calving rate should be a benchmark for cattle integration under oil palms as the main purpose of the cattle is to reduce management costs of the oil palm rather than beef production. A demonstration on estimation of stocking rate under oil palms was also conducted and found that carrying capacity at the location was 50 breeders plus calves per 500 acres (202 ha) based on a 90-day rotational grazing cycle. The Sarawak Government recommends a distribution rate to new recipient farmers of 20 young breeding stock per 500 acres, or 50 animals per 1000 acres (405 ha).

Development of herd management plans for the Karabungan Livestock Centre involved SWOT analysis, examination of herd and pasture records, soil and plant analysis, on-site inspections and forage production estimates. Many challenging issues need to be addressed at the farm in order to turn around the performance of the cattle herd to meet stated objectives. A detailed action plan of management activities required over the period between July and December 2007 for improving infrastructure, feed availability and herd productivity was prepared by DOA staff and reviewed by DPIFM officers. Progress will be evaluated, as a project milestone, including signs of improvement in herd productivity in early 2008. Further details can be found in a full report (Ffoulkes and Lemcke, 2007).

References:


PROJECT: Barkly Tableland Burning Trial

Project Officer: C. Materne

Division: Animal Industries
Location: Barkly
Keyword(s): pasture, fire, native grasses
Project Type: Technical

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 on Alexandria station.

To demonstrate the application of prescribed burning in the extensively grazed Mitchell grasslands of Buchanan paddock.

Background:

Traditionally, pastoralists have considered the Mitchell grasslands of the Barkly Tableland too valuable to burn in terms of their value as cattle feed. 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 not burnt pasture. This, along with anecdotal evidence suggesting that woody tree and shrub species are beginning to increase and encroach onto Mitchell grasslands, has enhanced the view among pastoralists that not enough burning is being conducted on Mitchell grass downs on the Barkly Tableland.

The aim of the Alexandria Station 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 Mitchell grasslands on the Barkly Tableland.

Method:

This trial consists of two parts:

- An intensively sampled plot trial to identify the response of Mitchell grass to burning at two different times of the 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.

Developments:

All practical burning and pasture data collection has been completed. Data collation and analysis is being conducted. A report will be published in 2007.
**PROJECT:** Northern Livestock Transporters Short Course

**Project Officers:** T. Oxley and T. Cowley

**Division:** Animal Industries  
**Location:** Katherine  
**Keyword(s):** cattle transport, capacity building  
**Project Type:** Technical

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**Objective:**

To develop a practical and interactive training course for truck drivers in the northern beef industry with the aim of improving the quality of livestock road transportation.

**Background:**

Addressing animal welfare concerns is a fundamental task of all parties involved in the handling livestock. The current climate of animal welfare activism makes it particularly important for the pastoral industry to demonstrate its commitment to the humane handling of livestock. There has been increasing emphasis placed on training staff on property to improve their handling of livestock. As it is well documented that transport is one of the most stressful events a domestic animal will undergo in its lifetime, it seems just as imperative to ensure that drivers are educated to take best possible care of animals during this time of elevated stress. Transport operators are also a very visible part of the red meat supply chain as the public can easily observe the conditions under which transported cattle are placed.

Difficulty in recruiting and retaining experienced drivers is another reason for this course. There is a real need to train new staff, some of whom have had no previous experience in handling livestock.

**Method:**

The course will be developed in consultation with drivers, operation managers, producers, stock inspectors, experts in the field of stock handling and livestock transporters from the NT, northern Western Australia and Queensland. A pilot course will be conducted in December 2007 to be attended by leading members of the industry. The course will then be reviewed if necessary and launched in March 2008.
PROJECT: Disease Surveillance

Project Officers: F. Human, Veterinary Officers and Stock Inspectors

Division: Animal Industries
Location: NT-wide
Keyword(s): disease investigations
Project Type: Technical

Objectives:

To provide credible disease surveillance information to support the sale of livestock and livestock products.

To investigate the occurrence of diseases in NT livestock industries.

To respond to reports of potential exotic disease incursions.

To participate in national animal health surveillance programs.

Background:

Surveillance of the animal population in the NT consists of collecting, analysing and interpreting health and disease data to add to our knowledge of endemic diseases, to identify new diseases, to elucidate risk factors for diseases and to plan and implement ways to control diseases. Surveillance encompasses:

1. The collection of animal health data during disease investigations initiated by the producer (passive/general surveillance).
2. Planned surveys to target a specific disease (active/targeted surveillance).
3. The provision of NT information as part of national programs to enhance Australia's trading status.
4. A secure and reliable computer system to store and retrieve data and communicate results to relevant parties.

Departmental investment in surveillance activities described in this and other projects in this report is around $1.2m for 2006-07, excluding external funding. Surveillance activities provide protection for a livestock industry worth over $210m on-farm in the NT.

Method:

The activities described below are major components of this project. Other disease surveillance activities are described under specific projects.

Passive surveillance

Investigation of disease events in livestock reported by producers achieves two objectives. First, the provision of a diagnostic service by veterinary officers and stock inspectors for sick animals assists producers to treat, prevent and control disease in their animals and thereby enhances profitability and animal welfare. Second, the provision of this service enables documenting of surveillance data for both endemic and exotic livestock diseases. Information from passive surveillance can be used for market health assurance in
trade. The accumulated knowledge over time regarding endemic disease conditions in livestock also improves the advice and extension information that is provided to producers.

Active surveillance

Veterinary officers and stock inspectors are involved in necropsies and sample collections for various programs. These surveillance activities are covered in other project reports. Regulatory work is reported under the stock movement project.

National animal health information system (NAHIS)

NAHIS is a surveillance program coordinated by Animal Health Australia (AHA) that has input from State/NT governments and the Commonwealth. NAHIS provides timely and accurate summary information on Australia's animal health status to support trade in animal products 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.

Information is provided quarterly to the NAHIS database on NT animal health status, specific testing carried out at Berrimah Veterinary Laboratories (BVL) and significant animal disease events. Similar reports from all the agriculture/primary industry departments, as well as information from AQIS, the 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 by AHA.

The world organisation for animal health, also known as the OIE, requests information on disease events, staff numbers and other relevant issues from its members on a six-monthly basis. The NT component of this information is provided in a timely manner mainly from BVL's animal disease information management system, ANDI.

Results:

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.

Diagnostic highlights 2006-07

The diagnostic highlights are a summary of interesting passive surveillance disease investigations for the period and as such do not cover all investigations carried out.

Chlamydia infection in juvenile farmed crocodiles

Outbreaks of disease causing high mortality in farmed saltwater crocodiles occurred on two properties in the Darwin region between June and August 2006. More than 3000 juveniles in the 2–5-month age group died. The animals consistently had fibrinous pharyngitis and conjunctivitis. Specimens tested positive for Chlamydiaceae by polymerase chain reaction tests. The infection spread rapidly after it was first noticed; a shared water body and regrouping animals probably contributed to the high infection rate. The animals responded poorly to antibiotic treatment.

Sporadic cases of a chronic nature were also seen in 1–3-yearold animals on all four of the major crocodile farms in the region. Outbreaks of Chlamydiaphila infection have been reported before in southern Africa and Papua New Guinea, but the clinical presentation was different. The literature describes an acute hepatitis or a chronic conjunctivitis, but no throat lesions. The affected animals in those outbreaks responded well to antibiotics.
Factors that appear to account for the high mortality in the juveniles are the anatomical features of the pharynx and larynx in crocodiles and their inability to cough. These factors make the animals highly susceptible to laryngeal obstruction by exudate. The build-up of exudate, associated with mucosal damage, partly accounts for the poor clinical response to antibiotic treatment. These animals had to be force-fed, which put them under further stress. Juvenile crocodiles, in general, poorly tolerate parenteral administration of antibiotics.

Reference laboratories are undertaking DNA sequence analysis for species and strain typing of the Chlamyphila. Preliminary results have shown that the strain of Chlamyphila from the crocodiles is different from Chlamyphila detected in birds on the same farms, but does not fully match sequences of known existing strains.

It is not clear why the disease appeared suddenly in outbreak form on the two farms this year. Possible factors include the unusually cold dry season and the opportunity for transmission of infection from older animals to juveniles. DPIFM obtained funding to further investigate the epidemiology of the disease.

Fowl pox

A small, free-range poultry farm in the Darwin rural area presented young chickens with severe pustular lesions around the cheeks and eyes. Five out of 30 young chickens had died, and another ten showed clinical lesions. Older birds were not affected. A diagnosis of fowl pox was confirmed at the laboratory. Fowl pox is caused by a pox virus and is spread by mosquitoes. The infection leads to the formation of wart-like nodules on the head and legs and, occasionally, lesions occur in the mouth and throat. This is then known as canker and causes difficulties in eating and breathing. A vaccine is available to protect young stock.

