9-1988

Proceedings of the Ninth Annual Joint Research Meeting CCNT / CSIRO / DPIF / WADA

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PROCEEDINGS

of the

NINTH ANNUAL JOINT RESEARCH MEETING
CCNT/CSIRO/DPIF/WADA

held at

FRANK J. WISE INSTITUTE OF TROPICAL AGRICULTURAL RESEARCH STATION
WESTERN AUSTRALIAN DEPARTMENT OF AGRICULTURE
KUNUNURRA WA

13-14 SEPTEMBER 1988

Compiled by

Ian T. Riley, WADA
PO Box 19, Kununurra WA 6743

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PROGRAMME
TUESDAY 13 SEPTEMBER

RESEARCH AND COMMERCIAL FIELD VISITS

0730 Depart Kimberley Court
0735 Hughes and Co. Essential Oil Production.
0810 Bruce Toohill Tree and vine crops, Sands Research Block.
0840 Dessert Seeds Small seed production.
0915 Wright Prospecting Cashew development.
0950 Joe Sherrard Maize, FWITAR
1005 Murray Blyth Chickpea, FWITAR
1020 Morning Tea, FWI Conference Room

SESSION 1 - OVERVIEW Chairman: Dr Ian Riley

1050 Dr Doug McGhie Western Australian Department of Agriculture.
1115 Mr Mike van Cuylenberg Conservation Commission, Northern Territory.
1140 Dr Bill Winter CSIRO Tropical Crops & Pastures.
1205 Mr John Sturtz Department of Primary Industries & Fisheries.
1230 Lunch, FWI Conference Room

SESSION 2 - MODELLING Chairman: Dr Bill Winter

1330 Dr Bob McCown An overview of a programme for developing a comprehensive crop yield simulation capacity for the tropics.
1345 Dr Peter Carberry Developing a family of crop models for SAT using the CERES framework.
1400 Mr John Dimes Development of a model of the N cycle of crop-pasture rotations in the semi-arid tropics.
1415 Dr Peter Carberry Visual/Interactive CERES models.
<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Topic</th>
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<tbody>
<tr>
<td>1430</td>
<td>Dr Ian Riley</td>
<td>The applicability of a Cercospora leaf spot simulation model to control of Cercospora in irrigated peanut crops.</td>
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<tr>
<td>1445</td>
<td>Discussion</td>
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<td>1500</td>
<td>Afternoon Tea, FWI Conference Room</td>
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<tr>
<td>1530</td>
<td>Mr Mohammed Dilshad</td>
<td>Preliminary results from the Croplands Erosion Research Project, (CERP).</td>
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<tr>
<td>1545</td>
<td>Mr Mike van Cuylenberg</td>
<td>Preliminary results from Crop Demonstration Trials, Douglas-Daly.</td>
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<td>1600</td>
<td>Dr Doug Abrecht</td>
<td>Progress in reducing the risk of poor emergence.</td>
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<tr>
<td>1615</td>
<td>Mr Neil Dalgleish</td>
<td>The effects of tillage system on soil physical characteristics and crop yield on a Fenton soil in the NT.</td>
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<tr>
<td>1630</td>
<td>Discussion</td>
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WEDNESDAY 14 SEPTEMBER

RESEARCH AND COMMERCIAL FIELD VISITS

0730  Depart Kimberley Court
0735  Cummings Bros.  Cucurbit and field crop production.
0810  Kimberley Milk  Tropical dairy farming.
0845  Torben Sass Nielsen  Field crop production.
0920  Ian Riley  Plantago ovata, FWITAR
0930  John Bonnardeaux  New Crops, Essential Oils, Fibre Crops, FWITAR.
0945  George Gardiner  Bananas, FWITAR.
1000  Morning Tea, FWI Conference Room

SESSION 4 - SUSTAINABLE SYSTEMS (Continued) Chairman: Mr John Sturtz

1030  Dr K Thiagalingam  Effect of tillage, rotation and nitrogen on the growth and nutrient uptake of maize and soybeans.
1045  Mr Chris Flint  Problems and potential of peanut production in the N.T.
1100  Mr Rob Bateman and  The effect of surface management on growth and yield of soybean.
   Mr John Berthelsen
1115  Mr Neville Gould  The effect of tillage, rotation and nitrogen on the emergence and establishment of soybeans from 1984-86.
1130  Mr Peter McFadden  Overview of entomology in the Ord River Irrigation Area.
1145  Mr Bob Shackles  Forage sorghum water management.
1200  Dr Joe Sherrard  Water management of maize in the ORIA.
1215  Discussion
1230  Lunch, FWI Conference Room
SESSION 5 - GENERAL

1330 Mr Rob Bateman
Cropping in the Douglas Daly - 6 years on.

1345 Mr Steve Yeates
Progress in the development of late maturing photoperiod sensitive mungbeans for the Northern Territory.

