Overview of Agricultural Research at Douglas Daly Research Farm: Part 2. 2010-2024

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1	7/05/2024	Peter Shotton	First version
2	29/05/2024	Rowena Eastick Ongoing DDRF review 2010-2023 - RE1	Structure and obvious missing sections
3	2/06/2024	Peter Shotton ps1 ongoing DDRF review 2010-2024 - RE1	Added other section topics
4	25/06/2024	Rowena Eastick DDRF review 2010-2024- RE2	Included references and reference links, most section content (notable not Leucaena) updated as draft.
5/	09/07/2024	Peter Shotton DDRF review 2010-2024- RE2_PS	Updated cotton info
6/	14/08/2024	Rowena Eastick DDRF Review 2010-2024 – RE3	1st Draft to DITT

7/	14/10/2024	Edward Mwando DDRF review 2010-2024 - RE3_low_res PS_ED	Comments on Draft provided by Edward Mwando and Tim Schatz
8/	16/10/2024	Rowena Eastick DDRF Review 2010-2024_RE_20241014	All comments incorporated for final document. Increased prescription of the CRCNA programs/projects. Added another leucaena trial.

Acronyms

Acronyms	Full form
ADMA	Agricultural Development and Marketing Authority
AGBU	Animal Genetics Breeding Unit
ARAR	Annual Research Achievements Report
CERP	Crop Erosion Research Project
CDU	Charles Darwin University
CRCNA	Cooperative Research Centre for developing Northern Australia
CRDC	Cotton Research and Development Corporation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DDRF	Douglas Daly Research Farm
DEPWS	Department of Environment, Parks and Water Security
DITT	Department of Industry, Tourism and Trade
DLRM	Department of Land Resource Management
DPIR	Department of Primary Industry and Resources
GRDC	Grains Research and Development Corporation
KRS	Katherine Research Station
MLA	Meat and Livestock Australia
NAMP	National Arbovirus Monitoring Program
NT Farmers	Northern Territory Farmers
NTG	Northern Territory Government
QLD DAF	Queensland Department of Agriculture and Fisheries
RIEL	Research Institute for the Environment and Livelihoods
RIRDC	Rural Industries Research and Development Corporation
TAR	Technical Annual Report
TNRM	Territory Natural Resource Management
TRaCK	Tropical Rivers and Coastal Knowledge

Contents

Summary

Douglas Daly Research Farm (DDRF) has been an essential resource to support the development and progression of the northern agricultural industry in the Top End of the Northern Territory (NT) since the 1960's. A Historical Overview of Agricultural Research at DDRF (1960s – 2010) Part 1 was collated in 2011. Research has continued since that time and is presented in this 'Overview of Agricultural Research at DDRF – Part 2 (2010-2024)'. This will increase awareness of research projects conducted to enable stakeholders to use the information, and to avoid duplication of work in future research activities.

Research was regularly collated in Annual Reports up until 2017-18, providing a valuable resource for stakeholders, and these reports are referenced extensively in this overview. Some of the departmental research does not progress into peer-reviewed journal papers. This overview presents activities conducted, and links to relevant references, including industry publications, field days and conference proceedings, to highlight the range of work conducted at DDRF since 2010 to present. Personnel and collaborators are identified where possible for each project to allow further cross-reference of associated activities conducted by individuals or industry organisations.

The farming industry in the Douglas-Daly has evolved significantly since 2010, and is now well-established with second generation farmers, much-improved roads and access, and improved technologies and information sharing. Research priorities have evolved to resolve specific production, market, and sustainability issues for cropping and cattle enterprises.

The main plant industries research at DDRF since 2010 has focused on diversification of crops, as components of both irrigated and dryland farming systems, and integration of pastures for intensification of farming systems afforded by the soils and climate of the Douglas Daly region.

Irrigation projects continued to assess agronomy and plant physiology of a range of crops, with an increased emphasis on water use efficiency practices and reducing environmental impacts of ineffective water use. Crops including sorghum, maize, lucerne, peanuts and mungbean were assessed as components of intensive irrigated systems. Poppies were assessed as a potential lucrative alternative crop for the north, but this was for less than two seasons. Leucaena and a range of improved pasture grass species within a grazing system was a significant project at DDRF for a limited period. Commercial plantings are still established in the region, although these are under rainfed conditions. Pasture species cultivars for increased biomass production over the dry season were also assessed under irrigation. There have been minimal research activities conducted on the DDRF irrigation area since 2020. However, there is ongoing demand from the NT agricultural industry to identify an environmentally and economically sustainable irrigated farming system.

Dryland cropping and grazing research have been plant industry cornerstones at DDRF since the farm's inception. However, there was relatively limited research in this sphere from 2010 compared to previous decades, with long-running projects such as the Pasture Species Grazing Trial and Sorghum variety trials of minimal ongoing relevance. A hemp variety project was conducted for one season, which was then relocated to Katherine Research Station. Rejuvenated interest in cotton production in the north, based on dryland production, has provided impetus for research to support such an industry. This has included specific cotton agronomy projects, such as row spacing and planter configuration, but also cotton farming rotation crops and integration with cattle production projects.

Pasture species work has continued, but this has primarily been associated with animal production projects, such as gamba grass intensive grazing, comparison between cell-grazed and set-stocked buffel grass pastures, and productivity on buffel-Centro pastures. The agroforestry trials at DDRF declined in significance over the last decade, although a commercial forestry industry in the Top End has continued to establish.

The ‘Selected Brahman’ and the ‘Crossbred’ projects have been two of the major Animal Industries’ projects over several decades. The research since 2010 has evolved to more specifically assess fertility traits using gene markers for enhanced accuracy of EBVs in Brahman herds and crossbred herds, as part of the ‘Repronomics I and II’ projects. The crossbred work continued to focus on selection of traits for market diversification, including evaluation of carcase traits and meat quality. A number of animal health projects have been conducted at DDRF since 2010, including effect of insecticidal fly tags, effect of coccidiosis on cattle growth, liveweight losses in cattle during transport and alternatives to spaying.

Biosecurity has a much-enhanced focus since the 2010 Overview was collated. There is increasing threat of incursions from nearby countries of a range of animal and plant diseases. Resources are increasingly being directed towards minimising this threat or treating incursions. DDRF plays an important role in maintaining a Sentinel herd as part of the National Arbovirus Monitoring Program (NAMP).

Soil conservation projects have evolved with the increasing awareness of carbon capture and carbon trading enterprises, with projects at DDRF assessing the effects of agricultural management on soil carbon, and soil carbon sequestration under grazing of buffel grass pastures. Environmental issues associated with agriculture in northern Australia may impact industry development and stakeholder investment, with a flow-on effect to resource allocation and project direction to DDRF. An assessment of the effect of a moratorium on land clearing pre-2010 presented environmental concerns with agricultural development.

There appears to be less investment into plant industry research at DDRF post-2010, compared to previous years. The unavailability of the irrigated area since 2020 dramatically constrained options for research trials. Dryland cotton, and associated farming system work, has been the main project since 2018, with industry a major driver. The evolution of the cattle production activities, primarily the Brahman and crossbred breeder work, to the Repronomics project has been the major change in the animal industry research. This necessitated a change in the breeder herd distribution and allocation from DDRF to other research stations.

Field days remain an essential avenue for dissemination of information and exchange of ideas between industry and researchers. Availability of information on current research projects is otherwise sourced through Agency newsletters, social network platforms, or Industry conferences.

There is increasing agricultural research and extension being conducted by industry, commercial entities and collaborative organisations, external to NTG and NTG-managed research farms. These include NT Farmers Association, Territory Natural Resource Management (TNRM), the CSIRO (Commonwealth Scientific and Industry Research Organisation) and Charles Darwin University (CDU). The Cooperative Research Centre for Developing Northern Australia (CRCNA), the Northern Hub (Drought Resilience Adoption and Innovation), and the Zero Net Emission CRC, are significant examples of collaborative multi-agency programs. There is opportunity for DDRF to be utilised as a vital and unique resource to expand relevance and availability across non-NTG agencies, and avail of significant external funding to contribute to targeted research as part of multi-agency collaboration.

Introduction

Douglas Daly Research Farm (DDRF) has been integral to supporting the research demand and development of the agricultural industry in the Top End of the Northern Territory (NT) since the 1960's. A summary of the investment and progress in agricultural research conducted at DDRF encompassing the 48 years from its inception until 2010, was collated in "A Historical Overview of Agricultural Research at Douglas Daly Research Farm (1960s – 2010)" (Shotton, 2011).

Research to address knowledge gaps of primary producers and support the progression of the northern agricultural industry has continued since 2010. This document updates the historical overview and describes the agricultural research for the period of 2010 to 2024 for DDRF – Overview 'Part 2'. This underpins two key objectives. One, to increase awareness of research projects conducted to enable stakeholders to obtain the information and use the lessons learnt to improve their agricultural practices. Second, to infer where knowledge gaps may exist, which may inform future research directions, and to avoid duplication of work.

The research trials since 2010 to current (2024), aim to address the knowledge gaps which have been identified by the Agency (NT Government Department iterations; currently, Department of Agriculture and Fisheries) in collaboration with plant and animal industry stakeholders. DDRF fulfils a vital niche in Top End primary industries, providing the basic research station function of a controlled site to allow evaluation of a range of factors which may impact agricultural production, minimising extraneous variables over time. It must also be acknowledged that research conducted at DDRF aligns with trials, both structured, and informal, on surrounding private land. E.g. The Crops for Cattle project. Other projects relevant to primary industry outcomes, such as climate change or land management research, are also conducted in the Douglas-Daly District, and selected ones are included here for completeness.

A description of research projects was reported annually in the Departmental publication, the Technical Annual Report (TAR), for most years from 1987, concluding in 2007-2008. These were a valuable resource, providing the main reference for industry stakeholders of the work conducted by NTG Plant and Animal Industries. The TAR was replaced by the Annual Research Achievements Report (ARAR) from 2011, which concluded in 2017-2018. The Plant Industry Group did not include reports in the 2013-14 ARAR due to an outbreak of the cucumber green mottle mosaic virus disease in the NT, because research officers were engaged in the control of the disease. This does highlight that biosecurity incursions can impact on Agency prioritisation of resources, and this is likely to continue in the future.

These technical-based reports enabled brief descriptions, photos and conclusions from research projects, which may not have progressed into peer-reviewed journal articles. Consequently, these projects ('grey literature') do not necessarily appear in standard 'literature reviews' and are not easy to source through most on-line search platforms. Links to these documents are provided in the associated sections in this report. These remain a valuable historical resource.

The ARARs provided context for research projects to align with Agency Development and/or Strategic Plans at the time. E. g. Research into intensification of cropping industries in the Douglas-Daly aligned with The NT DPIR Strategic Plan 2018-2022: '1.11 Undertake research, development, extension and services to improve the profitability and sustainability of our industries'. This illustrates that over-arching Agency visions and strategic direction have impacted, and will continue to do so, specific research projects.

There has been no annual technical reporting requirement from the Agency since 2018, but results from research projects have been presented and demonstrated to the public through various methods, including public field days, district "farm walks", organised visits from farmers, graziers and other interested visitors, and an increasing focus on use of social media. Outcomes of some research were also published and made available to stakeholders through industry conference proceedings,

government publications, libraries, handout information, agricultural and other research journals, manuals and newsletters (e. g. Northern Territory Rural Review | Department of Industry, Tourism and Trade, Agriculture and Biosecurity newsletter: February 2024 | Department of Industry, Tourism and Trade).

The scope of this Overview does not seek to compare and evaluate the outcomes of the research. This is unfeasible for some projects where limited data has been collated. Peer-reviewed publications do exist for some trials, and conclusions and recommendations are well covered for that specific project. This report does not aim to provide recommendations for Primary Industries research directions, although these may be considered briefly.

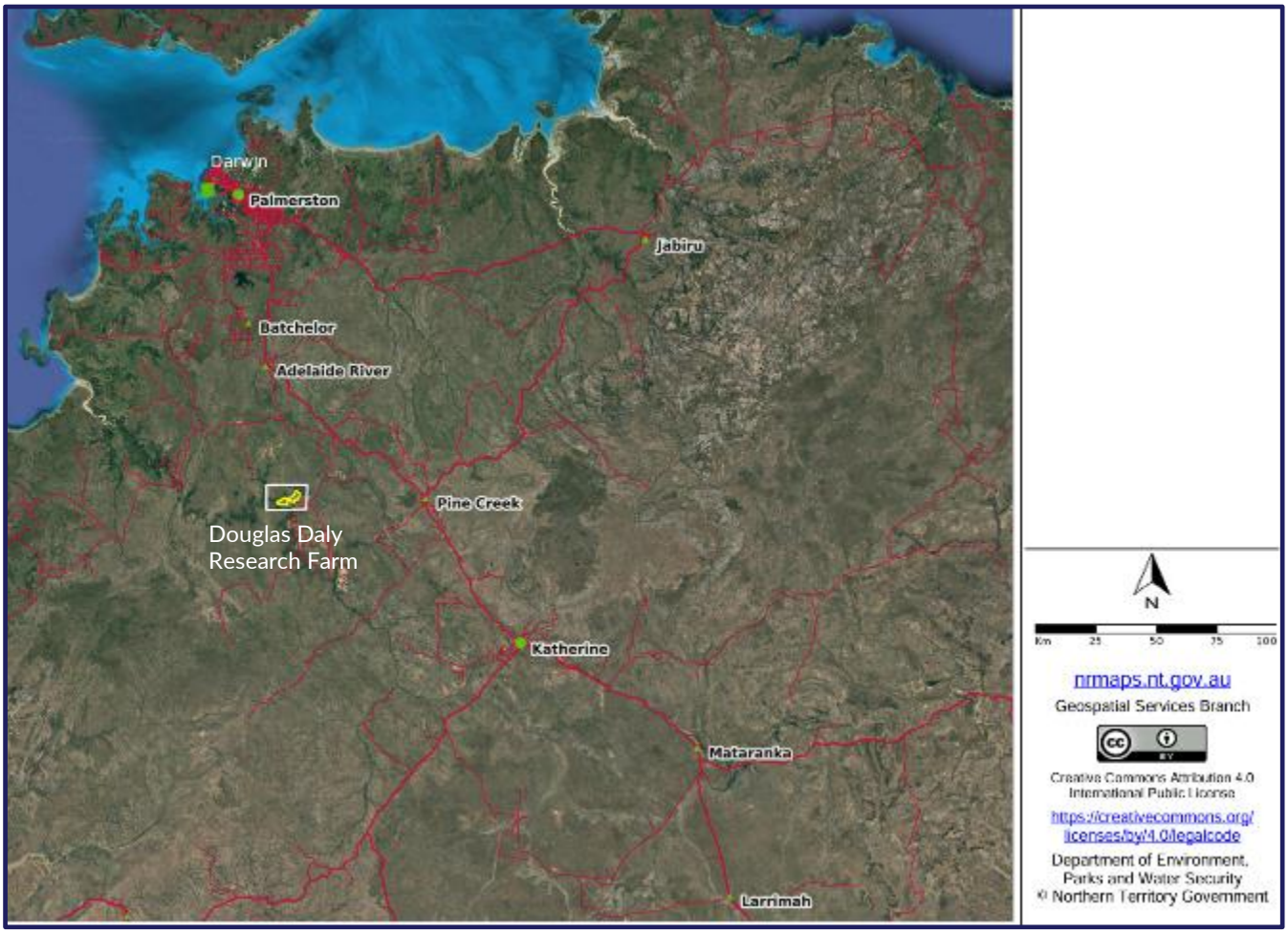
The aim of this Overview is to provide a base resource collating the research projects, and associated literature, conducted at DDRF for the period 2010-2024. This will enable a range of stakeholders from farmers to researchers to improve their agricultural practices, to avoid duplication of work, and to infer where knowledge gaps may exist to inform future research directions.