Abortions in goats

An abortion storm occurred in a goat herd in the Darwin rural area. Seven of 30 animals aborted, and two of the nannies died. A post-mortem examination of the nannies and foetuses did not indicate an infectious cause. The heavily pregnant goats were rejects from an export shipment. The remaining goats have produced kids normally.

Suspected Swainsona poisoning in horses

Horses with neurological signs were investigated on a southern Tennant Creek property. About 20 horses had died over a two-month period. Animals became weak and depressed, lost weight and showed various signs of ataxia; most appeared to be stiff in the hind limbs during movement, without obvious dragging of the hoofs. Affected animals died within 10–14 days, but a few survived to four weeks. The horses overreacted when approached, moving with a high stepping front gait, but would soon settle to their lethargic state. Semi-circular movement was observed when affected animals grazed or moved to the water trough. No gross organ pathology was seen on autopsy of an euthanised horse, but a histopathological examination of the brain and spinal cord revealed a degenerative axonopathy which is indicative of plant poisoning. This lesion has been described with swainsona and cycad poisoning. Cycads do not occur in the area. There are many Swainsona species in Australia, but only five are known to be toxic. In the NT the implicated species is Swainsona canescens, known as grey swainsona. Other toxic species are known as darling peas.

Ketosis in an extensive beef herd

A group of older cows on a Barkly Tablelands property was moved from the lakes country to open grassland before the wet season. Downers and deaths were seen a week later. More than 30 animals died. The majority of cows were in advanced stages of gestation or had just calved. A pale liver was a consistent finding on autopsy, but no other gross lesions were observed. The urine had very high ketone content as shown on a urine dip-stick. One of the animals examined showed signs of secondary photosensitisation on the muzzle. A diagnosis of ketosis, also known as pregnancy toxaemia, was made. The high protein diet
from legumes and shrubs in the lakes area could have been a contributing factor. This metabolic disturbance is mostly found in dairy cattle at the time of peak lactation, but in beef cattle the condition is more likely to develop around the time of calving.

**Suspected plant poisonings in cattle**

Two Brahman bulls died suddenly on a Katherine property after 40 bulls were transported from Moura and Cloncurry. The bulls had been accustomed to grazing *Leucaena* (a fodder tree) and had been moved directly toward ironwood suckers and trees (*Erythrophleum chlorostachys*) when unloaded. A post-mortem examination revealed evidence of haemorrhage around the valves of the heart and in the rumen. There were abundant ironwood leaves in the rumen and scant amounts in the small and large intestines.

Fifteen heifer deaths were reported in the Katherine region within one week of transport from Halls Creek. Two day-old carcasses were examined, but were not suitable for sample collection. There was no evidence of struggle before sudden death. Heavy growth of belly-ache bush (*Jatropha gossypiifolia*) was observed in the paddock, especially around the water point. Deaths ceased when the cattle started grazing and moved away from the water point. Jatrophas contain a toxic lectin in all parts of the plant, particularly the seeds. It affects mainly the gastrointestinal tract with associated signs of gastroenteritis and death in severe cases.

**Hendra virus excluded**

A horse from a rural block in the Katherine region lost its appetite and became lethargic over a 3-day period. It developed oedema of the infraorbital fossa, neck, ventral abdomen and perineum. The horse’s body temperature, respiration and heart rate were elevated, and its heartbeat was irregular. Treatment with anti-inflammatories and antibiotics was unsuccessful, and the horse was euthanised two days later.

Repeat blood samples revealed increased numbers of neutrophils, followed two days later by a drop in mature neutrophils and an increase in the number of immature neutrophils. The main histological finding was a severe supplicative and haemorrhagic bronchopneumonia. The appearance of the liver suggested ischaemia and acute circulatory failure. This was most likely from septicemic shock that arose from an overwhelming bacterial infection or an endotoxaemia. There was a marked increase in urea and creatinine at the time of death. This, along with low levels of dissolved solutes in the urine, suggested secondary renal failure.

The origin of the pneumonia could not be determined. No bacteria were cultured, probably due to antibiotic treatment during the period of illness. No other horses on the property have been reported ill. It is important to note that laboratory tests excluded Hendra virus.

**Escherichia coli peritonitis in a poultry flock**

The owner of an 18-month-old poultry flock in the gulf region of the NT reported low level mortalities from August 2006 onwards. The flock of 220 commercial layers had two deaths per month on average. Sick hens lost weight, became lethargic and developed paresis before death. The illness lasted for a few days, but the affected hens were capable of eating and drinking until death. The flock also produced increasingly deformed and thin-shelled eggs.

A sick hen was euthanised for autopsy and another frozen carcase was examined. Gross findings were similar in both hens: carcases were emaciated, with marked abdominal distension due to accumulation of coagulated, friable, yellow material in the abdomen, adhered to abdominal viscera and the oviduct. One hen had shell remnants in the oviduct and the other was egg-bound. A complete set of autopsy tissues was taken for laboratory investigation. Blood and faeces from the flock were also submitted.

Histological examination of tissues confirmed a severe, chronic, supplicative (pus-forming) peritonitis and yolk intermingled with inflammatory exudate. There was also chronic supplicative infection of the oviduct.
Bacterial cultures of organs and the coelomic exudate of both hens yielded *Escherichia coli*. Chronic *E. coli* peritonitis in mature hens can be a result of infection entering through the cloaca or via inhalation through the lung into the abdominal air sac. Parasitological examination of faecal samples revealed moderate numbers of ascarid-type eggs, most likely those of the caecal worm, *Heterakis* sp., and tapeworm eggs. Caecal worms are associated with ingesting soil or earthworms. The tapeworm eggs are probably those of *Raillietina* sp., the cause of nodular disease in chickens.

For a variety of reasons that are probably related to the tropical climatic conditions, it is common for commercial chickens in the Top End to experience laying problems, including non-production of eggs, egg binding and chronic peritonitis, after 12 months of production. The owner was advised on treatment and longer term prevention measures.

**Nitrate toxicity**

A 10-month old steer died overnight on a small property in the Darwin rural area without showing any noticeable clinical signs the day before. A necropsy revealed reddening of the oral mucosa and tissues of the neck. The lungs were oedematous and markedly congested, while the trachea and large bronchi contained foamy haemorrhagic fluid. Haemorrhages were present on and around the heart. Histopathology confirmed congestion and haemorrhages in other organs too. Nitrate toxicity was suspected, but none of the other 11 animals in the paddock was affected. The cattle grazed on pasture and received no supplement. Poisonous plants were not observed. On further testing, elevated nitrate levels were found in serum, urine and aqueous humour samples. The owner was informed of potential nitrate sources and on closer inspection he found a half open bag of fertiliser outside the shed which may have been accessible to the steer.

**Adverse weather affected exposed cattle**

A property in the Douglas Daly region lost four lactating aged cows from a group of about 40. Cows were reported to have a stilted gait and were showing respiratory distress. A necropsy on one animal revealed an extensive pleuropneumonia and on bacteriological culture of the lungs *Mannheimia haemolytica* was isolated. The cows were in an open paddock and had been exposed to unusually cold and wet weather. The owner moved the cows to a more sheltered paddock and no further losses occurred.

A significant number of weaner deaths were also reported across the Victoria River District, the Barkly Tableland and south western Darwin region during the spell of cold weather. Deaths were likely associated with hypothermia due to sub-normal temperature, high winter rainfall and windy weather conditions in areas where little shelter was available. There has been an increased incidence of coccidiosis in weaners on a number of properties too, following the cold weather. Some producers have since introduced a supplement containing monensin as a coccidiostat to the weaners.

**Respiratory disease in poultry**

A poultry keeper from Darwin rural area lost 15 birds of various ages from a poultry flock of 100 show birds over a two week period. The owner noted signs of respiratory distress and noises in birds while breathing. Clinically affected birds died mostly within a day after showing signs of illness. An infection with avian influenza virus was excluded. Death appeared to have been caused by laryngeal obstruction. Histopathology identified the respiratory disease as infectious laryngotracheitis, which is caused by a herpes virus. To our knowledge, this disease has not been diagnosed previously in the NT. It is not clear where the infection came from as there was no movement of the poultry or introduction of new stock in the recent past. The poultry are kept under free range conditions and contact with wild birds is a possible explanation.

**Disease surveillance reporting**

The *Animal Health Surveillance Quarterly* report is compiled by AHA based on the information recorded in the NAHIS database by State coordinators and other contributors. It also contains text contributions from all
States/Territories and the commonwealth Department of Agriculture and Fisheries. The report is circulated nationally; in the NT it is distributed to relevant government personnel and livestock industry groups. The report and more information about NAHIS is available on the AHA website at: www.animalhealthaustralia.com.au

*Animal Health in Australia* is a more comprehensive report produced annually by AHA and targets a wider audience nationally and overseas, including Australia’s trading partners.

*Animal Health News from the Northern Territory* is a quarterly publication produced by BVL 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 within and outside DPIFM. The articles by BVL and field staff in southern and northern regions cover topical animal disease events, animal health surveillance news, information from BVL and other items. Issues 42 to 44 were produced during 2006-07; about 200 copies of each were distributed.