1400 Mr John Sturtz
Kenaf/Fibre investigations in the NT.

1415 Mr Yan Diczbalis
Effect of alternative herbicides and their time and rate of application on broadleaf (Ludwigia sp.) and sedge (Cyperus sp.) weeds and the growth and yield of rice.

1430 Mr Malcolm Bennett
Weed control in sesame.

1445 Discussion

1500 Afternoon Tea, FWI Conference Room

SESSION 6 - GENERAL (continued)

Chairman: Mr Peter McCosker

1530 Dr K Thiagalingam
Preliminary investigation of the presence of vesicular-arbuscular Mycorrhizae (VAM) in a heavy and a light Tippera soil.

1545 Mr John Bonnardeaux
Development of new crops for irrigated cropping in northern Western Australia

1600 Dr Ian Riley
Plantago ovata research and commercial developments.

1615 Dr George Gardiner
Banana yield estimation - dealing with management scale research.

1630 Mr Bruce Toohill
Evaluation of table grape production in the tropics.

1645 Dr Tony Done
Recent developments in grain sorghum breeding.

1700 Discussion

SESSION 7 - FUTURE CO-OPERATION

Chairman: Dr Doug McGhie

1715 Open Forum

1830 BBQ dinner, FWI Conference Room and grounds

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LIST OF PARTICIPANTS
Abrecht, Doug G., B.Rur.Sci., PhD

CSIRO Tropical Crops and Pastures
Research scientist
089 221711

Doug was appointed to CSIRO in 1985 and is currently working on cropping systems with particular interest in the influence of seedbed environment on seedling establishment in existing and new cropping systems in the semi-arid tropics. Doug studied the influence of temperature on the changes in the dormancy and germination of Snowgum seed in the context of regeneration of the species during his PhD. Before that he worked as an Agricultural Extension Officer with the Queensland Department of Primary Industries in the Brigalow country, west of Rockhampton, in Queensland.


Department Primary Industries and Fisheries
Senior Agronomist
089 221204

I joined the Department in November 1986 as Senior Agronomist, bringing wide and varied experience in government and industry employment. I initially worked as Research and Development Officer with a seed company, Wright Stephenson Co. for nine years. The position was based in Brisbane with extensive travel to tropical Australia and overseas advising on crops, pastures and property development. In 1986 I joined the Queensland DPI as a Research Soil Conservationist based at Kingaroy to develop conservative cropping systems. Following completion of this project I was transferred to Mareeba in 1984 to develop conservative farming systems for the Semi-Arid Tropics.

Bennett, Malcolm, B.Agr.Sc.

Department of Primary Industries and Fisheries
Agronomist - New Crops
089 721722

I worked in the mine reclamation area before joining the Department. Since then I have worked with peanut research at DDRF, and was involved in the new crops research (including sesame, pigeon pea and guar). At present I am developing an agronomic package for sesame.
Berthelsen, John, Q.D.A.
Department Primary Industries and Fisheries
Senior Technical Officer – DDRF
089 753442

Following completion of college in 1968 I joined the Queensland Department of Primary Industries. Experience with that organisation includes testing of alternative crops (guar, guayule, niger, lupin and safflower), involvement with the cotton breeding program and responsibility for the summer crop variety testing in Central Queensland. Since joining the Department in early 1988 my main interest has been in surface management research.

Western Australian Department of Agriculture
Research Officer New Crops
091 681166

Worked 10 years as an agricultural consultant in rural development projects and research projects in various countries of Africa and South East Asia. Joined WADA in April 1987. In charge of research programme aiming at introducing new crops in the ORIA.

Carberry, Peter S., B.Sc.Agri., PhD
CSIRO Tropical Crops & Pastures, Davies Laboratory
Experimental Scientist
077 719539

I was appointed to Townsville in May 1986 to work on crop simulation modelling including development of a model of a cereal with a leguminous intercrop. I submitted my PhD thesis in 1986 on "The development and construction of a simulation model of the growth of pearl millet (Pennisetum americanum (L.) Leekeke)" from the University of Sydney. As part of this PhD programme I spent two 6-month periods (1982,1983) at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India studying the physiology of pearl millet as affected by photoperiod, density and genotype. Currently working on adapting simulation models to predict crop yields in the semi-arid tropics.
Conservation Commission of the Northern Territory
Soil Conservationist
089 894443
Soil surface management in agriculture and the
identification of the major causes of erosion.