Douglas Daly Research Farm (DDRF) 2010-2024

The DDRF is a NT Government research facility that was set up in the 1960's to investigate and research the development and extension of agriculture in the Top End of the NT. It has also played a major role in the fabric of the Douglas-Daly community since its inception. DDRF is located 230 km south of Darwin (13°50'S, 131°10'E) and 220 km north-west of Katherine in the Douglas-Daly region, with the south and north–west boundaries of the property represented by the Daly and Douglas rivers (Maps 1 and 2). The research farm encompasses approximately 2,870Ha, predominantly kandasols (red earths) (Aldrick & Robinson, 1972).

The Douglas-Daly region has been recognised for many years as a potentially valuable agricultural area within the NT. Its rainfall and soils have made it suitable for many aspects of agriculture, such as pastoral production, horticulture and agroforestry. The establishment and history of DDRF were further discussed in Overview – Part 1 (Shotton, 2011). The region continues to be a significant focus for ongoing agricultural development e. g. Hartley, et al., 2023.

The early research within the Douglas-Daly evaluated a range of crops, pastures, grazing management, and farming practices to provide information to a newly emerging intensive agricultural industry on management adapted to northern soils and climatic conditions. E. g. no-till vs conventional till farming practices to reduce soil erosion. The focus of agriculture within the Douglas-Daly has evolved over the years from cropping in the 1980s, intensive livestock production in the 1990's to a mixed diversity of agricultural industries in later years. The initial research directions aligned with the ADMA (Agricultural Development Marketing Authority) pilot farms focusing on grain production, with cropping trials evaluating best management, agronomy and variety screening of various crops. The advent of the increasing live cattle export market in the 1990s, provided impetus for research involving more intensive cattle production systems from traditional extensive pastoral production. E. g. Systems mixed farming trial and pasture species evaluation under grazing trials. These initial research directions and priorities were outlined in more detail in the Overview – Part 1 (Shotton, 2011).



Map 1. *Location of Douglas Daly Research Farm relative to Darwin and Katherine. Source*: NR MAPS (nt.gov.au)

The farming industry in the Douglas-Daly has evolved significantly since the inception of DDRF, and is now well-established with second generation farmers, much-improved roads and access, and improved technologies and information sharing. Research priorities since 2010 are less aligned with identifying adapted agronomy and plant varieties, new cattle breeds, and novel farming and grazing practices for northern conditions, and are more aligned with resolving specific production, market, and sustainability issues for cropping and cattle enterprises. These include cattle cross-breeding for diversified markets other than live export in the future, associated intensification and integration of crops, improved pastures and cattle production, sustainable soil health and the carbon economy, and improved irrigation and water use efficiencies. The NTG 2012 annual report stated that the Douglas-Daly research projects would cover the development of commercial cropping, improved pasture and beef production aiming at sustainable mixed farming systems and ideally, this research would be under industry direction and funding.

There has been increasing demand on diversification and increasing pressure on sustainable water use in the Douglas-Daly District over the last two decades. Plant Industries research since 2010 continued to focus on intensive cropping enterprises, initially irrigated systems including crops such as peanuts and leucaena, then more emphasis on rainfed (dryland) crop production with cotton being the dominant crop being assessed. Management of improved pasture for hay production continues to be a significant

industry. The demand for integration and diversification is reflected in the focus on research projects at DDRF on a range of crop species integrated with intensive and extensive cattle production, including legume pasture integration (e.g. Leucaena and *Centrosema* sp), cell grazing, and 'Climate Clever' beef. There was a generic program termed 'Intensive Cropping Systems in the Douglas Daly District' initiated in 2016. This was aligned with the Goal/Strategic Action from the NT DPIR Strategic Plan 2018-2022 to 'undertake research, development, extension and services to improve the profitability and sustainability of plant industries.'

An Irrigation Development Program began in 1996 at DDRF in response to an increasing interest in using irrigation to produce field crops. Research into irrigation continues to be a priority. One contributing factor is the regulatory onus on local landowners who hold a Water Extraction Licence, and associated conditions to use the water for which the licence is granted. The focus of the early experiments was mainly crop physiology rather than irrigation and water use effectiveness. There is an evolving focus on water use efficiency practices (e. g. Leucaena project) and increasing awareness of environmental impacts of ineffective water use.

There has been some research to find profitable irrigated crops, including irrigated cotton production, although this has been limited since 2020 due to non-research use of the irrigated paddocks at DDRF.

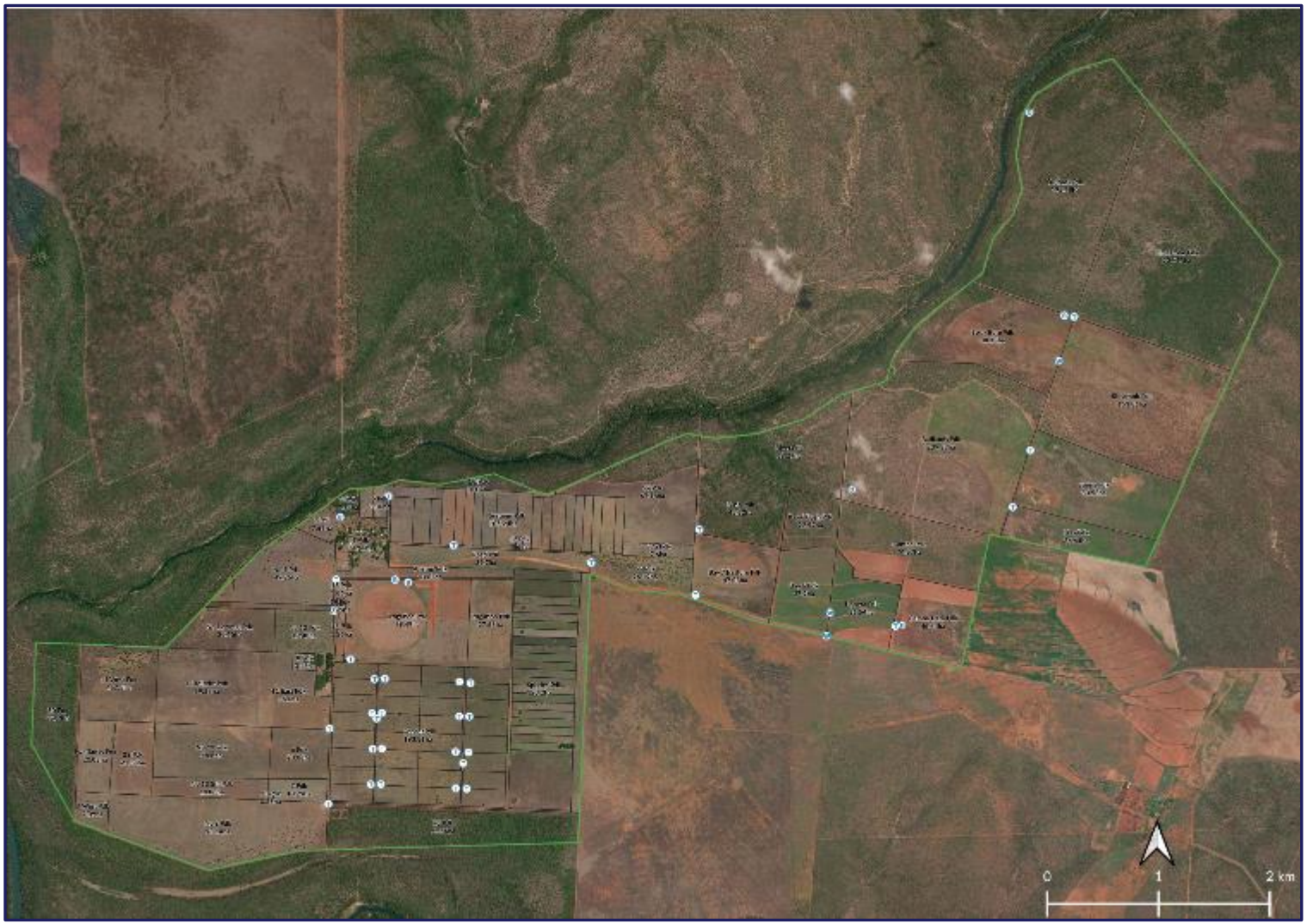
Soil conservation principles and associated trials such as Crop Erosion Research Project (CERP 1985 to 1989) and Land Management Strategies for the Semi-Arid Tropics (LAMSAT 1991 to 1995) were significant projects in the earlier years of DDRF. There has been less investment on soil health trials at DDRF since 2010. However, the increasing awareness of the 'carbon economy' as a potential additional income stream, and projects aimed at increasing resilience to climate change, have provided some impetus to assess soil health (e.g. Bithell, Shotton, & Hearnden, 2013).

The Animal Industries research since 2010 continued to focus on improved cattle productivity primarily through genetic improvement for fertility traits. Projects assessing crossbred cattle production for market diversification have also been a priority, underpinned by the requirement to consider market options other than just live export to Indonesia.

There have been subtle shifts in research direction and industry focus in the Douglas-Daly region. These include, but are not limited to, no on-going dedicated agroforestry projects on DDRF, the long-term Pasture Species Grazing Trial concluding, minimal projects on grain crops such as sorghum or maize, and less specific research on weed or disease issues. There appears to have been a decline in the extent of plant industry research conducted at DDRF since 2010 to present, although numerous projects and activities have developed and established at Katherine Research Station (KRS) over this period. Results and learnings from projects conducted at KRS may be transferable to the Douglas-Daly District, enhancing the knowledge and practices of local farmers.

Farm Biosecurity has a much-enhanced focus since the 2010 Overview was collated. There is increasing threat of incursions from nearby countries of animal and plant diseases such as Foot and mouth, Lumpy skin, American Serpentine leaf minor, Asian Honey bee, and Citrus Canker. Resources are increasingly being directed towards minimising this threat or treating incursions. DDRF has maintained a sentinel herd since 1984 as part of the NAMP (National Arbovirus Monitoring Program) to monitor the spread of economically important insect-borne viruses of livestock and their insect vectors.

The Plant Industry and Animal Industry projects conducted at DDRF since 2010 are discussed in more detail in the sections below.



Map 2. *Douglas Daly Research Farm (August 2024), including troughs (T), bores (B), dams (D), water tanks (W) and paddock layout and names.*

Climate

The local Douglas-Daly climate is characterised by tropical rainfall for seven months of the year with the remaining five months receiving little or no rain. Annual mean rainfall is 1246 mm with mean monthly minimum temperatures ranging between 13 to 24°C and mean monthly maximum temperatures ranging from 32 to 38°C.

DDRF has been recording climate data since the establishment of an official meteorological recording station in January 1968. Daily measurements of rainfall, temperatures, humidity, pan evaporation, wind run and barometric pressure have been recorded and for a few years, cloud cover and type have also been recorded. Rainfall and temperature data is shown below (Figures 1 and 2).

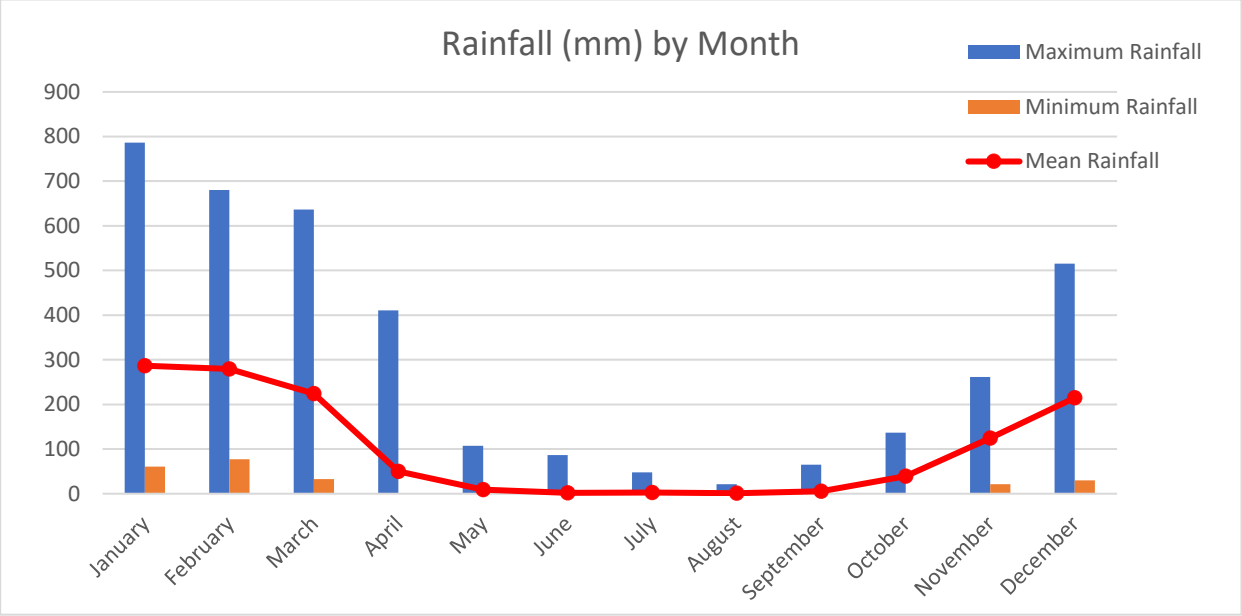


Figure 1. *Mean monthly rainfall since 1968 to 2023 with the yearly average rainfall of 1246 mm.*