**PROJECT:** Enterprise Planning for Economic, Environmental and Social Outcomes

**Project Officer:** S. White

<table>
<thead>
<tr>
<th>Division:</th>
<th>Animal Industries</th>
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<tr>
<td>Location:</td>
<td>NT-wide</td>
</tr>
<tr>
<td>Keyword(s):</td>
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**Objective:**

*To develop, promote and deliver a tailored program that will assist primary producers in the pastoral, agricultural and horticultural sectors of the NT to critically analyse their enterprises (within a triple bottom line context), identify business, personal and NRM goals and directions, and take action to achieve them.*

**Background:**

This project was developed to meet the property management planning targets set in the NT Integrated Natural Resource Management Plan and accompanying Regional Investment Strategy.

**Method:**

The methods outlined in the original project application included reviewing and updating an existing planning framework and the production of a tool kit for planning and creating demand for planning activities, delivery of workshops and one-on-one meetings, and collation of existing planning activities across industry at the commencement and completion of the project.

An application for project variation has since been submitted to the Natural Resource Management Board. Confirmation of the proposed variation has not yet been received.

The proposed scope of the new project includes developing benchmarks for all areas of the primary production business for producers to assess their performance and use as a basis for planning and decision making activities along with a tool kit of resources outlining how they are relevant to the primary production business. Case studies of producers who have previously been involved in planning activities will be documented and pilot properties will be asked to share their experience of using the developed benchmarks.
Results:

Detailed results are not available at this stage of the project. However, it is anticipated that main results will include enhanced business analysis, planning and decision making activities supported by a suite of tools and processes and strong benchmarks based on best practice in all areas of the business.

PROJECT: Effects of Desert Fire on Mulga Communities in Central Australia

Project Officers: C. Materne and C. Allan

Division: Animal Industries
Location: Alice Springs
Keyword(s): mulga, fire
Project Type: Technical

Objectives:

To provide an objective description of the number and density of mulga communities on pastoral properties in Central Australia.

To compare the regeneration of mulga communities after the 2001 and 2002 fires and test for differences based on seasonal conditions, principally pre- and post-fire rainfall.

To identify potential management implication associated with fire and mulga communities.

To recommend further studies to extend knowledge beyond the results of this project.

Background:

The rangelands of Central Australia are a dynamic system on which the profitability of the pastoral industry depends. The system can vary depending on the phase of the floristic composition at a particular time. Fire can affect the floristic composition of a rangeland. By understanding the relationships between fire and rangeland dynamics, it is possible for the pastoral industry to use fire as a tool to manage rangelands more profitably.

During 2000 and 2001 the Alice Springs district received about 2.5 times the average rainfall. This unique rainfall event was followed by above average vegetative growth and extensive wildfires that have been compared with those experienced during the 1920s, 1950s and 1974-75. During the two-year period large areas of country experienced a variety of effects from fire depending on such parameters as fire frequency and soil moisture.

The project is funded by the Desert Knowledge CRC and is collaboratively conducted by DPIFM and Bushfires NT.

Method:

The study site

Using the DOLA fire-scar mapping tool the 2000-02 fires in the Alice Springs region will be mapped according to fire frequency, timing and land system.
Three general fire types will be identified:

- 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.

Data was collected for each fire sampled along three replicated belt transect pairs in both burnt and unburnt mulga (*Acacia aneura*) communities. Each transect was divided into 100 quadrats of two parallel and contiguous lines of 2.5 m x 5 m.

Perennial tree and shrub woody vegetation was counted within each quadrat by species within six size-class categories for both dead and living individuals.

**Table 1.** Height classes used to collect woody vegetation data

<table>
<thead>
<tr>
<th>Height class</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>&lt; 0.5 m</td>
<td>0.5 – 1 m</td>
<td>1 – 2 m</td>
<td>2 – 5 m</td>
<td>&gt; 5 m thin basal stem</td>
<td>&gt; 5 m thick basal stem</td>
</tr>
</tbody>
</table>

**Results:**

Sampling of 91 transects has been completed, representing 15 individual fires and associated un-burnt areas.

Of the 27 573 individuals of woody vegetation recorded on all transects, 13 119 were mulga, of which 7318 were live (56%) and 5801 were dead (44%). There were 2799 live juvenile mulga plants (height classes 1, 2 and 3), or 52% of the total live mulga. The distribution of mulga by height class for all transects is shown in Figure 1. The regeneration of mulga can be represented as the ratio of the number of juveniles less than 1m (height classes 1 and 2) and the number of non-juvenile mulgas killed by the fire (height classes 3 to 6). The regeneration ratio for all transects was 0.71, indicating that regeneration has been less than the number of adults killed by fires.

![Figure 1. Distribution of mulga by height class for all transects](image)

Note: 0.71 in Figure 1 represents the regeneration ratio

The second aim of this project was to compare the regeneration of mulga communities after the 2001 and 2002 fires. There was considerably less regeneration of mulga within the un-burnt areas (regeneration ratio
0.36) (Figure 2). The impact of the 2001 fires represented as the number of adult plants killed by fire, was less than during the 2002 fires, and the regeneration ratio for 2001 was only 0.56 compared to 0.73 for 2002 (Figures 3 and 4).

**Figures 2, 3 and 4.** Distribution of mulga by height class separated into unburnt, burnt 2001 and burnt 2002 transects, respectively.

The regeneration ratio is shown for each group of transects.

For the NW region, represented by transects on Mt. Doreen, Mt. Denison and Coniston stations, there was considerable variation in the density of mulga between the fire history groups but the relationships were consistent with the results for all sites combined (Figures 5, 6 and 7). The regeneration ratio was lowest in the un-burnt sites; the fires in 2002 killed a greater proportion of the mulga than did the fires in 2001. There was less difference in the regeneration ratio between the burnt 2001 and burnt 2002 sites; however, this was influenced by the reduced density of mulga within the burnt 2001 sites.
Figure 5, 6 and 7. Distribution of mulga to the NW of Alice Springs separated into unburnt, burnt 2001 and burnt 2002 transects

The regeneration ratio is shown for each group of transects.

Conclusions:

Based on all data, preliminary analysis indicates the following conclusions (although further analysis is required):

Overall mulga numbers have decreased since the 2000-02 fire season.

The impact of the 2001 fires, represented as the number of adult plants killed by fire was less than the 2002 fires.

For the north-west Alice Springs region, the fires in 2002, without follow-up rain, killed a larger proportion of mulga than did the fires in 2001 with follow-up rain.
PROJECT: Fire and Vegetation Management in the VRD

Project Officer: C. Smith

Division: Animal Industries
Location: Katherine
Keyword(s): rangelands, fire, Victoria River Research Station
Project Type: Technical

Objectives:

To understand the long-term impacts of burning on woody plant cover and pasture condition.

To develop practical burning management guidelines for land managers.

To increase the use of fire as a tool to manage woody plants in pastoral areas of the VRD

Background:

Thickening of woody plant parts in the absence of fire will reduce pasture production due to increased competition for soil moisture and/or nutrients. Although many woody communities are adapted to periodic burning, the prescribed use of fire has been demonstrated to have an important role in the management of tree-grass balance and pasture condition. Guidelines concerning its use as part of a management system have been developed, based on results from the first six years of the fire trials at Victoria River Research Station. To understand the longer term effects of implementing recommended fire regimes, the fire trials at Kidman Springs are being continued with less vegetation monitoring.

Method:

Red and black soil plots are burned at two, four and six-year intervals in the early or late dry season. Pasture is monitored every second year before burning to get an estimate of its condition and fuel load. Yield, pasture composition, cover and grazing are assessed over all plots in the early dry season in July. Yield is assessed on plots to be burned in the late dry season in October. Aerial photographs are taken of the plots prior to burning in July.

Results:

Unseasonal rainfall in June 2007 postponed the burning of the ‘shruburn’ plots. The red soil plots in Conkerberry paddock were partially burnt (about 10% burnt) and the black soil plots in Rosewood were not burnt as fuel loads of more than 1500 kg/ha and 50% cover are required to conduct a fire (see Table 1).

Table 1. Yield and cover for Kidman ‘Shruburn’ plots designated for burning this year

<table>
<thead>
<tr>
<th>Plot</th>
<th>Rosewood paddock</th>
<th>Conkerberry paddock</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Treatment</td>
<td>Early 6</td>
<td>Early 6</td>
</tr>
<tr>
<td>Average yield (kg/ha)</td>
<td>751</td>
<td>810</td>
</tr>
<tr>
<td>Cover % (uncalibrated)</td>
<td>26</td>
<td>27</td>
</tr>
</tbody>
</table>
Figure 1. Rosewood plot designated for burning this year but not attempted due to lack of fuel and high moisture content of existing grasses

PROJECT: Indigenous Pastoral Program

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

Division: Animal Industries
Location: NT-wide
Keyword(s): indigenous development, capacity building
Project Type: Technical

Objectives:

To increase cattle numbers on indigenous land.