Dalgliesh, Neil, Q.D.A.
CSIRO Tropical Crops & Pastures
Senior Technical Officer
089 721488
Cropping systems etc. Particular interest in
long term effects of tillage on soil properties.

Department of Primary Industries and Fisheries
Agronomist Floodplain Cropping
089 221323
I was involved in crop physiology teaching at the
University of Queensland as a research assistant.
Later I worked with the Pigeon Pea programme at the
University of Queensland. At present I am in charge
of flood plain cropping research programme.

Dilshad, Mohammed, B.Sc., Dip.Nat.Res.
Conservation Commission of the Northern Territory
Scientist Grade 2
089 894569
Manage soil conservation research projects in the
Darwin Region, including control of staff and
finance, scheduling and direction of activities
and preparation of budgets. In liaison with project
manager, review and develop research tasks focusing
on high priority soil conservation needs in the
region. Report on progress and results of research
tasks and promote the utilisation of the research
results by industry. Train staff in soil
conservation research techniques.

CSIRO Katherine Research Station
Experimental Scientist
089 721488
Currently testing and adapting a simulation model of
soil nitrogen balance for use in the semi-arid
tropics in conjunction with a field research
programme on the effect on the mineral N supply to a
cereal crop by the previous crop rotation.
Done, Tony., B.Sc.(Hons), PhD

CSIRO Tropical Crops and Pastures
Plant Breeder
07 3770307/9

Tony joined CSIRO at the Kimberley Research Station in 1975 as grain sorghum breeder, and transferred to Darwin in 1981. Before that he worked on F1-hybrid wheat in the UK with a private company, and did his PhD on some aspects of F1-hybrid wheat breeding. Since graduating in 1968 he has undertaken working visits to Germany, France, Spain, USA, India, Nigeria and the Sudan.

Flint, Chris, B.Agr.Sc.

Department of Primary Industries and Fisheries
Grain Legume Agronomist
089 221323

After graduating from Melbourne University in 1977 I worked as dairy technologist, then potato agronomist in Victoria. I joined the Department in late 1981 as Peanut Agronomist. After a year overseas, I returned to the Department and over the last three seasons have continued applied research and farmer extension to the peanut industry. I am also researching some aspects of soybean agronomy particularly cultivars and seed production.

Gardiner, George, B.Sc., PhD

Western Australian Department of Agriculture
Research Officer - Horticulture
091 681166

Gould, Neville, B.E.(Agr.)

Department of Primary Industries and Fisheries
Agricultural Engineer
089 721722

Following completion of post-graduate studies in tractor performance at the University of Melbourne, I was appointed in the new agricultural engineering position within the Department in 1981, following an initial 18 month secondment to CSIRO in Katherine as part of multi-disciplinary team researching no-tillage system. I was then relocated to Darwin, where I have continued in this and other agricultural engineering endeavours.

McCosker, Peter F., H.D.A.

Western Australian Department of Agriculture Research Station Manager - Frank Wise Institute of Tropical Agricultural Research
091 681722

In the Ord River Irrigation Area since 1972 in various managerial capacities with CSIRO, Inghams Enterprises and WADA.

McCown, Bob, L., B.Sc., M.Sc., PhD

CSIRO Tropical Crops & Pastures, Davies Laboratory Principal Research Scientist
077 719564

Project Leader - evaluating cropping systems for the semi-arid tropics.

McFadden, Peter, B.Sc.(Hons)

Western Australian Department of Agriculture Entomologist
091 681166

I graduated from Murdoch University in 1980 where I majored in biology with emphasis on insect population regulation.

Two years of commercial fruit and vegetable production in the NT provided practical experience in tropical entomology. I joined the Department of Agriculture in late 1982 as a Research Technician developing control options for sheep blowfly, wingless grasshoppers and Sitona weevil.

Particular interests include population monitoring and forecasting of pest outbreaks and the application of novel control strategies.
McGhie, Doug, B.Sc.(Agric.) Hons., PhD

Western Australian Department of Agriculture
Kimberley Regional Manager
091 81166

Previous experience as a soil conservation adviser (4 years at Narrogin, in SW WA), followed by PhD studies and 4 years as research leader and research officer at Bunbury Regional Office of the WADA. Areas of research in that posting covered non wetting soils, soil acidity, irrigated pasture, raiingrown perennial pastures and the deterioration of pastures in summer rainfall events.