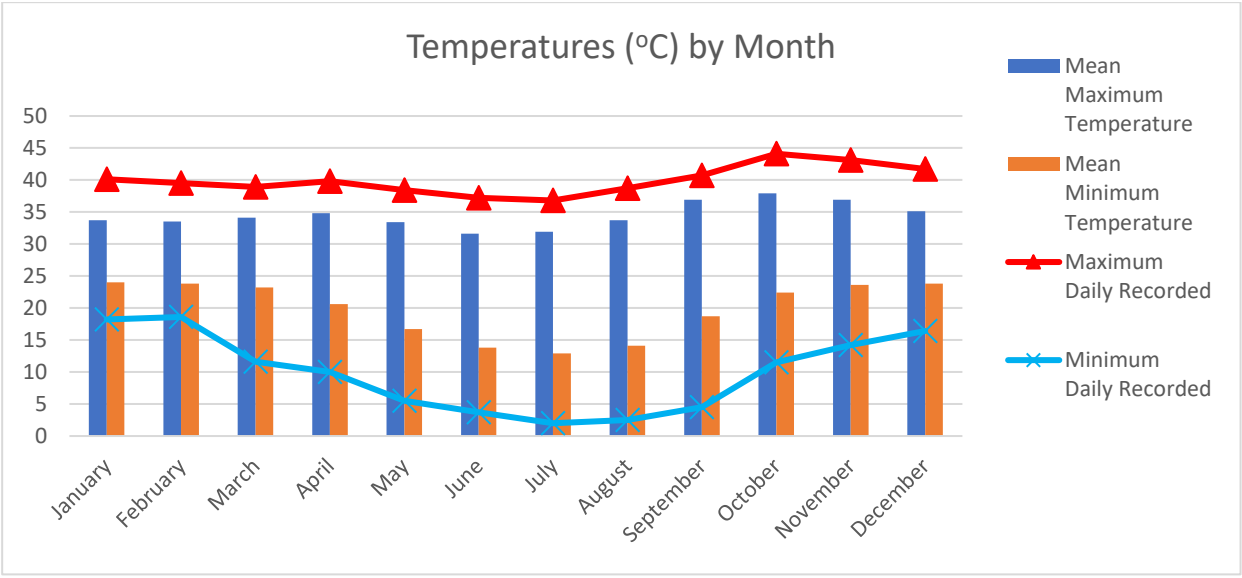


Figure 2. *Monthly mean minimum and maximum temperatures and the minimum and maximum daily temperatures recorded for each month (Source: BoM Darwin office work request).*

Agricultural Research (2010-2024)

1. Plant Production

1.1. Cereal and grain legumes

1.1.1. Intensive Irrigated Cropping Systems

Aim: To use dry season irrigation to rotationally grow grain and fodder crops year-round in the Douglas-Daly region.

Personnel: P. Shotton, R. Parker, C. Hazel, C. Heeb, C. Thompson and I. Biggs.

Period: 2015, 2016, 2017, 2018

Summary: The project aimed to assess suitable crop agronomy, phenology and yield to prepare guidelines for economic industry best practice across a range of grain and fodder crops. The project commenced in 2015, under the 28 Ha pivot of established Jarra grass on the Blain soils irrigation area. Over the 2016 dry season, the northern half of the pivot was sown to a peanut crop, which yielded 4.6 t/ha of peanuts and 5.1 t/ha of dry matter from fodder tops. Water use was 5.1 ML/ha. The southern half of the pivot was planted to lucerne (cv. Super Aurora), and a variety trial assessing 8 varieties, following a green manure crop of lablab. The lucerne crop and trial area established poorly and was ploughed in. The lucerne project subsequently moved to Katherine Research Station.

Sorghum (cvs. G22 and G23) and maize (cv. P2307) crops were grown over the 2017 dry season. The sorghum crop was harvested in October, yielding 2.4 t/ha of grain, with notable variability across the area. Six hectares of the maize crop as silage produced 100 round bales but no dry matter yield was recorded. The remaining area was harvested as grain yielding 3.8 t/ha.

Over the 2017-18 wet season, a cover crop of millet followed the maize, and mungbean (cv. Putland) followed the sorghum. The mungbean yielded @ 0.5 t/ha. Forage sorghum, lablab and guar were sown at times throughout the project, but failed due to a range of reasons, including nematode infestation, bird damage and wildfire. Wildlife, particularly cockatoos, galahs, magpie geese and brolgas were observed to damage crops by grazing, digging and pulling, consistent with previous cropping intensification projects, where wildlife has contributed to yield losses. The agronomy for crop production is good, although there was significant variability across the pivot area, attributed to inconsistencies in soil health given the long and variable history of cropping under the Blain soil pivot area. Further investigation of soil health issues was considered, but the project concluded in 2018 with the unavailability of the DDRF irrigation area for further research trials.

It was anticipated that findings from this project, including agronomic details such as dates of sowing, plant populations, varieties, harvest dates (days to maturity from sowing), and husbandry practices such as nutrition and weed control, would provide a basis for recommendations for a farming system in the Katherine-Daly region. This was not formulated.

Further Reading: NT Government (2016). Primary Industries Annual Research Achievements Report 2015-16. P46. Technical Bulletin No. 355. (Primary Industries Annual Research Achievements Report 2015-16)

NT Government (2017). Primary Industries Annual Research Achievements Report 2016-17. P51. Technical Bulletin No. 356. ARAR (nt.gov.au)

NT Government (2018). Primary Industries Annual Research Achievements Report 2017-18. P60-61. Technical Bulletin No. 358. DPIR Annual Research Achievement Report 2017-2018

1.1.2. Dryland cropping systems in the Douglas-Daly District

Aim: To address knowledge gaps in broadacre crop establishment, agronomy and biosecurity to support growers and investors in the responsible expansion of the NT's agricultural sector.

Personnel: E. Mwando, P. Shotton, N. Hartley

Collaborators: CRCNA (Project A.2.2122026), CRDC, GRDC, NTFA, CDU, NTG-DEPWS, Tipperary Station

Period: 2023 - 2026

Summary: This project is a major component of the CRCNA-funded Cotton/Grain/Cattle Program (2022-26) for agricultural development in northern Australia. This builds from the previous CRCNA project 'Potential for Broadacre Cropping in the NT' (A.2.1819004). The project aims to work collaboratively with the local dryland cotton and broad acre grains growers to address a range of priorities. These include: solutions to unreliable cotton establishment; the impact of various crop rotation combinations on cotton productivity; optimising nutrition options; identifying potential biosecurity risks; mapping the soil type and water holding ability at paddock and regional level; determining social acceptance and soil and landscape suitability for the NT Aboriginal titled land; the alignment of proposed cropping systems with environment and regulatory frameworks; and, assessing an economic decision support tool.

A crop rotation trial was initially established at DDRF on 7/1/2023. This trial was replicated in Paddocks 16, 17, 18 and 19, with the following sequences: continuous cotton, cotton – sorghum (*Sorghum halepense* x), cotton – cavalcade, and cotton – corn treatments. Plant establishment counts showed mortality in cotton seedlings, and bird and insect damage in the corn and sorghum. Blended fertiliser placement treatments at planting of drilled and surface applications were compared. Split and single applications of urea fertilizer were applied as top-dressing. Pest monitoring on the Bollgard3 cotton crops and refuge crops was carried out at DDRF and three Douglas-Daly properties. One of the main caterpillars, the recently established fall armyworm (*Spodoptera frugiperda*), is currently (2024) the subject of research on lure types and parasitoids and further development of a holistic IPM strategy.

The cover crop treatments used in the 2024 season trials were cowpea, millet and natural establishment alone, and cowpea and millet mixed. The rotation sequences were continuous cotton (Bollgard3 714 B3F), cotton- sorghum (*Sorghum halepense x*), cotton-cavalcade and cotton-soybean. Cotton refuge crop was 711RRF V2x. Seeding rates were 10 seeds per meter of row (100,000 SPH (seeds / Ha)), 80,000 SPH, 8kg/ha, and 8 kg/ha for cotton, soybean, cavalcade and sorghum respectively. Measurements include pre-sowing biomass weights, surface and under soil temperature, crop establishment and seedling survival, and fortnightly growth parameters. No results have yet been collated (2024).

This project is working closely with five other similar projects in Cotton|Grain|Cattle (CGC) program funded by CRCNA for sharing expertise, experiences and knowledge across regions.

Further Reading: Home - Cooperative Research Centre for Developing Northern Australia (crcna.com.au)

CGC 2.6 factsheet - Fundamentals of cropping (NT) (crcna.com.au)

N. Hartley, Shotton, P. et al (Hartley, et al., 2023) Potential-for-broadacre-cropping-in-NT-final-report_0.pdf (crcna.com.au)

Agriculture and Biosecurity newsletter: February 2024 | Department of Industry, Tourism and Trade

1.1.3. Crops for Cattle- Increasing the efficiency of north Australian cattle production systems using local crops

Aim: To investigate the feasibility and profitability of supplementary feeding strategies using crops grown in northern Australia to foster intensification of the northern cattle industry.

Personnel: T. Schatz, K. Phelps

Collaborators: CRCNA (Project A.2.2122027)

Period: 2023 onward

Summary: Dry season liveweight gain (LWG) through feeding different crop products and supplementary feeds produced in northern Australia (eg. cotton seed, sorghum, maize, peanut tops) will be assessed on commercial properties and DITT research stations. Compensatory growth in subsequent seasons will also be assessed. Desk-top analyses, including the effect of variation in the sale price of cattle ($/kg) and feed cost ($/t), will model the whole-of-herd impacts on the herd structure, productivity and profitability of a representative northern Australia case study property. The potential of the feeding strategies for obtaining carbon credits through reducing whole-of-life methane emissions will also be evaluated.

#Note: DDRF is NOT one the DITT research stations on which this project is being conducted (as of 2024). However, findings from the project would have obvious synergies and relevance with the intensive cropping region, resulting in a significant impact on agricultural systems and intense cattle production in the Douglas Daly region. This is especially relevant considering that in 2023-24, the region produced one of the largest areas of cotton historically grown in the NT, of which the cottonseed by-product is an excellent cattle feedstock.

Further Reading: T. Oxley, T. Schatz, K. Phelps. (2023). Crops for cattle- Increasing the efficiency of north Australian cattle production systems using local crops to improve dry season weight gain. Proceedings of NBRUC. P32. (Oxley, 2023). 698596_8f02c5ccd56c49d9b682aebbf9942e2d.pdf (nabrc.com.au)

CGC 1.6 factsheet - Crops for Cattle NT (crcna.com.au)

1.1.4. Wet season grain lupin demonstration DDRF 2017 – 18 (Peter Shotton notes only)

Aim: To assess how Lupins would grow and perform under tropical wet season conditions in the Douglas-Daly NT

Personnel: P. Shotton, M. Standish

Period: 2017/18

Summary: A demonstration as a preliminary assessment of lupin tolerance to northern wet season conditions was requested by Mark Standish (Down to Earth Agribusiness). A small area (0.31 ha) was prepared (pre-plant fertilizer @approx. 150 kg/ha of 10-12-11-9) and lupin sown (rate 60 kg/ha) using the trash culti-drill on 18 cm row spacing with cover harrows into Blain soil type on the 29/12/2017. The area was sprayed post planting / pre-emergent using Simazine® (1kg/ha) and Glyphosate (2L/ha). The lupins germinated and grew well, but the birds (cockatoos mainly and galahs) destroyed most of the emerged seedlings with the week. Lupins were re-planted on the 4/1/2018 at approx. 80 kg/ha, again using the trash culti-drill. A gas gun was set up to deter birds but the majority of the crop was again destroyed. Many of the emerging lupin seedlings seemed to have damaged cotyledons, although the cause was not determined. Lupins were again sown, using a hand planter, under a 3m x 3m

enclosure constructed to exclude birds. These plants grew well until the area become very wet with the monsoonal rains in February and with minimal sunlight, most plants had died by the end of the month. Plant height got to a maximum of 100 mm, plant and / or root disease was probably the main cause of plant death (possibly charcoal rot). Caterpillars and other insects attacked the leaves causing leaf drop and plant mortality.

Further reading: Unpublished internal report.

1.2. Cotton

A number of attempts at commercial cotton production have been attempted in the Douglas Daly region since the inception of the DDRF in the 1960s.The potential for cotton production in northern Australia with the advent of genetically modified crops was evidenced by development of a Cotton CRC (Collaborative Research Centre) 'Growth into northern Australia' from 1999 – 2005, including an extensive scoping study (Yeates, 2001). The subsequent 'Cotton, Catchment, Communities CRC' from 2005 – 2012 (Roth, Trindall, & Jones, 2013) further progressed efforts at a northern Australia cotton industry but commercial scale production did not eventuate.

Cotton has once again emerged as a significant broadacre crop in the Top End, with initial small plantings in 2018/19 to an estimated more than 10,000 Ha in 2023-24 (Cotton | NT.GOV.AU). The 'CRC for developing Northern Australia' (CRCNA) 2017-2027 has initiated numerous programs, including a range of cotton research and development projects. Dryland (rainfed) cotton trials have been one of the main projects at DDRF from the early 2020's. This demand will likely increase, with additional industry impetus provided by the establishment of a cotton gin near Katherine in May 2024.

1.2.1. Machinery planting configurations and mulch management for rainfed cotton establishment

Aim: To investigate different machinery planting configurations to increase zero till cotton seedling establishment in Northern Australia.

Personnel: N. Hartley, P. Shotton, E. Mwando

Collaborators: CRCNA (Project A.2.1819004), CRDC, GRDC, CSIRO

Period: 2020-2022

Summary: Poor cotton establishment on course textured soils in the NT was a key issue over initial seasons (e.g. 2018, 2019) for commercial on-farm testing of cotton planted early in the wet season. This was attributed to a combination of high soil temperatures, soil crusting, seed placement in the planting furrow (especially into thick mulch cover), and moisture availability. The consequences are replanting outside the optimum planting window or patchy crop establishment; both with yield penalties.

This trial compared five planting machinery configurations on cotton seedling establishment in an Oolloo soil; i/ no coulters, rubber press wheels, ii/ 40cm bubble coulter + rubber closing press wheels, iii/ 40cm fluted coulter +rubber closing press wheels, iv/ 40cm fluted coulter + spiked press wheels, and v/ 40cm bubble coulter + spiked press wheels. A John Deere Maxi-Merge 2 row precision planter with double disc openers was used. Cotton, variety SC748B3F, was sown at two times, 18th December 2021 into standing green mulch sprayed with glyphosate immediately after sowing, and 6th January 2022, into dead mulch. Plant germination (5 days after sowing) and establishment counts (2 weeks post-sowing), and soil temperatures were measured.