To increase indigenous participation in the pastoral industry.

Background:

The Indigenous Pastoral Program (IPP) is a multi agency approach to increase participation by Aboriginal people in the pastoral industry of the Northern Territory (NT). It was initiated by a memorandum of understanding (MOU) between the Indigenous Land Corporation, the Northern and Central Land Councils and the then Department of Business, Industry and Resource Development in February 2003. In September of 2006, the MOU was renewed to 2011 and included two new formal members, Northern Territory Cattlemen’s Association and the Commonwealth Department of Employment and Workplace Relations. The program has been a landmark case of cross agency cooperation and the setting of a unified goal.

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

- To achieve sustainable development outcomes and accommodate multiple land use aspirations, but focusing on pastoralism.
- To obtain 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* in the process of planning, development and implementation of any enterprise.
- To foster direct indigenous participation in the management and operation of pastoral enterprises and maximise indigenous employment and training outcomes.
- To maximise the coordination of resources from key agencies, business and industry.
- To maximise the delivery of benefits to landowners according to established key performance measures and criteria. Performance may include key measures such as employment, income generation, improved land and infrastructure condition and/or increased numbers of breeders.

The program is guided by a steering committee that oversees its strategic direction in line with the developed strategic plan.

The program enjoys the support of most senior staff of contributing agencies as they recognise that IPP provides real, on the ground solutions to indigenous enterprise development.

**Results:**

The Department of Natural Resources, Environment and the Arts 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 jobs per year. When initiating 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 the attention away from the need to establish long-term solutions. However, substantial success has been achieved including:

- Signing of a new MOU by the partner organisations extending the program for another five years (until 2011). The new MOU also formally adopts the NT Cattlemen’s Association and the Commonwealth Department of Employment and Workplace Relations as program partners.
- Engaging a full time program manager.
- Increasing animal numbers on indigenous land to 28,500 up to now.
- Increasing animal numbers on current developed country to 30,000.
- Filling over 60 short, mid and long-term positions in stock camps, contract fencing and apprenticeship roles by Aboriginal people at various locations.

Other achievements included:

- Cooperation and resource allocation from external agencies such as DEET, NRETA, CDU, IBA, NHT and DEWR for training.
- Provision of additional funding from DBERD for 50% of a position to work exclusively on business development.
- Provision of two dedicated pastoral extension officers for two years funded by NHT to establish grazing land management under pastoralism on indigenous land.
- Access to indigenous communities for the provision of appropriate land management techniques regarding fire, feral animals and weeds on indigenous land.

Change over of staff highlights the need for active engagement in skills auditing and succession planning to ensure continuity of the program.
The expansion of the Indigenous Pastoral Trainee Scheme in 2006-07 highlighted issues that come with multi agency agreements. Whilst it is necessary to engage with a range of agencies in a combined approach to address difficult issues, it is also necessary to continue to hack away at the bureaucratic restrictions that are inherent in a complex funding program arrangement.

**PROJECT:** Managing Grazing by Alternating Watering Points

**Project Officer:** H. James

**Division:** Animal Industries

**Location:** Barkly

**Keyword(s):** cattle, pasture, rangelands, watering points

**Project Type:** Technical

**Objective:**

*To reduce grazing pressure by spreading animals more evenly through a paddock*

**Background:**

This investigation aims 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 of the Northern Territory. Cattle grazing behaviour is being manipulated by having only 1 of 5 watering points in a paddock operating at any one time over the dry season (April to November). A control paddock exists which operates under a traditional grazing management regime. Extensive pasture and cattle data has been collected from the Rockhampton Downs Station site and indicates cattle performance is reduced initially by alternating the water management regime although pasture composition is improved. Preliminary results and observations indicate that managing cattle by alternating watering points is possible within the extensive grazing systems of the Barkly region. This investigation demonstrated that yield of perennial grass species increased under the alternate water management system.

**Method:**

A 530 km$^2$ paddock was divided into two. In the control paddock, 880 cattle are managed under traditional continuous grazing practices. All watering points in the control paddock are operational at all times and grazing by cattle is uncontrolled. In the treatment paddock 730 cattle are moved around by having only one of five watering points operating at any one time.

New watering points have been created by turning off existing troughs at bores and pumping the water to new troughs about 4 km away in areas traditionally not grazed. Cattle are held on watering points for six weeks which allows for each watering point area to be grazed once during an average dry season. During the wet season, when surface water is present, grazing is uncontrolled.

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 at new watering points and 5 km at existing watering points. Sampling occurs at 250 m intervals within 2 km of the watering point and then at 500 m intervals when farther than 2 km from the watering point.

Cattle weights, pregnancy status and weaner weights are also recorded in May. An extensive management diary has also been kept to evaluate the impact of this grazing system on overall station operations, thereby allowing for a greater understanding of its impact.
Results:
This trial is studying the effectiveness of controlling grazing without installing additional fencing. Holding the cattle on watering points proved difficult during 2004 but was resolved in 2005 through the persistence of the manager. Greater influence over the areas of the paddock that are grazed has been achieved through investing time in training cattle and modifying their behaviour. The investment in training cattle and developing more water points has allowed for savings in time and money when mustering by having cattle closer to yards, which reduces the need for helicopters.

Preliminary analysis suggests an increase in perennial grass species within traditional sacrifice zones, which represents an improvement in pasture composition. Increases in perennial grasses offer more feed towards the end of the dry season, increasing the overall carrying capacity of the paddock.

The ability to manage cattle on alternating watering points represents a vast change from traditional grazing strategies and is considered a major achievement of the trial.

Overall loss or benefit of grazing through alternating watering points will be determined at the conclusion of the trial.

PROJECT: Rangeland Grazing Strategies for Improved Economics and Resource Sustainability

Project Officer: A. Kain

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<tr>
<td>Keyword(s):</td>
<td>cattle, spelling, rangelands, pasture profitability</td>
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<td>Project Type:</td>
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Objective:
To develop industry acknowledged best practice guidelines for grazing strategies in Central Australia that incorporate spelling to 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 look at using their land more efficiently. There has been widespread interest by the industry in spelling practices, which hold out the potential for increased or sustained production without damage to natural resources. However, there has been little documented evidence of this potential, particularly at a practical whole-of-property/business level. Recently, Heytesbury Beef established a major commercial trial of intensified land use at Pigeon Hole Station in the tropical savanna regions of the VRD and a project in the southwest rangelands of Western Australia is monitoring the effects of various activities conducted there by pastoralists at the property level. In Queensland, a new Meat and Livestock Australia project is exploring environmental and economic benefits and costs of different grazing systems, particularly cell grazing. Thus existing trials encompass summer and winter-dominant rainfall regions of the rangelands but do not cover non-seasonal and more variable parts of the rangelands, which extend from western NSW and south western Queensland through Central Australia to the Murchison in WA.
The major benefits of spell grazing include:

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

Potential risks of spell grazing include:

- Capital costs of setting up more intensively fenced and watered systems.
- Possible errors of judgement in leaving stock for too long on country; though this may be offset by damaging less area at the same time. There is probably a greater risk of this in regions with a more variable climate or fragile soils.
- Lack of access to markets at critical times.

Method:

There are three grazing trials in Central Australia. Two of them are on pastoral properties, Mt Riddock and Idracowra Stations and the third is at Old Man Plains Research Station (OMPRS). The trials at Mt Riddock Station and OMPRS are continuing; however, the trial at Idracowra Station was suspended because the property has been sold.

At Mt Riddock, steers were 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 are also 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. One or two hoof prints is given a score of one. 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 km² paddock, 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 were weighed and pregnancy-tested at the beginning of their time in the paddock (May 2006) and will be monitored annually.

At OMPRS the trial consists of four paddocks that allow for annual summer spelling of the calcareous grasslands and biannual summer spelling of the mulga sand plains. Pastures are monitored pre- and post-grazing.

Results:

Mt Riddock

Two groups of 400 steers each have completed a four paddock rotation at Mt Riddock Station and have been sold. There are currently 400 steers in the trial paddocks. There are no results from the subsequent groups of steers at this time. Pasture monitoring results for 2006 involved pre- and post-grazing assessment. However, this intensive level of survey cannot be sustained. At present it is planned to monitor pasture annually at the end of the summer growing season. Pasture monitoring was completed in May 2007 but the data has not been analysed yet.

Idracowra

Due to the sale of Idracowra Station and the dry conditions at the time, there was no opportunity to muster and record the performance of any of the cattle in the trial. Pasture monitoring was completed in April 2007
but the data has not been analysed yet. Analysis will have little significance anyway because any differences between the two years are likely due to seasonal conditions rather than the grazing trial.