Appointed as OIC, Kununurra Regional Office, in November 1983 with responsibility for finance, staff and programme direction in the region. This position was renamed Regional Manager with similar but enhanced responsibilities in November 1987.

Riley, Ian T., B.Sc.Agr.(Hons), PhD

Western Australian Department of Agriculture
Legume Agronomist/Research Leader
091 681166

In late 1987 took up the position of Legume Agronomist/Research Leader at Kununurra. Research programme covers the legumes, chickpea, soybean and peanut and the pharmaceutical crop Plantago ovata. Research leadership function is to assist the Regional Manager in the co-ordination and implementation of cropping research in the Kimberley Region.

Shackles, Robert, F

Western Australian Department of Agriculture
Assistant Research Station Manager, Frank Wise Institute of Tropical Agricultural Research.
091 681722

In April 1982 I transferred to Kununurra and worked initially for Jon Warren in the cereals section and subsequently Joe Sherrard. Took up current position in early 1988.
Sherrard, Joe H., B.Agric.Sc.(Hons), PhD

Western Australian Department of Agriculture
Research Officer, Water Management and Cereals
programme
091 681166

Following completion of PhD studies on nitrogen
metabolism of wheat plants, postdoctoral studies at
the Univ. of Illinois included both field and tissue
culture work relating to nitrogen metabolism as a
basis for plant breeding in maize and soybean.

In 1984 I was appointed to the Kununurra Regional
Office as Research Officer to work on the Rice
Research Programme, and later the Cereals and Water
Management Programmes. The agronomy of maize and
forage have been researched and irrigation
scheduling programmes are now being developed for a
range of field and horticultural crops including
maize, forage sorghum, bananas, chickpea, soybean
and groundnut.

Sturtz, John, B.Agr.Sc.

Department of Primary Industries and Fisheries
Director, Crops
089 894267

After graduating from Melbourne University in 1961,
I joined the Agriculture Branch NTA as agronomist at
Berrimah working on pasture and horticulture
research and extension. From the mid 1960's to the
mid 1970's I was engaged in pastures and animal
production research and extension with Animal
Production Section with minor work on crops.

In 1974 I transferred back to the Agriculture Branch
as Chief Agronomist supervising Crops, Horticulture,
Weeds and Pastures work throughout the Territory.
Between 1987-1988 I was been in charge of Crops
Section and been directly involved in kenaf
research. At present I am the Assistant Secretary
responsible for Plant Industry Division activities
throughout the NT.
Thiagalingam, K., B.Sc.(Hons.), M.S., PhD

Department of Primary Industries and Fisheries
Crop Nutrition Agronomist
089 221314

Lecturer in Soil Science, University of Penang (1971-77); Lecturer/Senior Lecturer in Soil Science and Agronomy, Department of Agriculture, University of Papua New Guinea (1978-85), Crop Nutrition Agronomist, Darwin (1986-present). Major areas of research: Soil management with emphasis on tillage, soil fertility and plant nutrition in broadacre and small holder farming systems. Research on nitrogen transformation, liming, utilisation of agricultural and industrial wastes for crop production. Phosphorus, nitrogen and potassium studies on tropical soils with rice, maize, sorghum, soybeans, winged bean and sweet potato.

Toohill, Bruce, B.Agr.Sc.

Department of Agriculture
Research Officer
091 681166

Completed B.Agr.Sci at La Trobe University, Victoria in March 1976. Commenced employment with CSIRO Div. of Horticultural Research in March 1976 in tropical horticulture programme at Mildura, Victoria on a 3 year contract. Transferred to Darwin Laboratories December 1976 to develop experimental plantings of wide range of tree fruits and to collect data on these and plantings at Kimberley Research Station, W.A. Contract extended 12 months.

Resigned July 1979 and took up position with Office of Regional Administration & the North West, Premiers Department, W.A. government service, based at Broome WA. Responsible for horticultural programme north of Carnarvon, which W.A. Dept. Agriculture did not serve. Continued tree fruits introduction and evaluation; responsible for nursery production of ornamental and fruit plants at Broome and Karratha, provided horticultural extension service and oversaw operations of two farms in West Kimberley with field training component.