Results indicated that green standing mulch inhibited seedling establishment, irrespective of planting configuration, attributed to physical impedance from the vegetation, and grass pinning in areas of thick mulch contributing to variable seed soil contact and seed planting depth. There was > 50% mortality of

seedlings between germination and establishment counts in both the green and dead mulch treatments, across all planter configurations. In-crop rainfall after flowering enabled good compensatory growth of the lower population, resulting in a good dryland cotton yield (5.7 bales per hectare). It was concluded that mulch cover management is a challenge in the wet season, and that future cotton establishment work needs to evaluate additional mulch cover, planter set up, climate and soil scenarios (including diseases and pests).

Further Reading: N. Hartley, Shotton, P. et al CRCNA project A.2.1819004 potential for broadacre cropping in the NT. P82-91. Potential-for-broadacre-cropping-in-NT-final-report_0.pdf (crcna.com.au)

1.2.2. Rainfed cotton row spacing evaluation.

Aim: To compare row spacings to reduce yield variability and increase overall yields of rain grown cotton in the NT.

Personnel: N. Hartley, P. Shotton, C. Crawford,

Collaborators: CRCNA (Project A.2.1819004), CSIRO

Period: 2021, 2022

Summary: Rainfed cotton in the NT is traditionally grown in 1m rows. Row spacing, and the interaction with plant root structure and soil water availability, can affect cotton yields. This trial compared three row spacings of 0.5, 1.0 and 1.5 m (same plant density per m of row), at DDRF, following a long term perennial pasture field of low inherent fertility and moderate available soil water. Sowing was late in the planting window (7 & 25 January) when the likelihood of a water-shortened growing season is greatest. Measurements focused on yield, time to maturity, soil moisture extraction and crop inputs.

No significant lint yield difference between the row spacings was measured in 2021, with the treatments averaging 3.9 bales/ha. In 2022, lint yields were significantly greater for 0.5 m row spacing than 1.5 m, (3.8 vs 3.3 bales/ ha). The 1 m spacing yielded 3.5 bales/ha, but this was not significantly less than the narrow row treatment.

Further Reading: N. Hartley, Shotton, P. et al CRCNA project A.2.1819004 potential for broadacre cropping in the NT. P 68-81. Potential-for-broadacre-cropping-in-NT-final-report_0.pdf (crcna.com.au)

T. Rhebergen, & S. Yeates. (2023). Climate and soil-based constraints to rainfed cotton yield in the Northern Territory, Australia – A modelling approach using APSIM-OZCOT. (Rhebergen & Yeates, 2023). https://doi.org/10.1016/j.eja.2023.126998

B. Connolly (2020). Cotton in the Top End. TNRM Conference Presentation. (Connolly, 2020) PowerPoint Presentation (territorynrm.org.au)

Photo 1. *Harvesting the dryland cotton trials at DDRF in 2024.*

1.3. Peanuts

Aim: To compare peanut varieties to assess feasibility of peanut production in Top End.

Personnel: P. Shotton, Peanut Company of Australia (PCA)

Period: 2016

Summary: Peanuts have been one of the main crops assessed for production in the NT over the last several decades, although research projects have been intermittent, depending on industry and market drivers. 13.7 hectares (ha) of peanuts were planted on the 31 March 2016 at DDRF under the northern half of the 28 ha centre pivot as part of the intensive cropping program. The three varieties planted were 5.8 ha of Holt, 7.7 ha of Page and 4 rows (0.2 ha) of Kairi. The dry season crop was fully irrigated using 5.1 mega litres (510 mm) per ha. Harvest commenced 148 days after planting. A total of 62.88 tons of harvested nut in shell (nis) was delivered to Kingaroy Qld with a crop value of $57,244 ($910.37 per ton). The better variety seemed to be Holt with a higher return of $1015 per ton with Page of $980 per ton. Holt had a higher Jumbo % (62 %), a lower split % and higher moisture.

This work followed from assessment of 18 peanut varieties in small plots in the bird exclusion cage over two dry seasons (2014 and 2015) at Katherine Research Station. Variety Sutherland appeared to have potential as a grain and hay producing crop. The peanut varieties grew with minimum pest and disease problems. It was concluded that peanut production on a larger, semi-commercial scale would provide more information on cultural practices. Water use, irrigation and weed control studies would be useful for potential commercial producers. Further work at DDRF was not conducted due to several factors including unavailability of the irrigation area for research activities.

Further Reading: Unpublished internal report

1.4. Poppies

Aim: To evaluate the potential commercial development of poppy (*Papaver somniferum*) production in the NT.

Personnel: S. Smith, P. Shotton

Collaborators: Tasmanian Poppy Industry (TPI) Enterprises

Period: 2013-2014

Summary: This project to assess the viability of growing poppies in the NT was sponsored by the Tasmanian company TPI Enterprises, with an Exclusive Access Licence signed on 23 April 2013 between NTG and TPI. Poppies were grown under secure conditions and a permit from the Department of Health, issued under the Misuse of Drugs Act. Interest in poppy production in the NT was stimulated because land was becoming scarce in Tasmania and large tracts of undeveloped land in the NT could potentially be used for the cultivation of poppies. Wet weather at harvest in Tasmania washes away alkaloids from seed heads, and dry season production in the NT would avoid wet weather damage to seed heads at harvest.

Poppies were planted at two locations, including DDRF, on 3 May and 14 May, 2013. The sowings did not emerge, most likely due to inhibition of germination by high temperatures. Poppies were re-sown on 13 and 14 June, emerging within a week. On 27 June, plant density at location 1 was 297 plants / m^2. On 8 July, density at location 2 was 162 plants / m^2 when the press-foot on the small drill was down, and 108 plants / m^2 when the press-foot on the small drill was up. Agronomic practices used in the cultivation of the poppies are not described here due to confidentiality issues related to the legal production of the crop. Poppy heads had formed by late August at both sites. The 2013 trial crop was expected to be harvested in early October and morphine content was to be determined at that time. The trial plots were hand-harvested in the second week of October and the analysis of the capsules for alkaloid content was favourable and supports the continuation of commercial validation of growing trials in 2014.

No further work was conducted due to a lack of subsequent investment and interest by commercial stakeholders.

Further Reading: Northern Territory Government. Primary Industries Annual Research Achievements Report 2012-13. Department of Primary Industry and Fisheries. Technical Bulletin No. 349. P42. (NT Government, 2014). Annual Research Achievements Report 2012-13

1.5. Hemp

Aim: To evaluate hemp seed and/or fibre varieties to determine the best performing cultivars for non-irrigated systems.

Personnel: P. Shotton, A. Peachey

Period: 2021

Summary: The trial was planted at DDRF on 15 January 2021 using zero tillage planting techniques under rainfed (wet season) conditions. Eight monoecious industrial seed and/or fibre hemp varieties (Earlina 8, Fedora 17, Fibror 79, CRS 1, USO31, Katani, Ferimon and CFX 2) were trialled at three different locations in the NT. The dryland (non-irrigated) trials were conducted at DDRF and Coastal Plains and Katherine Research Stations. Data collection included plant heights and plant counts (30 and 60DAS and at harvest), emergence to flowering dates, seed weights (individual plants and 1000grain weight at harvest), biomass, and pest pressure. Despite good planting soil moisture, the varieties

germinated poorly with some varieties having virtually no germination or establishment. No further hemp trials were conducted at DDRF, but the project is ongoing at Katherine Research Station (as of 2024).

Further Reading: Internal unpublished report.

1.6. Pastures

1.6.1. Selecting a Tropically Adapted Lucerne

Aim: To compare tropically-adapted varieties of lucerne (*Medicago sativa*).

Personnel: C. Thompson, T. Alexander, K. Wagman, K. Bourne, J. Cooper and D. Hancock

Collaborators: Seed Genetics International

Period: 2014, 2015, 2016,

Summary: Lucerne is widely grown as a high quality legume fodder in southern Australia, but previous attempts to establish lucerne crops in the NT have been unsuccessful. There was interest in developing tropically-adapted varieties of lucerne, so a replicated variety trial commenced at KRS in 2014. Eight varieties were sown with three replications. Persistence counts were taken during the trial. Selections from these plots were taken for future breeding. In July 2016, 55 varieties and breeder lines were sown under pivot irrigation at the DDRF. Unfortunately, part of the trial area was damaged post-emergence, and the crop was re-sown at KRS, where it continued for a number of seasons. Assessment of tropically adapted lucerne varieties did not continue at DDRF, in part due to the unavailability of the irrigation area for research activities.

Further Reading: NT Government. (2016). Primary Industries Annual Research Achievements Report 2015-16. Technical Bulletin No.355 (NT Government., 2016). P.62. Primary Industries Annual Research Achievements Report 2015-16

NT Government. (2017). Primary Industries Annual Research Achievements Report 2016-17. Department of Primary Industries and Resources. Technical Bulletin No.356. P.60. TB356_compat.docx (live.com)

1.6.2. Gamba Grass Grazing Trial

Aim: To investigate how to use rotational grazing to control gamba grass whilst achieving good animal production outcomes.

See Section under Cattle Nutrition 2.3.3

1.6.3. Cool season growth of tropical grasses

Aim: To compare biomass yields of pasture species under a production system of rainfed during the wet season and irrigated through the dry season.

Personnel: P. Shotton, DDRF staff

Period: 2018-2019

Summary: Irrigated pasture systems provide an opportunity to maximise pasture yields over a 12-month period. However, the cooler dry season temperatures are a constraint to high biomass production of tropical grasses. Identification of higher-yielding dry season production grasses would be beneficial as the grass component in a leucaena-based cattle grazing system, diversification with hay production or could facilitate a pasture seed-production industry.

Initial studies had been conducted in 2014-2016 at Coastal Plains Research Farm which assessed eight tropical pasture grasses (Strickland, Premier digit, Fine-cut, Gulf cut, Reclaimer, Gatton panic, Nucal and Splenda Setaria) to find an alternative to Fine-cut Rhodes grass, which is not palatable to cattle and is difficult to grind, making it unsuitable for cubing or pelleting. Cultivars including Megamax 059 panic, Premier Digitaria, Splenda Setaria, Katambora Rhodes, Jarra finger grass, Mulato II Brachiara and Nucal were sown at DDRF for assessment, but work did not continue due to unavailability of irrigation facilities.

Further Reading: NT Government. (2016). Primary Industries Annual Research Achievements Report 2015-16. P75. Technical Bulletin No.355.

NT Farmers (2024). NT Fodder Production Guide (NT Farmers, 2024). NT-Farmers_NT-Fodder-Production-Guide-A5_WEB.pdf (northernhub.au)

1.6.4. Leucaena: Irrigated system

Aim: To assess the productivity and viability of irrigated leucaena and grass pastures and propose a best-bet leucaena-grass system.

Personnel: P. Shotton, R. Parker, C. Hazel and C. Heeb

Collaborators: The Leucaena Network

Period: 2017-2018

Summary: There was producer-driven demand to assess productivity of irrigated leucaena and grass pastures in producing and finishing heavier animals targeting wider-ranging market access. This was aligned with a MLA funded proposal (which did not eventuate) “Industry Benefit from a Northern Abattoir” to grow out animals to 450 – 500 kg by 18 – 24 months of age. Leucaena and grass had provided the highest liveweight gain (LWG) from the Pasture Species Grazing trial (Average 200 kg/year/head and 408 kg/ha/year, crude protein of Leucaena = 15 – 30 %.) and Fine Cut Rhodes was a high yielding grass for dry season irrigated fodder (7 cuts per year 30 t/ha, 10 % CP, 8.8 % MJ/kg).

The irrigated pasture was comprised of Circle 1 with a mix of Reclaimer Rhodes in the eastern half and Finecut Rhodes and Mulato II in the western half, and Circle 2 had majority Jarra grass with some Sabi grass and Pangola. The area was divided into 4 paddocks and was rotationally grazed (in 1 week intervals) at between 2.1 and 5.5 head per hectare depending on the amount of feed available. Live-weight gain was 0.34 to 0.75 kg/animal/day and 1.4 to 4.6 kg/ha/day. Management practices included 70 kg of NPS fertiliser per year, broad leaf weed (in grass) control with Starane®, 24-D, metsulfuron using a shielded sprayer, irrigation applied 4 to 5 ML /ha/year with an associated cost of diesel fuel to deliver 1 ML of water @ $100 to $120, and slashing leucaena for height control generally once a year @ $66/ha. The “Leucaena bug” was introduced into the herd to minimise the mimosine / DHP poisoning and to enable the cattle to use the high protein leucaena to its maximum potential. The grass to leucaena proportions (ratio) are an important consideration; too much leucaena will result in frequent height management. The leucaena grew above the browsing ability of the younger cattle with the 8m row spacings in the irrigated system. Taller heavier animals will push leucaena branches over to consume the leaf. Magpie geese, locusts, wallabies, soil grubs, bugs and termites contributed to some plant losses.

Future research to identify a better dual purpose tropical grass for both wet and dry season growth, and more detailed evaluation of costings of irrigated versus dryland systems, was proposed. However, the project was discontinued at DDRF after 2018 due to the leasing of the irrigation area to commercial interests. It appears that this irrigated pasture system is better suited to finishing heavier animals. The system's benefits can be improved by having a consistent supply of animals, a water monitoring system, timely fertiliser application and suitable grass species, such as Strickland, Mulato II, and Nucal for cool season production (NT Government., 2017).

1.6.5. Leucaena: Dryland system

Aim: To quantify the live weight gain productivity of established Leucaena-grass pasture systems at three sites, including DDRF.

Personnel: P. Shotton, DDRF staff

Collaborators: Leucaena Network, MLA

Period: 2020 -2022

Summary: The work conducted at DDRF was part of a larger project 'Value Chain Economics for Leucaena' coordinated by the Leucaena Network encompassing 3 sites across QLD and the NT. DDRF completed three trial cohorts from 2020-2022. The paddocks used were 4 ha with the 5 Leucaena paddocks containing Cunningham and Tarramba Leucaena (*Leucaena leucocephala*) with an inter-row mix of Sabi (*Urochloa mosambicensis*), pangola (*Digitaria eriatha*) and buffel grasses (*Cenchrus ciliaris*). The grass dominated paddocks contained pangola and buffel with some Sabi grass. Paddock biomass was assessed at the start and end of the dry season to estimate the available pasture yield and pasture composition including available Leucaena leaf biomass.

Uramol® lick blocks were supplied to both mobs during the dry season with average daily consumption approx. 50 g/hd/d. Maxi-phos® lick blocks were also supplied during the wet season with average daily consumption approx. 60 g/hd/d. Faecal NIR analysis was also conducted.