**OMPRS**

On 8 November 2006, 80 cows were allocated to West White Point (WWP) paddock and 30 cows to the control paddock. On 15 January this year, four bulls were introduced to the treatment paddock and one bull to the control paddock. All the bulls were removed on 12 March. At the end of April 47 animals were weaned from the WWP group and 19 from the control group. Details of herd data collected on 13 March 2007 are provided in Table 1.

Table 1. Herd performance data recorded on 13 March 2007

<table>
<thead>
<tr>
<th></th>
<th>Yarded</th>
<th>Av. cow weight (kg)</th>
<th>Calves</th>
<th>Calving (%)</th>
<th>Av. Calf weight (kg)</th>
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</thead>
<tbody>
<tr>
<td>Control</td>
<td>28</td>
<td>538</td>
<td>19</td>
<td>68</td>
<td>138</td>
</tr>
<tr>
<td>Trial</td>
<td>63</td>
<td>530</td>
<td>47</td>
<td>75</td>
<td>135</td>
</tr>
<tr>
<td>Total</td>
<td>91</td>
<td>534</td>
<td>66</td>
<td>73</td>
<td>137</td>
</tr>
</tbody>
</table>

Pasture monitoring and forage budgeting were conducted in April 2007 to coincide with the end of the growing season. The data has not been analysed yet.

The current project continues until 2008 following an extension by the Commonwealth Department of Agriculture, Fisheries and Forestry. DIFM intends to continue to monitor grazing strategies for the foreseeable future to achieve meaningful results.

**PROJECT:** Short Duration Grazing Demonstration

**Project Officers:** P. O’Brien, P. Shotton, S. Reed and Douglas Daly Research Farm Staff

- Division: Animal Industries
- Location: Darwin
- Keyword(s): cattle, grazing, pasture, Douglas Daly Research Farm
- Project Type: Technical

**Objective:**

To monitor a rotational cattle grazing system on introduced pastures to determine the benefits to soil health, plant composition and cattle performance compared with traditional grazing systems.

**Background:**

The basic objective of short duration grazing (SDG) is to divide the pasture grazing area into a series of smaller paddocks where cattle are rotated from paddock to paddock, spending from one to five days in each paddock. This allows cattle to continually graze quality feed, allows more even grazing distribution and allows pasture to rest before being grazed again.

Grazing evenly at high stocking rates and promoting even distribution of dung and urine, while allowing pasture adequate rest, may result in a dramatic improvement in pasture composition and soil health.
Advocates of cell grazing/SDG expect an improvement in pasture and paddock condition to increase 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 through increased animal weight gains or carrying capacity.

**Method:**

Sixteen paddocks of 2, 4 and 6 hectares each were used to rotationally graze year-round. Three paddocks were used as controls and continuously grazed.

The cattle used were Charbray – Brahman yearling heifers, average weight of 208 kg in 2006. Heifers remained in the demonstration until December and were then replaced with another group of yearling heifers.

Paddocks 2, 5 and 17 were selected as control grazing paddocks where heifers are set stocked at the same rate as in the SDG paddocks.

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

All paddocks received 50 kg/ha Generator® pasture fertiliser in December 2005 and were sprayed with herbicides (Amine® 24-D and/or Brush-off®) to control various broadleaf weeds, particularly Senna (*Senna obtusifolia*), Hyptis (*Hyptis suaveolens*), Sida spp. (*Sida*) and Caltrop (*Tribulus terrestris*).

The paddocks were stocked at 1.5 animals/ha in the wet season and reduced to 1 animal/ha in June. From June 2005 supplementary lick blocks were supplied ad lib to all animals: Uramol® in the dry season and Phosrite® in the wet season.

**Data collection**

Plant composition in each paddock was assessed in December 2005, 2006 and 2007 to determine pasture yield and monitor changes in desirable and non-desirable plant species.

All cattle movements and grazing days are recorded on a grazing chart. Cattle are weighed at the start of the grazing year (December) and then about every eight weeks thereafter to monitor live-weight changes and cattle health.

**Results:**

At the beginning of the trial in 2005 SDG heifers averaged 208 kg live-weight and control heifers 204 kg. Weight gains were 0.39 kg/animal/day in SDG heifers and 0.36 kg/animal/day in control heifers, to the end of April. Weight gains during the early dry season, between May and August, were 0.55 kg/animal/day in SDG heifers and 0.47 kg/animal/day in control heifers.

All heifers were last weighed on 21 December 2006 when SDG heifers averaged an annual live-weight gain of 125 kg/animal (0.34 kg/animal/day) and control heifers 90 kg/animal (0.25 kg/animal/day). The change-over heifers started joined the trial on 26 December 2006 at an average live-weight of 238 kg. By 23 May control heifers averaged a live-weight gain of 0.5 kg/animal/day and SDG heifers 0.4 kg/animal/day.

Plant composition and pasture yield varied throughout each paddock. Total plant biomass ranged between 5 and 8.5 tonnes/ha in May 2007.

The most dominant grass species in all paddocks was sabi (*Urochloa pullalans*) (Figure 1). Paddocks containing the least quantity of sabi grass generally had higher yields of summer grasses. This reduced the quality and quantity of dry season cattle feed.
In all paddocks, the main broadleaf weeds were Senna, Hyptis and Sida. Each paddock was assessed for changes in plant composition between the December 2005 and December 2006 assessments. Although inconclusive at this stage, it appeared that undesirable plant species, particularly Senna and *Sida acuta*, increased in a number of paddocks throughout the trial.

![May 2007 frequency of plant species](image)

**Figure 1.** Relative presence of grasses and weeds in paddocks

The information gathered so far is inconclusive as the grazing trial has been going for 18 only months.

The improvement in weight gain during the early dry season was probably due to Uramol® lick blocks, which were supplied in June 2006.

Wallabies have influenced grazing pressure in some areas of the trial, particularly in paddocks 1, 2 (control) and 3. This probably resulted in an overall lower yearly live-weight gain in control heifers.

At this early stage, rotational grazing paddocks do not appear to contribute much to live-weight gain or to pasture composition. Change is not expected in the short term. However, some changes are evident in the longer term.

Each of the 19 paddocks differs in plant composition, pasture yield and size. Therefore carrying capacity for each paddock differs and hence the time animals are allowed in each will vary. Weather conditions will also influence the grazing time and the length of rest periods.
Objectives:

*To evaluate improved pasture species and mixtures under a continuous grazing regime on Blain soil at Douglas Daly Research Farm (DDRF).*

*To determine their persistence, productivity and contribution to the weight gain performance of cattle.*

*To make pasture management recommendations for Top End livestock producers*

Background:

Promising pasture species and mixtures are evaluated under grazing from cattle at DDRF to determine their long-term potential in the Douglas Daly and wider Top End regions.

Method:

Pastures are grazed in 4 ha paddocks by six Brahman weaner steers per paddock (1.50 animals/ha). The exception is Paddock 49, which had four extra animals to increase the stocking rate to 2.5 animals/ha to monitor the long-term effects of heavy stocking rates on this productive buffel pasture. Steers are allotted to paddocks in June/July (post-weaning) and remain in the grazing trial until the following June (almost 12 months).

Paddocks are top-dressed annually with a phosphorus-based fertiliser. This year Pasture Prompt® (NPKS 0:14:0:18) was ground spread on the paddocks at 50 kg/ha. During the wet season, various weed control measures were conducted where required, usually spot-spraying for broadleaf weed control. Some grass only paddocks are boom-sprayed with Starane®/2, 4-D or 2, 4-D/Brush Off ® mixtures if broadleaf weeds become prominent. An application of 100 kg/ha urea was planned for Paddock 532, as in the previous three years, as a substitute for wet season block consumption. However, as the season was so sparse and variable, urea was not applied.

The animals were supplemented with ad-lib Uramol® blocks during the dry season and with Phosrite® blocks in the wet season. Intake was recorded monthly. Paddock 532 cattle received no wet season block supplement or urea this year.

The cattle were weighed monthly, were given a condition score and P8 (rump) fat was measured from January onwards and continuing until the end of the grazing season in June 2007.

Pasture composition and yield were assessed twice during the year, first in the early wet season in December 2006 and post-wet season in May 2007.
Paddock 39 has been divided into two and grazing is rotated monthly to allow leucaena to recover leaf on a regular basis.