Transferred to W.A. Dept. Agriculture October 1982, and began developing tree crops programme at the ORIA. Moved to Kununurra in January 1984. First plantings by the Department at the ORIA occurred July 1983. Priority crops are mangoes and cashews, with a minor programme encompassing table grape evaluation and the introduction and assessment of a wide range of tropical tree fruits. Provide extension service to Kimberley region.
Wigston, Sue., B.Sc.(Hons), Masters in Advanced Ecology

Conservation Commission of the NT
Science Officer II
089 894443

Science Officer II in the Land Resource Survey and Evaluation sector of the Conservation Commission of the Northern Territory. Working on the Alligator River Region soil monitoring programme. 1987 to date.

PhD programme in the process of being developed, but is broadly based upon the effect of excessive ammonium sulphate applications on native woodland vegetation in an area of Arnham Land Northern Territory.

Winter, Bill H., B.Agr.Sc., PhD

CSIRO Tropical Crops and Pastures
OIC - North West, Principal Research Scientist
089 221711

Project Leader, managing grasslands in N.W. Australia.

Yeates, Steve, B.Sc.Agr.

Department of Primary Industries and Fisheries
District Agronomist, Katherine
089 721722

I worked with the hybrid seed industry (soybean, maize, sunflowers) in Queensland and NSW, after my graduation. I also worked with tropical crops in the African SAT (Sudan). Before joining the Department I worked with agro-chemical industry in the NSW and Vic. At present I am the district agronomist responsible for crops research in the Katherine area.
ABSTRACTS
Overview of WADA involvement in cropping in the Kimberley

McGhie, D.A.
WADA

Introduction

The development of any form of cropping in northern Australia is basically related to the availability of resources for cropping. In the Ord River Irrigation Area these comprise:

a) the water resource of the main dam and the diversion dam.

b) irrigable land developed on the Ivanhoe and Packsaddle Plains. Land comprises several broad soil types of which Cununurra clay, Cockatoo sand, Ord sandy loam and their variations provide the basic types.

c) climatic influences of temperature, rainfall, humidity expressed as a wet and dry season.

These resources have long been recognised and possible industries have been based on research into various crops, both temperate and tropical. At times there has been Government influence through promotion of particular industries or by the provision of subsidies for some crops. This tended to restrict the development of a free market approach, and certainly did not encourage growers to be actively involved in the determination of which crops could be marketed and grown.

Historically cropping on the Ord was dominated by key crops (cotton, grain sorghum, sunflower) and all of these required some government support to survive as major enterprises. Since the removal of all forms of government support in 1985 agriculture on the Ord is totally market responsive and it is against that background that the Department of Agriculture must provide its services of:

* Research
* Advice
* Regulation

All must be commercially relevant.

Research

Assisted in the setting of priorities by farmer advisory committees market assessment determines the suitability of a crop.

Market assessment is determined by the key factors of:

* The location of the Ord and associated transport costs
* The timing and size of available market
This assessment has determined the development and maintenance of some crops, as well as the suggestion of possible new crops.

Advice

Servicing the expanding base of commercial crops, comprising field crops, horticultural and animal enterprise components. This is an important and increasingly demanding role for professional and technical staff.

Regulation

The crop protection role becomes increasingly important as industries establish and that is demonstrated by the establishment of a border quarantine checkpoint during this financial year.

A new factor in our relationship with farmers is the introduction of charges for service. Only particular services will be subject to the charges. Normal advisory and research services will remain free. Charges are directed at a series of duties which are either regulatory or could be provided by private enterprise. This will provide an interesting influence on a relationship that is critical to the preservation of our client relevance.

Internal Influences on Kununurra Staff and Programmes

Activities at Kununurra are strongly influenced by internal departmental policies. The main one of these is the CRF expenditure allocation as only limited external funds have been accessible by Kununurra programmes. New initiatives have been successful in attracting industry and special funds but the base crops such as maize, chickpea, soybeans, peanuts, and horticultural crops either have no industry funding basis, or are too small to support a research fund.

Staff numbers are also determined by central influences and although there is currently a policy of increasing regionalisation this has mainly related to centres in the south-west. All projected staff movement to support irrigated cropping on the Ord is dependent on our local ability to obtain external funding for the new positions.

Recent comments by the Director-General suggest that the staff and funding base of the Frank Wise Institute of Tropical Agricultural Research is, for the present time, stable.

The establishment of seven regions within the state and the appointment of a Regional Manager for each region should improve the transfer of information to the central cost and control centre. Mechanisms for the function of the Regional Managers are still developing but the major thrust of regionalisation lies with the key southern
agricultural regions. The acceptance of the northern potential is still limited and given the present value of production in the north this is understandable.