Cohort One (14 July 2020 – 17 May 2021) consisted of 42 Brahman steers, grazing at 1.5 head / ha (set stocked) during the dry season and adjusted to 1.75 head / hectare with the commencement of the wet season. Dry season LWG averaged 14 kg (0.12 kg/hd/day) for the grass paddocks and 25 kg (0.23 kg/hd/day) for the leucaena –grass paddocks. Wet season LWG were similar between the grass and leucaena – grass paddocks. Yearly LWG for the leucaena –grass paddocks averaged 186 kg/head and the grass only paddocks 176 kg/head over the 307 days. The Sabi grass with minimal Leucaena gave the lowest LWG of the seven paddocks being assessed (155 kg/h/day).

Cohort 2 (12 July 2021 - 17 May 2022) were rotationally grazed at 2 head / ha. Dry season LWG averaged 13.3 kg/hd for the leucaena - grass paddocks and 11.6 kg/hd for the grass only paddocks. Wet season LWG were similar between the leucaena - grass (147 kg/hd) and grass only (142 kg/hd). Over a total period of 309 days the leucaena – grass pastures (161 kg/hd) outperformed the grass only pastures (154 kg/hd).

Cohort 3 (28 June 2022 - 12 October 2022) were stocked at 1.5 head/ha in the dry season and adjusted to 2 head / ha with the commencement of the wet season. Cattle were rotated every 7 days and every 14 days in the leucaena – grass and grass only paddocks respectively. Dry season LWG averaged 20 kg/hd for the leucaena - grass paddocks and 13 kg/head for the grass only paddocks. Over a total period of 342 d steers in the leucaena - grass and grass-based pastures achieved similar liveweight gains, of 185 and 186 kg/hd, respectively.

Gross margin analysis based on an economic assessment conducted by QDAF using cohort 1 data and no forage growing costs allocated suggested a 23% benefit associated with Leucaena. Nevertheless,

the higher stocking rate in year 2 gave a slightly higher LWG per hectare than years 1 and 3 but reduced the average LWG per head.

Leucaena has potential to address the protein drought experienced in the Northern Territory during the dry season and result in increased productivity of grazing enterprises compared grass dominated pastures only. Leucaena provides a quicker turn-off due to a higher quality feed intake, resulting in a potentially higher stocking rate and fewer grazing days to meet an LWG target.

Further Reading: NT Government. (2016). Primary Industries Annual Research Achievements Report 2015-16. Technical Bulletin No.355 (NT Government., 2016). P.47. Primary Industries Annual Research Achievements Report 2015-16

B. Christensen & P. Shotton. (2022). *PDS Sustainable Long Term Leucaena Grass Production in Northern Australia.* Meat & Livestock Australia. (Christensen & Shotton, 2022) https://www.mla.com.au/contentassets/de4f171674db47cb97d1a9941fa9bc61/l.pds.1909-final-report.pdf

B. Christensen, P. Shotton, P., C. Lemin & B. Blennerhassett. (2023). *PDS: Value Chain Economics for Leucaena.* Meat & Livestock Australia. (Christensen, Shotton, Lemin, & Blennerhassett, 2023) https://www.mla.com.au/contentassets/f2988fba205d4a2eaf7e7b588ae7d210/p.psh.2006-final-report-1.pdf

29.04.2019 Douglas-Daly field day, Katherine Rural review edition #339 June 2019 Katherine Rural Review June 2019 (nt.gov.au)

Photo 2. *Cattle grazing the leucaena / improved pasture species trial in the Blain irrigation area at DDRF.*

1.7. Agroforestry

1.7.1. Quantifying interception with large scale plantation forestry in the NT.

Aim: To develop an initial assessment of water use of non-irrigated plantation forestry in the Daly River catchment.

Personnel: D. Reilly, DDRF staff

Collaborators: National Water Commission, CDU, RIEL, CSIRO, Eco Logical Australia, TRaCK

Period: 2012, 2013

Summary: A preliminary study assessed the potential impacts on the water resources of the Daly River region from a proposed expansion of plantation forestry. The project was structured around four aims; 1) Assessing the potential groundwater dependence of *K. senegalensis* (African mahogany) trees in low lying position in the landscape; 2) The establishment of a long-term monitoring plantation at the NT Government's DDRF; 3) An initial calibration of the growth model 3PG+ to model plantation water balance relative to natural vegetation and improved pasture, and 4) The development of a water use planning framework to assist with policy development associated with the land use.

African mahogany plantations represented a small proportion of the total catchment (<1%). However, it was anticipated that this area could increase at a rate of approximately 2000 ha per annum up to a total of 50 000 ha. The growth model, 3-PG2 was used to predict growth of *K. senegalensis* in the region. The model also reasonably predicted the major components of the water balance for savanna and pasture communities within the region. Annual evapotranspiration (ET) from mahogany plantations was similar to that observed in the surrounding savannas, although there were marked differences in the partitioning of total ET and the seasonal dynamics of ET. A scenario was modelled in which an annual plantation expansion rate of 2000 ha for 20 years was assumed and estimated annual components of the water balance for the total catchment area were assessed.

The scenario predicted that the projected expansion of the mahogany estate in the Stray Creek catchment would have little impact on the water resources of the catchment.

Further Reading: Northern Territory Government. 2013. Primary Industries Annual Research Achievements Report 2012-13. Department of Primary Industry and Fisheries. Technical Bulletin No. 349. P37. Annual Research Achievements Report 2012-13

L. Hutley, I. Lancaster, D. Reilly, A. O'Grady, A. Almedia, M. Kraatz, S. Smith, M. Bristow, B. Sawyer, D. Yin Foo (2012) Quantifying interception associated with large-scale plantation forestry in the Northern Territory. Australia. National Water Commission, Canberra. https://hdl.handle.net/10070/382045 (Hutley, et al., 2012)

1.7.2. Optimise Silviculture for high value mahogany plantations

Aim: To identify the necessary silvicultural inputs to optimize the value of African mahogany in existing and future plantations in northern Australia

Personnel: M. Bristow, P. Richter, D. Anson, DDRF staff

Period: 2016, 2017, 2018

Summary: The expansion in the production of African mahogany (*Khaya senegalensis*), which is an internationally important high-value forest tree species, is continuing in the NT. The project, initially named '*Mahogany plantation measurement, maintenance and use'* identified the necessary silvicultural inputs to optimise the value of African mahogany in existing and future plantations in northern Australia. Results of older local farm trials on African mahogany were recorded for use. Commercial

plantation establishment commenced in 2006 in the NT and (as of 2016-17) covered about 14 000 hectares. Trials in northern Australia have demonstrated significant potential for plantation expansion. Logs were harvested for the first graded recovery study, which is complete; some have been processed at Queensland's Department of Agriculture and Fisheries.

Further Reading: NT Government. (2017). Primary Industries Annual Research Achievements Report 2016-17. Technical Bulletin No.356. P.55. ARAR (nt.gov.au)

J. McGrath, et.al. (2022). Silvicultural systems to optimise value from northern Australian mahogany plantations. Forest & Wood Products Australia Limited. (McGrath, et al., 2022)

Territory Natural Resource Management. (2021). Sustainable Forestry Practices: Guidelines for the Northern Territory. (Territory NRM, 2021). da28f0_df72240145134698aa6e1c5aea687a9d.pdf (territorynrm.org.au)

2. Cattle Production

Cattle production in northern Australia has historically been based on native extensive pastures (rangelands). The higher rainfall areas of the 'Top End' have facilitated the use of improved pastures to contribute to increased cattle productivity. DDRF has been a significant enabler in the enhanced knowledge of cattle production on improved pastures, and the integration with crop production, over several decades. The main cattle research over the last 14 years has evolved from the 'Selected Brahman' and Cross-breeding projects which dominated the previous decade, to the more focused 'Repronomics' research. This used improved technologies to assess gene markers to select for high fertility. This meant a substantial herd transition at DDRF, with the Brahman breeder herd relocating to Kidman Springs Research Station to facilitate the more intensive research and heifer numbers required for the Repronomics work to be maintained at DDRF.

2.1. Fertility

2.1.1. Selected Brahmans - Improvement in Fertility using BREEDPLAN EBVs and Selection

Aim: To use EBVs and high selection pressure to improve Brahman reproductive traits.

Personnel: W. Dollemore, T. Schatz, C. Hazel, K. McCosker, B. Lemcke.

Period: 2010 - 2018

Summary: The introduction of Brahman cattle to northern Australia has resulted in large productivity gains in beef cattle due to the breed's adaptation to tropical environments. However, it is recognised that the breed has lower fertility than Bos taurus breeds. Research and using high selection pressure to improve fertility in a Brahman herd started in 1986 at DDRF using local cows and bulls. Artificial insemination (AI) was also used to introduce new genes. The herd joined the Australian Brahman Breeders' Association and became a member of BREEDPLAN in 1994. The success of this project as of 2016-17 was shown by the improvement in reproductive EBV traits, such as the average days to calving and scrotal circumference, which are better than the breed average for the Brahman Group BREEDPLAN, the Jap Ox Index and the Northern Live Export Index.

Future emphasis will include the collaborative project with AGBU: Intensive genotyping and phenotyping for accelerated genetic improvement of reproduction in northern Australia. This project also has an extension component to increase and disseminate knowledge on objective selection

techniques. An additional aim is to make high fertility Brahman cattle genes available to the industry through the sale of bulls.

This project evolved into the Repronomics Projects.

Further Reading: R. Golding, T. Schatz, & G. Jayawardhana (2011) Breeder fertility improved through selection in a NT Brahman herd. *Proceedings of the Northern Beef Research Update Conference*,3 & 4 August. P.113. http://www.jkconnections.com.au/nabrc/activities_and_events/nbruc/august-2011-proceedings (Golding, Schatz, & Jayawardhana, 2011)

NT Government (2018). Primary Industries Annual Research Achievements Report 2017-2018. Technical Bulletin No.358. P.39. DPIR Annual Research Achievement Report 2017-2018

M. Bethel, G. Bailey-Preston & T. Schatz T (2023). Stayability trends in a Brahman herd that has been selected for fertility. NBRUC Conference Proceedings, Darwin, NT, 22-25 August P.127. (Bethel, Bailey-Preston, & Schatz, 2023)698596_8f02c5ccd56c49d9b682aebbf9942e2d.pdf (nabrc.com.au)

2.1.2. Comparison of performance of Brahman heifers at different age and pasture type

Aim: To assess the performance of Brahman heifers at their first mating as yearlings grazing on improved pasture in the Douglas Daly region and as 2-year-olds grazing on native pasture in the Victoria River District.

Personnel: T. Schatz

Period: 2015, 2016

Summary: The relationships between pre-mating weight and pregnancy rate were established for Brahman heifers mated as yearlings on improved pasture, and as 2-year-olds on native pasture with pre-mating weights recorded in late October/early November (before the wet season starts) and in late December (just before the start of mating). These relationships were found to be different indicating that there is an interaction between age and weight that modifies the effect of weight. The relationships were used to model pregnancy rates that are likely to result from different pre-mating weights for these three scenarios. These estimates can be used to identify target mating weights for different situations, and to predict the pregnancy rates for groups of heifers, which will be useful in budgeting and assessing the profitability of different management strategies. (Schatz & Hearnden, 2017)

Further Reading: T. Schatz (2010b). Understanding and improving heifer fertility in the Northern Territory. *Final report for MLA Project NBP.339*. Meat and Livestock Australia, North Sydney. (Schatz, 2010)

T. Schatz & M. Hearnden (2017). The effect of weight and age on pregnancy rates in Brahman heifers in northern Australia. *Animal Production Science*. 57(10):2091-2095. https://doi.org/10.1071/AN16212

2.1.3. Repronomics1: enabling genomic selection for fertility traits in young female cattle.

Aim: To improve the evaluation of animals for a number of economically important performance traits, with a focus on fertility traits in young female cattle and improving the accuracy of EBVs and genomic evaluation.

Personnel: T. Schatz, W. Dollemore, C. Hazel, C. Heeb, D. Bethel, G. Bailey-Preston

Collaborators: QLD DAF, AGBU, Animal Genetics Laboratory

Period: 2014-2018

Summary: Reproduction is a key profit driver in northern Australia and genetic improvement is a key tool for increasing commercial weaning rates. The Repronomics Project generated significant numbers of calves and recorded traits including age at puberty, lactation anoestrous interval, calving and weaning rates, for numerous females. These records were combined with DNA chip genotyping on all project and industry animals to enable genetic improvement of female reproduction through genomic selection. The project used 3 breeds and a combination of research facilities, including DDRF, and industry seedstock herds. Real-time ultrasound determined the follicle development and presence of a corpus luteum (CL) which was used to determine the age at puberty, and for lactating first calvers, their return to cycling post-calving. To enable the development of genomic selection all females were DNA parent verified and genotyped. All the data was fed into new BREEDPLAN evaluations and will enable tropical breeds to make genetic change in improving female reproduction rates (Grant, Johnston, Schatz, Burns, & Lyons, 2016). (Johnston, et al., 2017) (NT Government, 2018)

Further Reading: T. Grant, D. Johnston, T. Schatz, B. Burns, R. Lyons. (2016). Repronomics Project update – enabling genomic selection for reproduction. Proceedings, Northern Beef Research Update Conference, P.197. 698596_2c8848c0ffe9435a97dec33ba377ca28.pdf (nabrc.com.au)

Johnston DJ, Grant TP, Schatz TJ, Burns BM, Fordyce G, Lyons RE (2017) The Repronomics project – enabling genetic improvement in reproduction in northern Australia. In 'Proceedings of Association for the Advancement of Animal Breeding and Genetics' 22, 385-388. EFFECTS OF BREED AND HETEROSIS ON PREWEANING GROWTH OF (une.edu.au)

NT Government (2018). Primary Industries Annual Research Achievements Report 2017-2018. Technical Bulletin No.358. P.39. DPIR Annual Research Achievement Report 2017-2018

https://futurebeef.com.au/repronomicstm/

2.1.4. Repronomics 2

Aim: To build on work conducted in Repronomics1 to further lift the accuracies of Estimated Breeding Values (EBVs) across the full range of traits, but particularly for female reproduction traits, and increase the size of the genomic reference populations for key tropical breeds.

Personnel: T. Schatz, G. Bailey-Preston

Period: 2019-2024

Summary: The Repronomics II project is the successor of the Repronomics I project. It aims to determine genetic effects on age at puberty and postpartum anoestrus interval after first calving. It is hoped the project results will increase the accuracy of fertility estimated breeding values (EBVs), which will improve the rate of progress through selection. It may also develop new fertility EBVs and find genomic markers for fertility traits. Ovaries of groups of heifers were scanned at regular intervals to determine age at puberty (age at which a corpus luteum is present on an ovary). Ovary scanning commences in the December following weaning just prior to the heifers being mated for the first time as yearlings and continues until all have reached puberty after mating at two years of age. Age at puberty of heifers was determined by ultrasound scanning their ovaries at regular intervals to determine when a corpus luteum was first present on an ovary.