**Results:**

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

<table>
<thead>
<tr>
<th>Paddock No.</th>
<th>Pasture type</th>
<th>July 06-Nov 06 (mid-late dry)</th>
<th>Nov 06 - April 07 (wet season)</th>
<th>April 07-June 07 (early dry)</th>
<th>Total July 06-June 07</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>Buffel/leucaena (split paddock-heavier stocking))</td>
<td>14.0</td>
<td>111.0</td>
<td>29.1</td>
<td>154.1</td>
</tr>
<tr>
<td>40</td>
<td>Nunbank buffel</td>
<td>-2.0</td>
<td>93.2</td>
<td>25.3</td>
<td>116.5</td>
</tr>
<tr>
<td>41</td>
<td>Tully (B. humidicola)</td>
<td>4.3</td>
<td>63.0</td>
<td>16.3</td>
<td>83.7</td>
</tr>
<tr>
<td>42</td>
<td>Wynn cassia/Jarra</td>
<td>1.2</td>
<td>116.6</td>
<td>36.0</td>
<td>153.8</td>
</tr>
<tr>
<td>43</td>
<td>Ooloo /forage sorghum*</td>
<td>32.0</td>
<td>Out of paddock for re-sowing</td>
<td>21.2</td>
<td>143.4</td>
</tr>
<tr>
<td>44</td>
<td>Pangola</td>
<td>2.4</td>
<td>108.8</td>
<td>28.4</td>
<td>143.4</td>
</tr>
<tr>
<td>45</td>
<td>Pangola/leucaena</td>
<td>16.8</td>
<td>116.5</td>
<td>37.0</td>
<td>170.3</td>
</tr>
<tr>
<td>46</td>
<td>Sabi</td>
<td>-1.8</td>
<td>82.3</td>
<td>30.7</td>
<td>112.2</td>
</tr>
<tr>
<td>47</td>
<td>Jarra</td>
<td>-1.7</td>
<td>95.3</td>
<td>29.0</td>
<td>122.6</td>
</tr>
<tr>
<td>48</td>
<td>Sabi/leucaena</td>
<td>17.7</td>
<td>106.5</td>
<td>32.7</td>
<td>156.8</td>
</tr>
<tr>
<td>49</td>
<td>Buffel/tall variety (heavier stocking)</td>
<td>-10.0</td>
<td>106.0</td>
<td>29.3</td>
<td>125.3</td>
</tr>
<tr>
<td>50</td>
<td>Buffel/legumes</td>
<td>4.5</td>
<td>117.8</td>
<td>36.8</td>
<td>159.2</td>
</tr>
<tr>
<td>51</td>
<td>Strickland/Wynn</td>
<td>24.4</td>
<td>93.0</td>
<td>42.0</td>
<td>159.4</td>
</tr>
<tr>
<td>52</td>
<td>Arnhem/Ooloo</td>
<td>-7.6</td>
<td>91.8</td>
<td>23.0</td>
<td>107.3</td>
</tr>
<tr>
<td>531</td>
<td>Buffel/sabi/ WS blocks</td>
<td>9.7</td>
<td>109.3</td>
<td>25.2</td>
<td>144.2</td>
</tr>
<tr>
<td>532</td>
<td>Buffel/sabi (no urea)</td>
<td>0.3</td>
<td>102.5</td>
<td>25.5</td>
<td>128.3</td>
</tr>
<tr>
<td>533</td>
<td>Buffel/sabi/Wynn</td>
<td>-12.7</td>
<td>123.5</td>
<td>28.8</td>
<td>139.7</td>
</tr>
<tr>
<td>534</td>
<td>Leucaena/buffel/sabi</td>
<td>10.0</td>
<td>102.3</td>
<td>39.5</td>
<td>151.8</td>
</tr>
<tr>
<td>535</td>
<td>Buffel / Ooloo</td>
<td>12.5</td>
<td>105.3</td>
<td>29.8</td>
<td>147.7</td>
</tr>
<tr>
<td>All paddocks Mean live-weight change</td>
<td>6.0</td>
<td>101.8</td>
<td>29.8</td>
<td>137.6</td>
<td></td>
</tr>
</tbody>
</table>

*Paddock 43 was ploughed and sown with a crop of forage sorghum and restocked on 15/3/07*

**Table 2.** Mean cattle live-weight gains for the previous nine years

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LWG/animal</td>
<td>190.4 kg</td>
<td>187.7 kg</td>
<td>176.1 kg</td>
<td>173.0 kg</td>
<td>173.1 kg</td>
<td>176.5 kg</td>
<td>168.0 kg</td>
<td>205.9 kg</td>
<td>137.6 kg</td>
</tr>
</tbody>
</table>

There was a dramatic reduction in average live-weight gain per animal this year compared with all other years. This was caused by two factors, seasonal variation and stocking rate. Stocking rate rose by 20% with an extra steer per paddock, except for Paddock 49 which remained at 2.5 animals/ha. Live-weight gains overall dropped by 33.2% compared with the previous year. When analysed, excluding the paddocks with the same stocking rates, the reduction was 33.4% compared with a reduction of 27% in Paddock 49 where the stocking rate remained the same over the two years. This means that roughly 80% of the difference is likely to be seasonal. When each seasonal period is compared over the last two years, the dry season component was 20% (-14 kg/animal) of last year’s gains, the wet season component was 75% (-33.5 kg/animal) and the early dry component was 74% (-10.5 kg/animal). This shows that the greatest loss occurred during the dry season. When each month was checked this year there were two months when weight loss occurred, compared with none last year. The wet season arrived a month later this year before wet season gains (around 1 kg/animal/day) were achieved. The seasonal rainfall for each year was markedly different with 1846 mm (119 rain days) in 2005-06 and 1127 mm (76 rain days) in 2006-07. This factor would account for most of the live-weight differences.
The patterns of previous years are again apparent. Animals in grass/leucaena paddocks performed best, in grasses/legumes paddocks performed less well and in grasses alone paddocks, poorly.

Table 3 shows a comparison of animal performance between mixtures of legumes and grasses over the previous two years.

**Table 3. Cattle performance on different pastures**

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean LWG all leucaena/grass paddocks</th>
<th>Mean LWG all legume/grass paddocks (excluding leucaena)</th>
<th>Mean LWG all grass-only paddocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006-07</td>
<td>158.3 kg/animal</td>
<td>150.5 kg/animal</td>
<td>119.8 kg/animal</td>
</tr>
<tr>
<td>2005-06</td>
<td>235.0 kg/animal</td>
<td>204.8 kg/animal</td>
<td>193.8 kg/animal</td>
</tr>
<tr>
<td>Increase in 05-06 performance over 06-07 (%)</td>
<td>48</td>
<td>36</td>
<td>62</td>
</tr>
</tbody>
</table>

These are considerably less live-weight gains than during last year, but the differences are quite variable between the different pasture classes.

**Other observations**

The older the Tully pasture becomes, the worse is the performance of cattle. This year production was 22% lower than the next worst paddock.

Last year’s problem of the swamping of the Strickland by the Chamaecristas (mainly Wynn) appears to have been resolved with the legume content of the pasture dropping considerably this year.

The Jarra/Wynn reversed last year’s results and outperformed the Jarra-only paddock as would be expected.

The doubling of the stocking rate in Paddock 39 did not appear to unduly compromise productivity (buffel/leucaena) with a per hectare live-weight gain of 385 kg, which is good considering the season and comparing to the 313 kg gain in Paddock 49 (buffel) at the same stocking rate.

The other standout performance was the dry season gains on Paddock 43 which was mainly Oolloo/Cavalcade. It was well ahead of the best of the grass/leucaena combination.
PROJECT: Pasture Species Evaluation under grazing at Douglas Daly Research Farm: Buffel/Legumes

Project Officers: P. Shotton, B. Lemcke and Douglas Daly Research Farm Staff

Division: Animal Industries
Location: Darwin
Keyword(s): cattle, Douglas Daly Research Farm, pasture, grazing, legumes
Project Type: Technical

Objective:

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

Background:

Buffel grass is a commonly used improved pasture in the Top End, mainly 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 N to the grass resulting in higher quality and better yielding pastures. A higher protein diet for cattle due to the legume would be an added benefit, apart from reducing potential weeds in the grass.

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

Method:

On 6 January 2000, five pasture legume species were planted in a 4-ha paddock (Paddock 50) at Douglas Daly Research Farm. The legumes were Wynn cassia (Chamaechrista rotundifolia), Verano stylo (Stylosanthes hamata), Oolloo (Centrosema brasilianum), Maldonado (Macroptilium gracile) and Milgara Blue pea (Clitoria ternatea). The legume treatments and control (Buffel only (Cenchrus ciliaris)) were randomized and replicated four times with a plot size of 12 m x 130 m.

In December each year about 50 kg/ha of Goldphos 20® or equivalent fertiliser was applied.

The area was left non-grazed in the first wet season to allow legumes to set seed. The paddock was grazed over the 12 month period by five Brahman weaner steers (1.25 animals/ha) which were weighed, condition scored and after December, tested for fat depth (P8) every 28 days. Steers were put in at the end of June each year and the animals were changed over every 12 months. The practice in 2004-05 and 2005-06 differed slightly by altering the breed of steers to a mixture of Brahman, Composites and Droughtmaster. In 2006-07 animal numbers were increased to six head (1.5 animals/ha).

The animals were supplemented with Uramol® blocks during the dry season and Phosrite® blocks in the wet season.