Local Operations

Locally the agricultural industries are serviced by seven independent teams which operate under limited direction within the guidelines provided by:

* Commercial relevance
* Financial and staff restrictions with increasing accountability
* Peer review

Within the various constraints presented above there is still a regular attempt to guarantee that our isolated staff can obtain regular contact with their research peers from around Australia, and even overseas. All research staff have regular travel within Australia available to them. The annual meetings with our Northern Territory colleagues are an important part of the network of contacts all research and advisory staff need. The opportunity to involve both professional and technical staff in these meetings is particularly important. Importantly while final approval for any interstate travel (apart from the NT) lies with the Minister. The priority for travel is largely locally determined.

Because of the history of the Ord River Irrigation Area communication of the progress of the area is critical for the area and the Department. Although demanding, the agricultural "tourist" is important and must be considered so. Some ability to discern the level of importance must be developed. All research and advisory staff are affected by this.

Communication with Perth based administrators or politicians is another important role for the same staff.

Against the above background I consider it possible to have a productive and active research and advisory team at Kununurra. Increasing commercial activity is welcomed by all who hear of the changes. The difficulty lies with the history of the area and it is important for those who are best placed to ensure the changing history is recorded to do just that. For regionally based research staff this will take many forms and will involve diverse forums. Scientific and popular press and meetings are components. This is but one of the challenges confronting us.

Importantly a commitment to maintaining the present level of staff and funding support has been given. Demands will not lessen but a team of sufficient size and flexibility will maintain our desired productivity.
CSIRO has been actively involved in dryland crop research for the semi-arid tropics for over 40 years. The effort on pasture and animal production research is about 10 years younger.

Much of the earlier crop research concentrated on definition of the climate, the physical and chemical properties of the soils, the identification of suitable arable crops and the cultural practices necessary for successful productivity. In the past 10 years the emphasis has been upon the development of a sustainable cropping system which integrates cropping with livestock production, the use of legumes to provide at least some of the nitrogen requirements of grain crops and the development of reduced tillage practices. This effort has been accompanied by research designed to identify the environmental and genetic limitations to crop yield. Inevitably the integration of information from this research has led to the development of models of crop production, and this topic will be discussed by Dr McCown and others in the second session.

CSIRO will substantially reduce its effort on crop research during the next 2 years for a number of reasons. We believe that the grain industry in the north west can only expand to the stage of reaching self-sufficiency, and this market is small by standards in other parts of Australia. Research and recent practical experience has indicated that crop production in this region is a very risky enterprise. We have enough information to be able to define the degree of risk and are in the process of documenting this information so that others can make value-judgements as to whether crop production will be encouraged or not.

Pasture research saw an early emphasis on the phenology, growth, and nutritive value of the native tropical tall grass pastures. When the severe limitations of this resource were identified the emphasis was shifted to the culture of intensive systems using improved pastures and forage crops. More recent work has concentrated upon the augmentation of the native pastures with legumes, and development of techniques for better use of the native pastures. It is planned that this work will be continued and expanded, with a particular emphasis upon the development of sustainable and profitable systems of land use.
Overview - Department of Primary Industry and Fisheries

Crops Research

The DPIF crops research programme is primarily concerned with identifying, researching and promoting suitable, viable crops and cropping systems for various parts of the northern areas:

1. Flood plains of upper Adelaide River
   (with annual rainfall of 1200-1500 mm)
2. Rainfed cropping of the Douglas-Daly area
   (with annual rainfall of about 1200 mm)
3. Rainfed cropping of the Katherine area
   (with an annual rainfall of 600-900 mm)

The crops research can be grouped into:

1. Flood plain cropping system programme covering rice, soybeans and pasture legumes
2. Tillage research programme
3. Cropping system programme for rainfed areas
4. Grain legume research programme
5. Maize breeding programme (in conjunction with QDPI)
6. Crop nutrition programme
7. Weed control programme
8. New crops research programme, including sesame, guar, pigeon pea.
9. Mungbean breeding programme (in conjunction with CSIRO)
10. Seeds research programme

With the inclusion of commodity specialist research (such as rice, grain legumes, mungbeans, etc.) interacting with disciplines oriented research (eg. tillage research, nutrition research, weeds research etc.), it is hoped that a more effective research into developing and supporting crops industry in the NT can be achieved.
An overview of a program for developing a comprehensive crop yield simulation capability for the tropics

McCown, R.
CSIRO

Background

The first phase of CSIRO research on dryland crop production at Katherine began in 1946. By 1969 it was concluded that yields and costs were such that development of a cropping industry was not economically feasible and research ceased.