The field work for this project recently concluded (2024) and final conclusions and recommendations will be available in the future.

2.2. Cross breeding

2.2.1. A Comparison between the productivity of a multi-breed composite and a Brahman breeder herd

Aim: To compare the performance of a multi-breed composite with that of the Brahman under Top End Conditions

Personnel: Numerous, including W. Dollemore, B. Lemcke, B. McDonald, J. Palmer, T. Messner, C. Hazel, G. Bailey-Preston

Period: Long-term ongoing

Summary: The NT Government has been selecting for fertility traits within the Brahman breed since the 1980's and the Composite herd was bred out of this in the early 2000's, producing around 200 Brahman and Composite bulls annually in the initial years. These bulls are ranked at 12 and 18 months old by their weight, scrotal size, percent normal sperm and dam performance. The top 24 bulls are selected for the NTG herds, with the remainder that meet temperament, conformation and performance criteria being sold in the annual NTG Bull Sale. The aim is to provide industry with animals of high fertility and that are adapted to the NT environment. Females that do not produce a weaner every year are removed from the herd. The Composite herd began as 56.3% Brahman, 12.5% Africander, 12.5% Tuli, 6.3% Shorthorn, 6.3% Charolais and 6.3% Hereford but has evolved over time with selection. Artificial insemination (AI) was also used to introduce new genes. The breeder herd located to Beatrice Hill Farm in 2009, but heifers from this herd and the Brahman herd are transported to DDRF after weaning where they stay for two matings before re-joining the breeder herds at BHF. A detailed herd structure in 2014-15 is provided in (NT Government, 2015).

In 2017-18, the project evolved to be co-managed with the Selected Brahman project and the collaborative Repronomics 2 project under the title "Enabling genetic improvement of reproduction in tropical beef cattle". The aim of this research was to improve the accuracy of fertility EBVs and across-breed EBVs for industry. The herd will make a significant contribution of phenotypic and genotypic information to the reference population. As of 2017-18, the EBVs achieved in days to calving and scrotal circumference in this project are better than the breed average for the Brahman Group BREEDPLAN.

Further Reading: NT Government (2018). Primary Industries Annual Research Achievements Report 2017-18. Technical Bulletin No. 358. P32-33. DPIR Annual Research Achievement Report 2017-2018

W. Dollemore & G. Bailey-Preston (2019). Effect of age at first calving on the incidence of calf loss in Brahman and Tropical Composite mobs in northern NT. Proceedings of Northern Beef Research Update Conference . P.97. (Dollemore & Bailey-Preston, 2019) 698596_2787d3204033487ca4842dee02644995.pdf (nabrc.com.au)

2.2.2. The use of alternative tropical breeds: Senepol crossbreeding

Aim: To investigate whether crossbreeding Senepol bulls with Brahman cows will produce offspring that perform well under NT conditions and have better quality meat than pure Brahman cattle.

Personnel: Numerous, project led by T. Schatz

Period: 2008 to 2020

Summary: Cattle with a high *Bos indicus* (usually Brahman) content are required for their adaptive traits to northern Australian climate and environment. However, Brahman cattle have a reputation for poor meat tenderness. This has not been a problem in live export markets, but high-grade Brahman cattle are not favoured in southern Australian domestic markets, making northern producers vulnerable to live export market down-turns.

This project compared the performance of F1 Senepol x Brahman cattle with that of pure Brahman cattle as a strategy to produce suitable cattle for both the live export and Australian domestic markets. The NT Senepol crossbreeding project has been continuing since late 2008 when Senepol bulls (a *Bos taurus* breed) were mated to Brahman cows for the first time. The first group of calves was weaned in May 2010. All males were transported to DDRF to grow on improved pasture and all females were kept at Victoria River Research Station (VRRS) for comparison of fertility with Brahman cattle. On average, Senepol cross male calves were 21 kg heavier at weaning, and 32kg heavier after the postweaning year, compared to Brahman. Preliminary data showed around 70% of females and 53% of males were polled and 27% of females and 43% of males were scurred, resulting in considerably fewer animals requiring dehorning at branding.

These preliminary results indicated that F1 Senepol cross animals performed better than Brahmans under local conditions. However, the main reason for crossbreeding is to produce animals for improved meat quality compared to pure *Bos indicus* animals to improve marketing options for producers. This is addressed in 2.2.3.

Further Reading: NT Government Annual Research Achievements Report 2011-12. (2012). Technical Bulletin No.347 P.13-14. Microsoft Word - TB347.docx (nt.gov.au) (NT Government, 2012)

T. Schatz (2013) A comparison of F1 Senepol x Brahman and Brahman steer growth in the NT. *Proceedings of the Northern Beef Research Update Conference*, 12-15 August 2013. P181. (Schatz, 2013). 698596_30a687cfd4a44e90902871b3a3acd40d.pdf (nabrc.com.au)

T. Schatz, S. Thomas, S. Reed, & M. Hearnden (2020). Crossbreeding with a tropically adapted *Bos taurus* breed (Senepol) to improve meat quality and production from Brahman herds in Northern Australia. 1. Steer performance. *Animal Production Science* **60**, 487-491. https://doi.org/10.1071/AN18609

T. Schatz, M. Hearnden, J. Wheeler (2022) Crossbreeding with a tropically adapted Bos taurus breed (Senepol) to improve meat quality and production from Brahman herds in northern Australia. 2. Female performance. Animal Production Science 62(13) 1219-1228 https://doi.org/10.1071/AN21499 (Schatz, Hearnden, & Wheeler, 2022)

2.2.3. Comparison of the growth and meat tenderness of Brahman and F1 Senepol × Brahman steers.

Aim: To compare feedlot performance and meat quality between Brahman and F1 Senepol x Brahman steers.

Personnel: T. Schatz, S. Thomas and G. Geesink

Period: 2012-2014

Summary: The growth of 116 Brahman (BRAH) and 96 F1 Senepol × Brahman (F1 SEN) steers grazing improved Buffel pasture in the NT was compared. Average growth was 10 kg higher in F1 SEN during grazing in the 9 months following weaning. Twenty-five steers of each genotype were compared for feedlot performance and meat quality. There was no significant difference in feedlot growth over 73 days in a commercial feedlot. On average F1 SEN carcasses graded two boning groups lower in the Meat Standards Australia (MSA) grading system. While *M. longissimus* samples from both genotypes

were quite tender (shear force <4 kg), F1 SEN samples were found to be significantly more tender than BRAH (−0.44 kg) by shear force testing.

These results indicate that crossbreeding with a tropically adapted *Bos taurus* breed, such as the Senepol, may be a viable method for cattle producers with Brahman herds in northern Australia to improve the meat quality of the cattle they produce (Schatz, Thomas, & Geesink, 2014).

Further reading: T. Schatz, S. Thomas, & G. Geesink (2014). Comparison of the growth and meat tenderness of Brahman and F1 Senepol × Brahman steers. Animal Production Science 54, 1867-1870. https://doi.org/10.1071/AN14243

T. Schatz (2014) Senepol feedlot performance and meat tenderness. MLA final report for project B.NBP.0782. (Schatz, 2014) b.nbp.0782_final_report.pdf (mla.com.au)

2.2.4. A comparison of the performance of Brahman and F1 Senepol x Brahman steers in an Indonesian feedlot

Aim: To compare the performance of F1 Senepol x Brahman steers (F1 SEN) to Brahman (BRAH) steers in an Indonesian feedlot. This aimed to address concerns that crossbred cattle are discriminated against by live export cattle buyers due to a perception that they do not perform as well as Brahmans in Indonesian feedlots.

Personnel: T. Schatz, S. Thomas, S. Reed

Period: 2014, 2015

Summary: F1 SEN (n=54) and BRAH (n=32) steers that had grazed together since weaning at DDRF were exported to Indonesia and fed for 121 days in a feedlot near Lampung (Sumatra, Indonesia). The average daily gain of the F1 SEN steers over the feeding period was 0.17 kg/day higher than the BRAH steers (1.71 vs 1.54 kg/day) with a resultant 21.6 kg more weight gain over the 121-day feeding period. Consequently, F1 SEN steers performed better than BRAH in an Indonesian feedlot and these results should encourage live export cattle buyers to purchase this type of cattle (Brahman crossed with a tropically adapted *Bos taurus* breed) with confidence that they can perform at least as well as Brahmans in Indonesian feedlots, although it should be noted that growth rates are usually higher in F1 crosses than in subsequent generations (Schatz.T, 2017).

Further Reading: T. Schatz (2015). Indonesian Feedlot Performance Comparison of Brahman and F1 Senepol Steers, MLA Report. (Schatz, 2015) Final report template (mla.com.au)

NT Government. Primary Industries Annual Research Achievements Report (2015). Tech. Bulletin No. 354. P.8-10. (NT Government, 2015). Annual Research Achievements Report 2014-15 Primay Industries

T. Schatz (2017). A comparison of the growth of Brahman and F1 Senepol × Brahman steers in an Indonesian feedlot. *Animal Production Science* **57**, 2096-2099. https://doi.org/10.1071/AN16211

2.3. Nutrition

2.3.1. Comparison of cell grazing versus constant grazing (set-stocking) on buffel grass.

Aim: To compare the effects of set-stocking and cell grazing regimes on animal and pasture production, pasture composition and sequestration of soil organic carbon.

Personnel: T. Schatz, D. Ffoulkes, P. Shotton

Period: 2009-2018

Summary: A cohort of Brahman and Brahman-cross weaners was randomly allocated each year to intensive rotation grazing (IRG) (cell grazing) and CG (constant grazing) treatments. They grazed predominantly buffel pasture at DDRF from shortly after weaning for about a year, at which time they were replaced by the next year's group. The average liveweight gains of the treatments over the post-weaning year were compared each year for the nine years of this study. Soil organic carbon was measured in the topsoil (0-30 cm) twice each year for 5 years (2009 - 14) and changes in carbon stocks over time were compared between treatments.

In each year of this study, the growth of cattle grazing buffel pasture was lower under IRG than CG. In each year, liveweight gain was lower ($P < 0.05$) per head and per hectare under IRG. Topsoil soil organic carbon stocks did not increase in the IRG treatment over the 5 years of this study. The lower per head and per area production from the IRG system, combined with the extra infrastructure and operating costs for IRG systems, make it unlikely that adoption of IRG would improve the profitability of cattle-grazing operations on similar pasture systems in northern Australia. However, the findings of this study may not apply to other pasture systems and environments. (Schatz, Ffoulkes, Shotton, & Hearnden, 2020)

Further reading: T. Schatz, D. Ffoulkes, P. Shotton, and M. Hearnden. (2020) Effect of high-intensity rotational grazing on the growth of cattle grazing buffel pasture in the Northern Territory and on soil carbon sequestration: Animal Production Science 2020. 60(15):1814-1821. https://doi.org/10.1071/AN19552

https://industry.nt.gov.au/__data/assets/pdf_file/0004/227920/cell_grazing_ddrf.pdf

NT Government (2014). Primary Industries Annual Research Achievements Report 2013-14. Department of Primary Industry and Resources. P23-24. Technical Bulletin No. 353. (NT Government, 2014) (Primary Industries - Annual Research Achievements Report 2013-14)

Schatz T (2016) Evaluation of intensive rotational grazing on improved pasture in the NT. *Proceedings, Northern Beef Research Update Conference,* 2016. p. 92.

Schatz T (2019) Intensive rotational grazing of improved pasture in the NT – update. 2019 NBRUC Conference Proceedings No. 229. P. 64 698596_2787d3204033487ca4842dee02644995.pdf (nabrc.com.au)

2.3.2. Cattle production on buffel grass - Centro pastures in a seasonally dry tropical environment.

Aim: To evaluate the quality of the diet selected and the growth of young cattle grazing a buffel grass (*Cenchrus ciliaris*)–Centro (*Centrosema brasilianum*) pasture to relate the diet selected to cattle growth.

Personnel: R. Dixon, P. Shotton and R. Mayer

Period: 2005 - 2009

Summary: Liveweight (LW) gain of grazing cattle in the seasonally dry tropics is usually moderate during the wet season (WS) and declines to slow growth or LW loss during the dry season (DS). Cattle growth can often be improved by inclusion of herbaceous legumes into pastures to improve their nutritional quality. During three annual cycles at DDRF, young steers grazed a grass–Centro legume pasture at moderate stocking rate. LW was measured monthly, and diet attributes (legume content, DM digestibility (DMD) and crude protein concentration) were measured fortnightly by near-infrared reflectance spectroscopy analyses of faeces. Pasture available and species were measured twice annually.

The annual LW gain and diet attributes followed a consistent profile through the annual cycles. The diet DMD and crude protein concentration increased abruptly following the seasonal break and then declined approximately linearly during the remainder of the WS and the wet–dry transition season (TS). Cattle selected for Centro during the TS and the DS, but not during the WS. Cattle LW gain reflected diet quality averaging 0.86, 0.59 and 0.12 kg/day during the WS, TS and DS respectively (Dixon, 2020).

Further reading: R.M. Dixon, P. Shotton and R.Mayer. Diets selected and growth of steers grazing buffel grass (*Cenchrus ciliaris* cv. Gayndah)–Centro (*Centrosema brasilianum* cv. Oolloo) pastures in a seasonally dry tropical environment. Animal Production Science, 2020, 60, 1459–1468 https://doi.org/10.1071/AN19327

2.3.3. Rotational grazing of gamba grass for control and improved cattle production.

Aim: To evaluate whether rotational grazing is effective in controlling the height and spread of gamba grass and improving the liveweight gain of cattle grazing it.

Personnel: T. Schatz, DDRF staff

Period: 2018 - 2021

Summary: Gamba grass (*Andropogon gayanus*) is an introduced perennial grass that is now a Weed of National Significance. It has spread through large areas of the northern NT. Intense gamba grass fuelled wildfires are a danger to animals, people, property and a threat to biodiversity. While unmanaged gamba grass is problematic, many graziers view it as a valuable pasture. However, effective grazing strategies to optimise cattle liveweight gain, and to minimise the threat of gamba grass spread, have not been evaluated.

A 180-ha gamba grass infested paddock at DDRF was subdivided into 5 smaller (20-38 ha) paddocks to enable rotational grazing. A mob of 360 cattle rotationally grazed the paddocks over the wet season months, with a grazing density ranging from 9.5 to 18.5 head/ha, and paddocks grazed for between 2 and 6 days. The paddocks were spelled during the dry season. Liveweight was recorded at the start and end of the grazing period over each of the four years to enable calculation of average daily gain (ADG).