Prior to planting, broadleaf weeds were controlled by using Starane® as a post-planting/pre-emergent herbicide in January 2000. Some hand-weeding and spot-spraying were carried out for broadleaf weeds, mainly spiny head sida (Sida acuta) Flannel weed (Sida cordifolia), Hyptis (Hyptis suaveolens) and Senna (Cassia 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, Ooloo and Maldonado. Wynn cassia and Verano stylo were less prolific than the twining legumes. Verano, Wynn and Blue pea seeded well with Ooloo and Maldonado seeding poorly, although all legumes seeded down well in the second year. Results from the April 2001 biomass harvest indicated the greater the legume content, the higher the overall yield, although grass yields in the Ooloo treatments were lower indicating the Ooloo legume was competing with buffel grass.

During the first three years the percentage of legumes decreased with only the Ooloo showing signs of sustaining a grass/legume mix (Figure 1). Very few legumes were present over the 2003-04 wet season. However, in the following season (2004-05) the Ooloo, Verano and Wynn treatments increased in legume percentage, particularly Wynn and Ooloo. In 2005-06 DDRF received 1846 mm of rain which encouraged strong growth in the legumes.

Plant analysis results suggest that the higher the proportion of legume content, the higher the N in the companion buffel grass. This could be visibly seen throughout the wet season and early dry season when plants in Ooloo treatment appeared dark green and buffel grass flowered earlier, creating a denser looking stand of pasture.

Intake of supplement block was recorded monthly. Average intake was 104 g/animal/day of Uramol® and 70 g/animal/day of Phosrite®.

The average 12 month live-weight gain was lower compared to past years Table 1). This may have been due to a different mix of steers used, the shorter wet season or the decline in legume in the pasture. The last two are the most likely reasons.

Table 1. Mean cattle yearly live-weight gains

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average weight gain (kg)</td>
<td>208</td>
<td>189</td>
<td>180</td>
<td>160</td>
<td>199</td>
<td>159</td>
</tr>
</tbody>
</table>
Discussion

Hard seediness, climatic conditions, insect pests, and palatability of legumes have long-term effects on the pasture mix. Different management techniques of the pasture such as non-grazing to allow seed to set every second or third year will improve sustainability of pasture legumes. A limitation of this trial was that the animals could selectively graze plants of preference, which could result in over-grazing and depletion of some legumes, allowing the less palatable to survive or dominate. The promising performance of Oolloo as a companion legume in buffel grass has led to further production monitoring in Paddock 535, where the legume was introduced in December 2002 into an existing buffel grass paddock.

After four years of dormancy and very little growth, in 2006 plant composition results showed Maldonado within and outside the treatment plots showing up in 17 of the 24 plots and an estimated 7% of total biomass within the treatment plots and 4% of the total paddock biomass. The drier wet season in 2007 reduced the proportion of Maldonado to 0.3%.

In 2006, Wynn and Verano were found in all 24 plots throughout the paddock with Verano having 14% of the biomass within the treatments and 6% over the total area and Wynn having 42% of biomass within the treatments and 15% over the total area. The 2007 survey found only 6% total biomass of Wynn and less than 0.5% of Verano.

A similar trend happened with Oolloo in the 2006 wet season. Oolloo biomass was 27% but reduced to 10% in 2007.

The pasture composition surveys carried out in June 2006 and 2007 found no Milgara in any of the treatment areas.

Other than the buffel grass and introduced legumes, Chamaecrista pilosa, Ocimum basilicum (Basil), Centrosema pascuorum (Cavalcade) and Sida acuta were the common plant species in the trial paddock.
**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

**Division:** Animal Industries  
**Location:** Darwin  
**Keyword(s):** surveillance, biosecurity, arboviruses  
**Project Type:** Technical

**Objectives:**

*To develop and evaluate micro-arrays for the rapid identification (sero-typing and topo-typing) of arbo-viruses.*

*To use global virus characterisation arrays and polymerase chain reaction (PCR)-select suppressive subtractive hybridisation for the rapid and full characterisation of a selection of existing and new isolates that remain uncharacterised by conventional methods.*

**Background:**

DPIFM has a key responsibility for monitoring arbo-virus activity in the Northern Territory through the Veterinary Laboratories. Surveillance is undertaken by virus isolation and serological testing. Viruses isolated in the program (can be several hundred 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 in the National Arbovirus Monitoring Program and from clinical disease in livestock and wildlife are characterised and to fully characterise viruses, which remain unidentified by current classical virology techniques.

**Method:**


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


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:

Design and printing of sero-typing/topo-typing 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 about 20 unknown isolates on the global virus characterisation array

RNA and cDNA has been prepared 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 was previously unidentified. Several others 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 data bases 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.

Discussions with Dr. Ian Lipkin at the AB CRC meeting in Cairns indicated agreement for the AB CRC project to access the new panpathogen arrays available from Columbia University. Negotiations are currently underway to do so and to access additional oligonucleotide designs for the subarrays to be used for virus characterisation at Berrimah NT.

Ten unknown virus isolates, two known controls and an uninfected cell culture control subjected to microarray analysis by Columbia University have now been completed. The two knowns were submitted blinded and these were correctly identified. 7/10 unknowns yielded one virus related to Sindbis (Western Australian type), orbiviruses related to a Chinese isolate Yunan virus, EHDV-2 (Ibaraki virus), and novel orbiviruses related to but often very distinct from currently known orbiviruses.

A joint publication describing the utility of the arrays and elution of nucleic acid from the arrays and sequencing of this for the identification of novel viruses is being prepared.

Suppressive subtraction hybridisation on about 20 unknowns

The PCR select technology has been successfully transferred to BVL. The M genome segement of an uncharacterised Bunya virus has been completely sequenced except for the very ends of the segment. L and S genome fragments have been partially sequenced but this has been put on hold to allow M to be sequenced for comparative phylogenetic analysis. Preliminary analysis indicate that this virus – provisional name “Buffalo Creek virus” is distantly related to La Crosse virus of USA origin; it is known to be involved in human disease in the USA.

An NT uncharacterised Rhabdo virus is currently being subjected to PCR-select analysis

Two PhD student projects have proceeded. One project has completed the genome sequence (high quality) of a rhabdo virus _Wongabel_ except for the 3’ and 5’ ends. Preliminary analysis reveals unique genome arrangements with additional genes of undefined relationships and function. The sequence of the genome ends are currently being sought. A thesis chapter and a draft manuscript are being prepared. The second project has completed two genome fragment sequences from two unique orbiviruses not previously reported in Australia. The first is related to Yunan virus – a Chinese orbivirus and the second is unique and distinctly related to known orbiviruses.
Evaluation of arrays with known viruses and evaluation of arrays for use in rapid characterisation

Ten known and frequently isolated viruses obtained during the NAMP program were sent to AAHL. The coded samples were processed on the sub arrays for presumptive identification. So far two viruses have been completed and both have been identified at the genus level i.e. bunya virus and Ibaraki (EHDV). There are background issues on one of these analyses which will be repeated when the other samples have been processed. The results to date suggest that this approach will be able to provide presumptive genus level identification of the common viruses being isolated in the NAMP program.

Retrospective screening by PCR of previous years’ isolates for identification of further unknown viruses

A PhD student successfully characterised 140 stored unknown viruses to the Yunan virus group. Serology to V4440 was carried out on approximately 1200 samples. V4440 has been provisionally named Middle Point virus.

PROJECT: Developing Sustainable Carrying Capacities in the NT

Project Officers: C. Smith, R. Cowley, R. Allan and A. Kain

Division: Animal Industries
Location: NT-wide
Keyword(s): rangelands, carrying capacity, GRASP, SWIFTSYND, pasture, cattle
Project Type: Technical

Objectives:

To develop methods for objective assessment of carrying capacity, including calibration of pasture growth models, for the Sturt Plateau, Barkly region and the Alice Springs region.

To transmit carrying capacity information and methods to evaluate it to pastoralists to enable them to make informed decisions on seasonal and long term stocking strategies.

Background:

There is potential in the NT cattle industry to increase production through subdivision and intensification of land use. However, land 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 we have 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 in the Barkly, Sturt Plateau and Alice 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 overview across the region.

Monitoring events (harvests) are conducted four times throughout the year, except for the Alice region, where harvests are conducted every two months. The timing of harvests depends on seasonal conditions. At each harvest time, pasture, soil and rainfall data is collected from the sites.
Method:

Alice Springs - Six sites were constructed on four stations and the Old Man Plains Research Station (OMPRS) during 2004-05. They represented the following land systems: Alcoota (Alcoota Station), Ebenezer (Mt Ebenezer Station), Muller (OMPRS), Outounya (Umbeara Station), Renners (Deep Well Station) and Sandover (Alcoota Station). Harvests are undertaken when the predominant annual grasses have begun seeding (about 10-14 days after rain).

Barkly - Twelve monitoring sites have been constructed in the Barkly region on eight stations, including five land systems.

Nine sites were reset by burning and two were reset by mowing in October 2006.