In 1978 a second phase of cropping research was initiated. Grounds for this decision included:

- interest by the newly autonomous N.T. government in developing a cropping industry.
- availability of pasture legumes superior to Townsville stylo which provided an improved prospect for legume leys.
- availability of the technology for cropping without tillage and demonstration of the large benefits of mulch in the tropics.
- crop cultivars with higher yield potentials than those in the previous research era.

Our approach to this research was to ask two sequential questions:

1. To what degree can important ecological problems of dryland cropping be ameliorated by improved technology/management? (What is the best way to farm in this zone?)

2. How successful can the improved system be in this climate? (How good is the "best system"?)

From 1978-86 our research focus was on the feasibility of legume leys and no-till/mulch retention for ameliorating problems of high N fertiliser costs, high runoff and erosion, and poor crop establishment. (A sister project to that at Katherine began in 1984 in eastern Kenya. This is a region in which dryland cropping of maize and pulses is integrated with livestock grazing. Rainfall is low and extremely variable, and risk of crop failure very high.)

Since 1986, emphasis in both projects has shifted to development of models which make it possible to answer the second question, ie. how productive is the "best" technology under the full range of climatic conditions which occur, based on historical weather records? The value of any technological improvements in key areas such as water conservation, N supply, or soil conservation can be determined only by placing the results in the context of temporal and geographic variability. Consequently, a major objective of this project has been to develop models to provide this capability.
Our aim is to have, when the project ceases after 1990, a research product that provides (a) understanding of the nature of the environmental problems which agriculture faces in this region, now or in the future, (b) the efficacies of various management options for alleviating these problems, and (c) all this in the context of the climatic variability which occurs in each of the major potentially-arable regions in the North. Our hope is that this will be a product that is sufficiently transparent and general that whenever there are reasons to reconsider cropping development in the far North, re-examination under new circumstances is easy and the outcome believable.

Activities and Participants

1. Simulation of yield variability for important crops

- testing and adaptation of CERES-Maize at Katherine (Carberry and Muchow)
- testing and adaptation of CERES-Maize in Kenya (Keating and Wafula)
- testing and adaptation of CERES-Sorghum (SAT) (Carberry Bristow, and Muchow)
- development and testing of CERES-Kenaf (Carberry and Muchow)
- development and testing of CERES models for peanuts and grain legumes (Carberry, Muchow, Cogle)
- risk analysis of maize, sorghum, peanuts northern Australia (McCown, Carberry, Cogle)
- analysis of potential for kenaf industry in N.T. (Carberry, McCown, Muchow, and N.T. collaborators)
- risk/return analysis of maize in Eastern Kenya (Wafula and Keating)

2. Modelling Mineral N and P supply in crop models

- testing and adapting the N submodel in CERES-Maize

Katherine: detailed study of N balance in crop rotations to test and calibrate model; adaptation of model (Dimes, McCown, Myers, Saffigna, and Carberry)

Kenya: multi-site/year minimum data sets for testing and calibration of model (Keating, Simpson, and Kenyan collaborators)
- testing existing P models for suitability in CERES models (Probert)

3. Simulation of the effects of soil surface management and soil type on water balance

- development of an alternative approach to Curve Numbers for partitioning rainfall (Ross, Williams, and Bristow)
4. Simulation of seedbed environment and crop establishment

- field studies of (a) mulch type, amount, and proximity to row and (b) slot geometry on water, temperature and impedance (Abrecht and Bristow).
- development of a 2-dimensional model to simulate water, temperature, and impedance around and above the seed in a slot (Bristow, Ross, and Abrecht).
- development of a maize emergence/seedling growth model appropriate for the SAT to improve CERES-Maize.

Katherine: (Abrecht and Carberry)
Kenya: (Itabari, Keating, and McCown)

5. Simulation of mulch dynamics

- field data collection on growth of weeds/pasture and mulch decomposition in relation to weather.

From standpoint of N cycling: Dimes
From standpoint of soil energy balance: Abrecht

6. Models of main crop + additional crop

- maize + pasture legume (Carberry and McCown)
- maize + beans (Keating, McCown, and Kenyan collaborators)
- maize + leucaena (Chapman, Xu, Carberry, and McCown)

7. Testing and adapting erosion models for use with crop models in a cropping systems model.

- small catchment studies in Kenya comparing systems of surface soil management (Okwach, Williams, McCown, Keating, C. Rose)
- plan for collaboration with N.T. Conservation Commission for modelling hydrology and erosion in conjunction with cropping systems catchment study at Douglas Daly Research Station (Williams, Dilshad et al., McCown).