The average ADG (0.63 kg/day) is better than what occurs when cattle are set stocked on gamba grass but is lower than from other more preferred pasture species. In each year, the gamba grass was kept short (< 1m) by rotational grazing and did not produce any seeds. Results demonstrated that rotational grazing controls gamba grass (limits its height, seed production and spread) and increases the growth rate of cattle grazing gamba grass, delivering a “win/win” for graziers and the environment. (Schatz, Heeb, & Marschall, 2023)

Further reading: T. Schatz, C. Heeb, and J. Marschall. (2023). Rotational grazing of gamba grass for control and improved cattle production. NBRUC Conference Proceedings, Darwin, NT, 22-25 August 2023. P31. f78d028b-0f2d-4a99-a59c-b43be7da5ac1.docx (live.com).

2.4. Animal Health

2.4.1. Observations on the impact of buffalo flies on liveweight gain of cattle in a cell grazing operation in the Douglas Daly region, NT.

Aim: To assess the impact of buffalo flies on cattle liveweight gain (LWG) between cell grazing and set stocked grazing management systems.

Personnel: T. Schatz

Period: 2009-10

Summary: There is little published information on the effect of stocking density on the impact of buffalo flies (*Haematobia irritans exigua*) on cattle growth. Within an experiment at the DDRF comparing the growth of cattle in cell grazing (CG) and set stocked (SS) management systems, it was observed that buffalo flies were affecting the behaviour of cattle more in the CG treatment. The experiment was conducted in a lattice of almost identical 6 Ha paddocks of buffel grass pasture. The stocking rate was 1.3 hd/ha in each of the SS paddocks and in the total area of CG treatment, however all 208 CG animals were only ever in 1 paddock at any time as they rotated around the 26 CG paddocks. Brahman weaner steers were randomly allocated (weight stratified) to the treatment paddocks in July and they remained in the experiment for a year. They were weighed at various times throughout the post weaning year. All cattle were fitted with insecticidal ear tags on 7 January 2010.

Analysis of data collected at several weighing dates showed that average liveweight change during the post weaning year was similar in both treatments except during the period from 26 November 2009 to 6 January 2010. During this period average liveweight change was 28 kg lower in the CG than the SS treatment. This difference was mostly maintained until the end of the post-weaning year when liveweight change was 23 kg lower in the CG treatment. These results suggest that buffalo fly control measures should be considered where cattle are at high densities eg. in cell grazing. (Schatz, 2011)

Further Reading: T. Schatz (2011) Observations on the impact of buffalo flies on liveweight gain of cattle in a cell grazing operation in the Douglas Daly region, NT. *Proceedings of the Northern Beef Research Update Conference*, 3 & 4 August 2011. Darwin NT. p. 143. ALEX NEW_P90.eps (nabrc.com.au)

2.4.2. Bopriva™ as an alternative to spaying cattle in northern Australia.

Aim: To evaluate the effectiveness of using Bopriva™ as a non-surgical method for spaying cows in northern Australia.

Personnel: T. Schatz, L. Taylor, P. Letchford and K. McCosker

Period: 2014-2015

Summary: Spaying is widely used in northern Australia to prevent pregnancy in cows that are intended to be fattened and sold after a wet season as bull control is often poor. However, there is a desire to develop non-surgical methods of preventing pregnancy for both production efficiency and animal welfare considerations. Bopriva™ is a vaccine that reduces the effect of Gonadotrophin Releasing Factor (GnRF) in both males and females by generating antibodies against GnRF. Two vaccinations are required to supress GnRF activity to a level that will prevent pregnancy.

Ninety non pregnant cull cows of various ages were weighed and allocated to either a Spay (spayed using the Willis dropped ovary technique) or Bopriva treatment (first injection) at DDRF on 1 Sep 2014 (day 0). Two (4.4%) of the Spay cows died following spaying. All cows were weighed and a second Bopriva™ injection given to the Bopriva cows 81 days later. Bulls were added to the cows at this time. Cows were weighed and pregnancy tested using real time ultrasound on day 206 and day 253 (12 May 2015) and date of conception was calculated from foetal age. One (2.2%) Bopriva cow was pregnant on day 206 and 14 (31%) were pregnant on day 253.

There were no significant differences between treatments in average weight over time. Economic analysis found that use of Bopriva™ to prevent pregnancy became more cost effective than spaying when mortality rates were above 2.1%. (Schatz, Taylor, Letchford, & McCosker, 2016).

Further Reading: T. Schatz, L. Taylor, P. Letchford and K. McCosker (2016) Bopriva as an alternative to spaying cattle in northern Australia. Proceedings, Northern Beef Research Update Conference, 2016. p110. 698596_2c8848c0ffe9435a97dec33ba377ca28.pdf (nabrc.com.au)

2.4.3. Do insecticidal fly tags protect against three-day sickness?

Aim: To investigate the effectiveness of insecticidal ear tags at preventing young bulls from becoming infected with BEF through repelling the insects that spread the disease.

Personnel: T. Schatz, A. Feez, M. Hearnden and C. Heeb

Period: 2017-2018

Summary: Bovine Ephemeral Fever (BEF) or Three-Day sickness is a viral disease that occurs commonly in cattle in northern Australia and is spread by mosquitoes and biting midges. On 15/11/17, one year old Brahman and Brahman cross bulls were allocated to either a Control or Tagged treatment group at DDRF. The Control group did not receive any treatment for fly control while Tagged animals were each fitted with 2 Python® fly tags on 15/11/17, then replaced with a single Maxima® tag on 28/2/18. The two treatment groups grazed in separate paddocks approximately three kilometres apart. Blood samples were collected from all animals on 15/11/17 and again at 4, 9, 15 and 22.9 weeks and BEF virus neutralisation test (VNT) results were used to determine which animals had been infected (seroconverted).

After 15 weeks the infection rate in Control (41%) was higher than in Tagged (20%). After 22.9 weeks the infection rate was higher in Control (49%) than in Tagged (25%). The fly tags were observed to be effective in repelling buffalo flies from the cattle during the study (pers. obs.). Although this resulted in a significant reduction in BEF infection, the fact that almost a quarter of Tagged animals became infected means that they were not completely effective in repelling the main vectors of BEF transmission. Therefore they cannot be recommended as a preventative measure against BEF as there is a chance that important animals (eg. bulls in single sire mating groups) may become infected despite being tagged. The reduction in infection rate in TAGGED animals may have benefits such as higher liveweight gain, but this was not investigated in this trial due to differences between the paddocks in which the treatments grazed. (Schatz, Feez, Hearnden, & Heeb, 2019).

Further Reading: T. Schatz, A. Feez, M. Hearnden and C. Heeb (2019) Do insecticidal fly tags protect against three day sickness? 2019 NBRUC Conference Proceedings No. 201. P.37. 698596_2787d3204033487ca4842dee02644995.pdf (nabrc.com.au)

2.4.4. The effect of insecticidal fly tags on cattle liveweight gain in the Douglas Daly region.

Aim: To determine the effect of a new type of insecticidal fly tag (development tag number YT1625) on cattle liveweight gain (LWG).

Personnel: T. Schatz, A. Feez and C. Heeb.

Period: 2018-19

Summary: Buffalo flies (*Haematobia irritans exigua*) can cause irritation to cattle resulting in reduced growth, and the response to control measures in northern Australia can be variable. An experiment was conducted at DDRF to evaluate a sustained-release, plastic ear tag containing a synergized formulation of Zetacypermethrin, and Abamectin, which have not previously been used in combination on cattle. One-year-old Brahman and Brahman cross bulls were weighed and randomly allocated (stratified for

weight) to either a Control (n=59, no fly control treatment) or Tagged (n=59, fitted with 2 fly tags) treatment group.

After 16.1 weeks and the extended 25.1 week period, the average LWG of Tagged was 9.8 kg (0.085 kg/day) and 16.7 kg (0.095 kg/day) more than Control respectively. This was similar to reported results of repeated spraying with insecticide, and less than results reported from using diazanon ear tags. The LWG of 16.7 kg found in this study was worth $48.43/head at the cattle price at the time of $2.90/kg. The cost of the fly tags was $7/head, providing a return on investment from the TAGGED treatment of 692% assuming that the difference in weight gain persisted through to the time of sale. (Schatz, Feez, Hearnden, & Heeb, 2019).

Further Reading: T. Schatz, A. Feez, M. Hearnden, and C. Heeb (2019) The effect of insecticidal fly tags on cattle liveweight gain in the Douglas Daly region, NT. *NBRUC Conference Proceedings* No. 200. P36. 698596_2787d3204033487ca4842dee02644995.pdf (nabrc.com.au)

2.4.5. Long term effects of coccidiosis infection and treatment on cattle growth.

Aim: To investigate the effect of different levels of coccidiosis infection and treatment for coccidiosis on subsequent growth of weaners.

Personnel: T. Schatz, J. Marschall

Period: 2021-22

Summary: Coccidiosis is a disease caused by protozoan parasites (*Eimeria* spp.) that can cause scouring in calves at weaning, a stressful time which reduces resistance to coccidiosis infection. In May 2021, weaners that had been transported by road train to the DDRF from a site near Katherine, NT, immediately after being weaned, were exhibiting signs of coccidiosis infection. On 24/5/21 the male Brahman weaners were individually assessed in a veterinary crush and drafted into three groups: Not effected (N) (n=33), Mildly effected (M) (n=73), and Severely effected (S) (n=35). The groups were kept in separate similar buffel grass paddocks for 40 days where they received the following treatments: N: Rumevite Boost with Rumensin™ supplement blocks, M: Laucke Beef weaner pellets™ and, S: Drenched with Baycox™ on 24/5/21 and Laucke Beef weaner pellets™. The liveweight gain of the groups from 24/5/21 until 15/12/22 was compared.

The mean weight of the S group was lightest (136 kg) when the severity of coccidiosis infection was assessed in 2021, compared to N (147 kg) and M (155 kg). This is not surprising, as lighter (younger) weaners are more prone to coccidiosis infection since their immune systems are less developed and they are more likely to be stressed by weaning (which lowers their resistance to coccidiosis). There were no differences in mean growth between the groups over the trial period (N= 154 kg, M = 149 kg, S = 151 kg), despite one S animal having much lower growth (60 kg) than all the others. This indicated that the treatments for coccidiosis were effective and suggested that short term, treated, coccidiosis infection does not negatively impact long term growth. The effect of longer term, untreated coccidiosis infection was not studied, as all affected animals were treated in this study. (Schatz, Hearnden, & Marschall, 2023)

Further Reading: T. Schatz, M. Hearnden and J. Marschall (2023) Long term effects of coccidiosis infection and treatment on cattle growth. 2023 NBRUC Conference Proceedings, Darwin, NT, 22-25 August 2023.P98 fca8d951-f575-42e9-940a-44f58e501942.docx (live.com)

2.4.6. Live-weight Losses in Young Cattle during Transport

Aim: To determine live-weight losses in young cattle during commercial transport and the effect of trailer position.

Personnel: K. McCosker, S. Thomas, C. Heeb, DDRF staff

Period: 2016, 2017, 2018

Summary: Live-weight (LWT) changes were recorded in three cohorts of weaners that were transported from Victoria River Research Station (VRS) to DDRF. LWT losses in transported animals were calculated by comparing them with weights taken about 12 hours before transport (BTLW). The changes in LWT were similar in 2016 and 2018 when weights were taken soon after disembarkation (-8.9%, and -9.2% respectively). However, when initial LWTs were compared with those taken after a 12-hour access to feed and water, the loss was only 5.6%. These results indicate that animals require more than 12 hours to fully regain the weight lost during transport.

Results showed a strong positive association between BTLW and LWT losses in all years. However, a similar association did not exist between the percentage LWT loss and BTLW, suggesting that LWT loss as a percentage of the BTLW is similar within the range of weights observed in this study. Trailer number and deck level were independent of LWT losses, except in 2018, when a significant association was found between LWT losses and the top deck of the middle trailer, which cannot be easily explained. (NT Government, 2018).

Further reading: Primary Industries Annual Research Achievements Report 2017-18. Department of Primary Industry and Resources. P19-20. Technical Bulletin No. 358 (NT Government, 2018) DPIR Annual Research Achievement Report 2017-2018

2.4.7. Sentinel Herd

Aim: To use sentinel cattle herds to identify any new arboviruses through the National Arbovirus Monitoring Program (NAMP).

Personnel: Virology team including L. Melville and N. Hunt

Period: Ongoing

Summary: The sentinel herd was established at DDRF in 1984. These animals are are bled monthly and the insects on the animals collected. Light traps are used to collect insects from the surrounding environment for identification. The sentinel herd will continue to play a vital role in biosecurity risk management protocols.

3. Other

This section presents projects that do not traditionally sit under the Plant Industries or Animal Industries banner. However, they contribute in some way to addressing knowledge gaps in the overall agricultural industries in the Douglas Daly region.

3.1. The Feasibility of Commercially Harvesting Agile Wallabies in the NT.

Aim: To investigate the feasibility of a game meat business based on wallabies to provide economic development as well as to mitigate their impact as pests on agricultural production in the Top End of the NT.

Personnel: W. Hunt, C. Heeb, B. Beumer and D. Frost.

Collaborators: UNE, RIRDC, NTG-DLRM, Dan and Sarah Thompson (Ceres Downs), Joe and Catherine Scottney (Garibaldi), Phillip and Annette Howie (Maneroo), Chris and Amanda Howie (Bundaroo Station), Rohan and Sally Sullivan (Cave Creek Station).

Period: 2016, 2017, 2018

Summary: Wallabies are found in large numbers in the Douglas Daly District, supported by year-round available surface water and improved pastures. This project investigated the feasibility of commercially harvesting Agile wallabies, including wallaby carcass yield, meat quality and meat safety. The project also explored options of other wildlife species for meat production, such as feral pigs (*Sus scrofa*) and magpie geese (*Anseranas semipalmata*).

Mean weights of male and female harvested wallabies were 16.2 and 10.4 kg, respectively. Dressing percentage was not affected by either sex or harvesting period; it ranged between 69.5% and 71.5% across three harvesting periods. Wallaby muscle displayed a relatively higher proteolysis and tenderisation post-mortem, with a relatively modest aging response during longer storage. Meat tenderness in the loins and topside was comparable with that of high value cuts of lamb and beef but was superior to kangaroo meat. The harvesting season and carcass suspension affected wallaby meat quality.