Sturt Plateau - Currently, there are ten SWIFTSYND sites located around the Sturt Plateau on five different land systems. The selected land systems are Banjo, Larrimah, Sturt, Bulwaddy and Elsey. Together, these land systems represent 71% of the total Sturt Plateau region. Two sites (Gorrie Station, Larrimah land system and West Elsey Station, Elsey land system) have been completed. The remaining sites are due for the eighth and final harvest in October 2007. All sites were re-set using fire in late 2006.

Results:

Alice Springs

Rainfall was patchy across the Alice Springs district and included short growth events during both summer and winter. Table 1 provides details of harvests at each site.

Table 1. Details of seasonal plant growth at different land systems

<table>
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<tr>
<th>Land System</th>
<th>Winter Growth Event</th>
<th>Summer Growth Event</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcoota</td>
<td>2</td>
<td>4</td>
<td>Site produces little growth. Thought to be partly because of land type and land condition.</td>
</tr>
<tr>
<td>Ebenezer</td>
<td>0</td>
<td>1</td>
<td>Poor seasonal conditions have meant that only one harvest was completed at this site. Due to a complete lack of pasture at visiting time, no harvest could be done. However, soil data was collected.</td>
</tr>
<tr>
<td>Muller</td>
<td>3</td>
<td>4</td>
<td>This site is in C land condition and is probably deteriorating. Harvest 7 in particular was done at a good time when seed was nearly mature but not dry.</td>
</tr>
<tr>
<td>Outounya</td>
<td>1</td>
<td>2</td>
<td>This site has been 'scalped' when it was initially mown. This has caused a significant decline in land condition within the enclosure and is unlikely to provide representative data for some time. Poor seasonal conditions prevented data collection.</td>
</tr>
<tr>
<td>Renners</td>
<td>2</td>
<td>3</td>
<td>Due to a poor land condition combined with poor seasonal conditions, this site is not responding well. Due to a complete lack of pasture at the last two visits, no harvests were conducted. However, soil data was collected.</td>
</tr>
<tr>
<td>Sandover</td>
<td>3</td>
<td>5</td>
<td>Excellent data has been collected from this site as it is in good condition and has received good rain. Preliminary attempts to model this data have, however, highlighted some problems for Central Australia and further work will need to be done to make the model work with ‘pulses’ of growth in the semi-arid regions.</td>
</tr>
</tbody>
</table>

Barkly

In February 2007, data collected from seven sites was processed using the GRASP model software.
At August 2007, sites at Beetaloo, Newcastle Waters, Helen Springs and Rockhampton Downs have been monitored to harvest 7. Sites at Alexandria, Brunette Downs and Walhallow have been monitored up to harvest 3. Bulk density data has been collected from all Barkly sites. Plant nutrient analysis is also continuing and should be completed by December 2007.

Sturt Plateau

Data from some sites has been modelled using the GRASP software in February 2007. These were not full data sets as bulk density data was not available at the time. Bulk density data has subsequently been collected for all ten sites and is being processed. Plant nutrient analysis is also continuing and should be completed by December 2007.

**PROJECT:** Berrimah Farm

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

**Division:** Animal Industries

**Location:** Darwin

**Keyword(s):** research farm, Berrimah Farm

**Project Type:** Technical

**Objective:**

*To provide land, infrastructure and laboratories to the DPIFM Primary Industry Group to conduct research, development and extension (RD&E) programs for NT primary industries.*

**Description**

Berrimah farm is the headquarters of DPIFM and accommodates 200 primary industry and fisheries staff.

Berrimah Farm complex comprises:

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

The farm land and facilities are used for a range of RD&E projects, including grazing animals used in projects, land used for horticulture and agro-forestry trials and land used for grazing departmental cattle and buffalo from other research and demonstration farms on their way to market.

**Annual highlights**

- The farm produced 130 tonnes of good quality pangola hay from 12 ha of land, at 11 tonnes/ha. The hay will be used at Berrimah Farm, Victoria River Research Station and Old Man Plains.
- A small cattle herd of sentinel animals is kept for Virology and the national arbovirus monitoring program.
- The farm facilitated a project to evaluate the impact of various manipulative and surgical procedures performed on the reproductive tract of cows by the NT beef industry on animal welfare.
- Stockyards were set up to demonstrate the national livestock identification scheme procedures to industry.
- The farm is a base for equipment and workshop facilities for the transport of heavy machinery and stock around all the research farms.
- Farm personnel maintain lawns and gardens at the farm.
- The farm provided holding facilities for feed for stock from other research farms.
- The army used some of the paddocks for various defence exercises.

**PROJECT:** Beatrice Hill Farm

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

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<td>Keyword(s):</td>
<td>Beatrice Hill Farm, buffalo</td>
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**Objective:**

To provide land, livestock and infrastructure to DPIFM staff to conduct research, demonstration and extension programs for cattle and buffalo production on coastal floodplains across the Top End of the NT.

**Background:**

BHF is a 2600-hectare property 160 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, about 80% of it is floodplain. Very high pasture productivity is achieved during the dry season using ponded paddocks.

**Annual highlights**

- The buffalo breeding herd project monitors the performance of various riverine/swamp buffalo crosses for both meat and dairy production.
- Riverine buffalo were sent to New Zealand and Queensland.
- 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 turn-off.
- The herd is used in a RIRDC project to improve artificial insemination in buffalo.
- A sentinel herd is kept on the farm for the Virology Section as part of the national arbovirus monitoring program.
- BHF provides pasture to surplus stock from other research farms until they are ready for market.
- About 180 tonnes of hay was produced, most of which is used at BHF.
- Jarra grass replaced gamba grass pasture on 20 ha as part of a program to replace all gamba on the farm.
- The stockyards were used for demonstrating National Livestock Identification Scheme activities.
PROJECT: Douglas Daly Research Farm

Project Officers: Research Farm Managers and Staff

Division: Animal Industries
Location: Darwin
Keyword(s): cattle, crops, Douglas Daly Research Farm
Project Type: Technical

Objective:

To conduct research, demonstration and extension programs for mixed farming production systems for the Katherine Daly Basin and the Top End of the NT.

Background:

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

DDRF received 1125 mm of rain in the 2006-07 wet season. The average is 1208 mm. The first substantial rain fell in mid November. April was dry, but 18 mm of rain fell in May/June.

Annual highlights

• Improved pasture species and the importance of legumes were evaluated.
• Multi-bred composite cattle were assessed.
• Improvement of Brahman herd fertility.
• Heifer fertility and improvement of through better nutrition were assessed.
• Assessing the impact of short duration-high intensity grazing on pasture composition, soil health and cattle performance.
• Assessment of 15 hectares of irrigated peanuts.
• Irrigated hay production trials including lucerne, Rhodes grass and oats for export.
• Cavalcade hay was produced on 20 hectares.
• Grain sorghum was produced on 15 hectares for a Katherine Research Station feedlot trial.
• Tropical perennial grass pasture was established on 80 hectares.
• Sold by tender 30 Brahman and composite bulls.
• Sold by tender 184 surplus heifers.
• The farm hosted a successful industry field day for Top End producers in May.
• Several individuals and industry groups visited the farm, including interstate farmers, and industry and government representatives.
• The farm provided facilities for various industry group meetings.
• As part of the DPIFM South East Asian industry development program, the farm hosted three research farm managers from Sabah for four days.
• Provide facilities for Bushfires level 1, senior first aid and advanced resuscitation courses.
• Peanut seed was produced on 13 hectares for the Peanut Company Australia.
PROJECT: Victoria River Research Station

Project Officers: Research Farm Managers and Staff

Division: Animal Industries
Location: Katherine
Keyword(s): cattle, pasture, Victoria River Research Station
Project Type: Technical

Objective:

To conduct research, demonstration and extension programs for the NT pastoral industry.

Background:

Victoria River Research Station is located in the Victoria River District (VRD) and is about 314 km² in area. It is managed as a breeding operation and most progeny transported to DDRF following weaning. Currently 1100 breeders are stocked at VRRS.

Annual highlights

- Fire was used in the VRD to control woody vegetation (Shruburn).
- Pasture Sustainability
- Improved breeder herd profitability was assessed.
- NIRS sampling was conducted.
- Multi-breed crossbred (composites) were assessed.
- Sentinel herd monitoring.
- A major producer field day was held at the Station in August 2006.
- A National Livestock Identification Scheme workshop was conducted.
- An indigenous land management course was hosted.
PUBLICATIONS, CONFERENCE PAPERS AND PRESENTATIONS

Scientific Journal Publications


Other Publications/Presentations


Daly, A. M. and Hennessy C. R. (2007). Grapevine leaf rust - Assessment of cultivars for resistance or immunity and fungicides useful for control (Project1B); and Molecular characterisation, host range and biological studies (Project 1C). Final Report to the Grape and Wine Research and Development Corporation.


INDEXES

The indexes are divided into three parts for easy access of information.

You can find projects by:

- Project Location – NT-wide, Darwin, Katherine, Barkly or Alice Springs. Any project covering two or more regions can be found in NT-wide.
- Project Type – Scientific or Technical.
- Keyword – various keywords for a project.

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