An initial desktop analysis indicated that profitable harvesting of feral pigs and magpie geese may be possible. There is a need for market access, resource access (i.e. particular sites where animals can be harvested), supply chain integrity and engagement of established and credible game harvesters with suitable equipment. Harvesting agile wallabies was a marginal economic proposition for the shooter/game harvester at the time of the study.

Further Reading: NT Government (2016). Primary Industries Annual Research Achievements Report 2015-16 Technical Bulletin No: 355. P83. Primary Industries Annual Research Achievements Report 2015-16

NT Government (2018). Primary Industries Annual Research Achievements Report 2017-18. Technical Bulletin No. 358. P60-61. DPIR Annual Research Achievement Report 2017-2018

W. Hunt, J. Mullen, G. Geesink, A. Van den Heuvel & M. Bedoya-Perez (2018). The feasibility of commercially harvesting Agile Wallabies in the Northern Territory. AgriFutures Australia Publication No 18/052. 74pp. https://agrifutures.com.au/wp-content/uploads/2018/12/18-052.pdf (Hunt, Mullen, Geesink, Van den Heuvel, & Bedoya-Perez, 2018)

3.2. Effects of agricultural management on soil carbon and pH in the Douglas Daly region

Aim: To provide information on the effects of agricultural practices on soil pH and soil carbon (C) from three long-term agricultural trials in the Douglas Daly region of the NT.

Personnel: S. Bithell, P. Shotton, M. Hearnden

Period: Long-term

Summary: The effects of agricultural practices on soil pH and soil carbon (C) from three long-term agricultural trials were compiled and evaluated if these measurements were suitable for use as agricultural soil quality indicators for agricultural land in the NT. The three trials were the Pasture Species Evaluation under Grazing Trial (comparison of tropical pasture species on beef production; the

ROTGUT Trial (rotation of tropical grains under different tillage); and the Ley Farming Systems Trial (mixed cropping rotations with differing ley pasture species and grazing intensities).

The Rotgut trial showed that cropping sorghum for successive seasons lowered oxidizable C. In contrast, one Cavalcade-based ley rotation showed increased oxidizable C concentrations. However, both the Pasture Species Trial and the Farming Systems Trial showed large annual fluxes in soil oxidizable C concentrations with most treatments having neither sustained increases nor decreases. In both the Rotgut and Farming Systems Trials, there was evidence of significant soil acidification, but not in the Pasture Species Trial. Supplementary urea application (70 and 140 kg/ha) increased soil acidification in the Rotgut tillage practices trial. Key practices and factors that affected both soil pH and soil C were nitrogenous fertilisers, soil type, sampling depth, measurement methods, the type of agricultural system and seasonal variability (Bithell, Shotton, & Hearnden, 2013).

Further Reading: S. Bithell, P. Shotton, & M. Hearnden (2013). Effects of agricultural management on soil carbon and pH in the Douglas Daly region of the Northern Territory. Technical Bulletin No. 343. Northern Territory Government 108 pp. Microsoft Word - TB343.docx (nt.gov.au).

3.3. Soil Carbon sequestration on cell-grazing buffel grass pasture

Aim: To determine the effect of a cell grazing management system for cattle grazing on improved pastures at DDRF on soil carbon sequestration. This was in conjunction with cattle productivity (discussed in previous section Comparison of cell grazing versus constant grazing on buffel grass).

Personnel: T. Schatz, D. Ffoulkes, P. Shotton, M. Hearnden

Period: 2009-2014

Summary: In each year of this 9-year study, a cohort of Brahman and Brahman-cross weaners was randomly allocated to IRG (cell grazing) and CG (constant grazing) treatments. They grazed predominantly buffel pasture at DDRF from shortly after weaning for about a year, at which time they were replaced by the next year's group, and the average liveweight gains of the treatments over the post-weaning year were compared each year for 9 years. Soil organic carbon was measured in the topsoil (0-30 cm) twice each year for 5 years (2009 - 14) and changes in carbon stocks over time were compared between treatments. Topsoil soil organic carbon stocks did not increase in the IRG treatment over the 5 years of this study. However, the findings of this study may not apply to other pasture systems and environments.

Further Reading: T. Schatz, D. Ffoulkes, P. Shotton, and M. Hearnden. (2020) Effect of high-intensity rotational grazing on the growth of cattle grazing buffel pasture in the Northern Territory and on soil carbon sequestration: Animal Production Science 2020. 60(15):1814-1821. https://doi.org/10.1071/AN19552

3.4. The effects of a moratorium on land-clearing in the Douglas-Daly region

Aim: To use historical remotely sensed data to assess the effectiveness of a land-clearing moratorium in the Douglas-Daly river catchment.

Personnel: Non-NTG

Collaborators: RIEL

Period: Long-term

Summary: The Northern Territory government promulgated a moratorium on the clearing of native vegetation on freehold land in the Douglas-Daly river catchment in 2003. The moratorium was intended to limit the rate and extent of land-clearing for a period of time so that informed policy could be concurrently developed to guide future land-clearing and minimise negative impacts. Remotely sensed data (1977-2011) were used to explore the effectiveness of the moratorium. The analysis shows that, during moratorium years (2002-2009), clearing rates accelerated rather than slowed in the moratorium area and was mostly (81%) conducted without the required permits. The moratorium failed because it was not formally legislated and was too broadly defined. It was concluded that effective policy is only as good as its level of implementation (Lawes M. J., 2015).

This work was not conducted on DDRF but had implications on agricultural development on commercial properties in the Douglas-Daly District. This had associated implications on resourcing for research into intensive pasture and crop production.

Further Reading: Lawes M. J., Greiner R., Leiper I. A., Ninnis R., Pearson D., Boggs G. (2015) The effects of a moratorium on land-clearing in the Douglas-Daly region, Northern Territory, Australia. The Rangeland Journal 37, 399-408. https://doi.org/10.1071/RJ15014

4. Field days

Field days are a vital platform from which results from research trials are demonstrated and disseminated to a range of stakeholders, from local producers to agribusiness. They are a tool to help validate the relevance of the research, as well as provide impetus for continued input and direction for future research trials. Literature associated with a field day is obviously a valuable resource for the day, but also provides a valuable historical reference, especially in the absence of more formal technical reporting formats (i.e. Annual Research Achievements Reports).

The sections below present some of the information available from field days conducted in 2017, 2019, 2021 and 2023. They reiterate information presented in the project descriptions above of the work conducted at DDRF since 2010.

DDRF Field Day 31st August 2017

“Attendees of the field day were next treated to a tour of the Douglas Daly Research Farm facilities where DPIR research scientists summarized results and observations from the **Cell Grazing trial** and learnings found when establishing **Leucaena under centre pivot irrigation**.

Peter Shotton, Research Officer, Douglas Daly Research Farm, answered many questions from field day attendees regarding the challenges of establishing and grazing Leucaena. “One of the main issues is growing enough **palatable grass during the dry season**”. Currently the Jarra grass grows well during the wet season providing high yielding palatable feed however, under irrigation during the dry season it grows very slowly. The Fine cut Rhodes grass grows well year-round, however the grass does not appear to be very palatable to the grazing stock. The Leucaena grows well year-round so one of the biggest challenges we have is having enough grass pasture available with the Leucaena to maximize beef production. To address this issue, we are currently opening up additional non-irrigated areas to allow the animals to get the roughage they need but the solution would be to have a better dual purpose tropical grass for both wet and dry season growth which we are currently looking into. Young growing heifers have been used to graze the pasture over the last 2 years and although live weight gains have been generally good, the Leucaena seems to be growing taller than the heifers can browse or push over resulting in the Leucaena hedge growing too tall which will require mechanical pruning. An alternative grazing strategy to mitigate this challenge would be to graze or include mature animals such as heavier steers or cows to browse and push over the taller bush.

Arthur Cameron, Principal Pasture Scientist, Berrimah Farm, was able to provide a summary of improved pasture research that has occurred locally over the last 20 years. "The trouble is," Arthur said, "that each of the species we have looked into so far have been found lacking in more than one area. Some pastures produce a lot of bulk in terms of kilograms per hectare of dry matter during the dry season, but are relatively unpalatable to cattle (such as Fine Cut Rhodes), and others are lacking in the former, making consistent grazing pressure during the year impossible, including under irrigation. I believe we haven't found the ideal pasture species for grazing in tropical to subtropical northern Australia yet. The search continues."

DDRF Field Day 4th April 2023

Around 55 producers, industry representatives, NTG researchers and extension staff came together on the 4th of April at Douglas Daly Research Farm (DDRF) for a field day centred around sustainability, integration of mixed farming in the northern beef industry, and to hear research updates. Projects discussed included:

Rotational cropping potential investigated

Entomology a major focus due to Fall army worm burden

Local producers discuss trials and tribulations of dryland cotton management

Rotationally grazing gamba a win-win tool for previously unproductive land

"Crops for Cattle"— analysing benefits of supplementary feeding

Buffalo fly tag trials prove effective in comparison to control group

Leucaena proving a unique and hardy grazing forage

Select herds targeting high fertility to increase production

Combatting low fertility through increased EBV accuracies

Producer engagement key to industry future

Sourced from: DDRF Field day recap - FutureBeef

Conclusion

Douglas Daly Research Farm (DDRF) has been an essential resource to support the development and progression of the northern agricultural industry in the Top End of the Northern Territory (NT) since the 1960's. It should continue to play a major role in enabling research for industry to address knowledge gaps. Collation of the work conducted at this Research Farm, as well as the others under the remit of the NT Government, is essential. This is especially critical without formal publicly available annual technical or research reporting requirements for activities which are not published in peer-reviewed papers or reports. This ensures outcomes of research projects are available to stakeholders and helps identify knowledge gaps to inform future research activities, while avoiding duplication of work. This overview supports the published papers from Agency researchers, as well as non-published literature which may otherwise be difficult to locate through on-line search platforms. There should also be increased onus or opportunities for researchers to ensure results from their work is available to stakeholders, such as through Industry Conference proceedings or publicly available reports to funding bodies.

There is increasing industry demand for diversification, intensification and integration of agricultural industries in the Douglas-Daly region, enabled by the soils and climate conducive to a range of crops, pastures and cattle production. This is reflected in the Plant and Animal Industry research projects conducted at DDRF since 2010 until current (2024).

The increased emphasis within irrigated farming systems on water use efficiency practices and reducing environmental impacts of ineffective water use, is necessary from a cost effectiveness perspective as well as perceptions of social licence for agricultural development. The decline in the availability of resources for irrigation research at DDRF since 2020 is likely to be of some concern to local stakeholders. There appears to be ongoing demand from the Douglas-Daly agricultural industry to identify an environmentally and economically sustainable irrigated farming system to best avail of their Water Extraction Licences.

The dryland cropping and grazing research which have been long-term plant industry cornerstones of DDRF have been relatively limited since 2010 compared to previous decades. This may be justified, with continuing attempts at large scale grain crops being largely unsuccessful, so there may be minimal industry drivers for continuing research. However, the resurgent interest in dryland cotton production has provided impetus for research to support such an industry. There have been a number of agronomic issues, which resulted in issue-specific projects, such as mulch management and planter configuration. The demand for issue-specific agronomy research is likely to be ongoing. A sustainable cotton farming rotation system needs to be developed. DDRF should be a major resource to enable addressing this knowledge gap, supported by industry and other agencies such as CSIRO, CDU and the current over-arching CRCNA.

Wildlife can be a constraint to achieving sustainable crop yields. A study was conducted on the feasibility of harvesting wallabies in the Douglas-Daly region, and options for other wildlife including magpie geese. Magpie geese are emerging as a significant threat to the establishment and yield of crops and pastures in the Douglas Daly. These were not historically at high numbers in the region, but populations have increased significantly so further work is required.

The 'Crops for Cattle' project within the CRCNA Cotton/Crops/Cattle Program may have significant synergies with the Douglas-Daly farming systems – probably more than any other cattle producing region in the NT. Although DDRF is not one of the sites for this project, modelling using the project results should help inform opportunities for integration of crops and cattle in the Douglas-Daly.

The evolution of the 'Selected Brahman' and the 'Crossbred' projects to the Repronomics Projects (I and II) to more specifically assess fertility traits for enhanced accuracy of EBVs is using advances in technology to improve industry beef herd standards. The crossbred work which has a focus on

selection of traits for market diversification, is likely to be of increasing importance over the next decade as cattle market options change.

The much-enhanced focus on Biosecurity is essential. Resources are increasingly being directed towards minimising this threat, such as conducting Emergency Response Scenarios, treating incursions, or negotiating with trading partners regarding risk (e.g. Lumpy skin). DDRF could play a major role as a 'Control Centre' in the case of a northern Australia disease incursion.

The 'Carbon Economy' and 'Zero Net Emissions' is a current and future driver of agricultural practices. This provides opportunities for both Plant Industry and Animal Industry to develop projects aligned with the Carbon and Zero Emissions impetus. These include widely-ranging practices to improve soil health, incorporate legumes, reduce greenhouse gas emissions, or increase cattle productivity.

There is increasing research and extension being conducted by industry, commercial entities and collaborative organisations, external to NTG and NTG-managed research farms. These include NT Farmers Association, Territory Natural Resource Management (TNRM), the CSIRO (Commonwealth Scientific, Industry Research Organisation) and Charles Darwin University (CDU). The Cooperative Research Centre for Developing Northern Australia (CRCNA) is a significant example of a collaborative multi-agency program aiming to improve industry's economic and environmental sustainability. This is investing $75 million in Australian Government funding to support sciened based research and development in the north over 10 years: 2017 to 2027 (Home - Cooperative Research Centre for Developing Northern Australia (crcna.com.au).

The Northern Hub is one of eight national Drought Resilience Adoption and Innovation Hubs created as an initiative of the Future Drought Fund. The consortium of regional partners is committed to building the resilience and sustainable prosperity of rural industries and communities across the region through a range of projects (Home - Northern WA and Northern Territory Drought Resilience and Innovation Hub). The Zero Net Emissions from Agriculture CRC was announced at the end of 2023, with potential projects to be developed, and implications for agriculture in the NT (Home - Zero Net Emissions Agriculture CRC (zneagcrc.com.au).

This trend of industry-driven research, development and extension, and multi-agency collaboration, is continuing now and into the future. The NTG 2030 Agribusiness targets include 'lift the NT cattle herd productivity, expand the horticulture industry by doubling the area and encouraging new farmers, and increasing the area of broad acre cropping to 100,000 ha'. The DDRF should continue to strengthen relevance within NTG agencies, but also to expand relevance and availability across non-NTG agencies, and avail of external funding opportunities. There is opportunity for DDRF to be utilised as a significant resource to contribute to northern Australia development and resilience aspirations through targeted research and problem-solving of production issues, as identified through multi-agency collaboration.

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