8. Development of cropping systems model (McCown, Carberry, Hargreaves, Keating).
Developing a family of crop models for SAT using the CERES framework

Carberry, P.S.
CSIRO

An objective of the Cropping Systems group is to develop a family of crop models adapted to the semi-arid tropics of northern Australia, with which the climatic risk to cropping in this region can be assessed. The CERES-Maize model was first selected for testing against maize growth and development in the SAT. CERES-Maize was readily available and treated crop physiology and soil and nitrogen dynamics at a level of organisation appropriate for our purposes. The treatment of nitrogen was an important advantage over other crop models e.g. SORGF. To date, CERES-Maize has been calibrated against maize grown at Katherine NT for various sowing dates and moisture regimes. Similar data were used to develop and test CERES-Sorghum (SAT) using CERES-Maize as a model template. CERES-Kenaf is also being added to the family of crop models adapted to this climatic zone.

In CERES-Maize, phenology is predicted from temperature and daylength parameters. LAI is predicted from leaf area per plant which is estimated from the combination of final leaf number, rate of leaf appearance, maximum area per leaf and leaf senescence. The same framework as used in CERES-Maize was found to be applicable for the simulation of phenology and LAI for both sorghum and kenaf.

The test of CERES-Sorghum (SAT) at Katherine has identified areas where the model requires further development. The significant effect of water stress on sorghum phenology is not handled well by the model. CERES-Kenaf is still under development.
Development of a model of the N cycle of crop-pasture rotations in the semi-arid tropics.

Dimes, J.P., McCown, R.L., Saffigna*, P.G. and Myers, R J. CSIRO

The CERES-Maize nitrogen model simulates soil and plant nitrogen dynamics and their effect on maize growth and grain yield. This model has been developed and tested for high production maize crops grown with high nitrogen regimes in temperate climates. The aim of our work is to test the model's capabilities for predicting mineral N supply to moderate-yielding maize crops grown in rotation with legume or grass pastures in a tropical climate.

Important processes in the nitrogen cycle simulated by the model include: mineralisation of organic N, immobilisation of mineral N, nitrification, denitrification, nitrate leaching as well as plant uptake and partitioning of N. Our focus to date has been on the simulation of nitrogen mineralisation, immobilisation and nitrate leaching in a residue/soil system where no crop was planted. Serial profiles for soil mineral N under various types of mulch cover at Katherine provide the test data.

A description of how the model operates and which information parameters it requires will be presented along with predictive performance so far. Areas for modification/calibration to better reflect our environmental and residue conditions are identified.

* School of Australian Environmental Studies, Griffith University, Brisbane.
Crop simulation models are generally developed to run in 'batch mode' which constrains their use to limited capabilities. V1 CERES-Maize (Sorghum, Kenaf) considerably improves the capabilities of CERES-Maize by providing monitoring of and interaction with the simulation as it proceeds, and also providing a more flexible parameter input. Daily graphical display of important variables and graphs of soil water and soil nitrate on screen allow the user to monitor the simulation. The user interacts with the model by halting the model on any day and controls the simulation with a small set of simple commands.
The applicability of a Cercospora leaf spot simulation model to control of *Cercospora* in irrigated peanut crops.

Riley, I.T.
WADA

A model based a weather index, a function of hours of relative humidity above 95% and minimum daily temperatures, has been developed in the USA. The use of the weather index for scheduling of fungicide application has been evaluated in the ORIA and has proven successful in reducing in most years the number of sprays required for maximum yield. For the method to be adopted by commercial growers weather data could either be provided from a central site or collected from individual crops. However, there were no data to indicate the effect of irrigation practice on the weather index.

A trial was conducted to evaluate the irrigation of peanut at five deficits, 7, 14, 21, 35 and 49 mm of potential pan evaporation. The four lower deficits were monitored for canopy humidity and temperature. The crop was fully protected from *Cercospora* so no direct effect on disease could be determined. The four treatments differed in their effect on the canopy environment and a summary is presented below.

Weather index and it determinants over four irrigation regimes*

<table>
<thead>
<tr>
<th>Irrigation</th>
<th>Minimum night temperature (°C)</th>
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<tr>
<td></td>
<td>7 mm</td>
<td>11.7</td>
<td>26.8</td>
<td>24.1</td>
<td>22.9</td>
</tr>
<tr>
<td></td>
<td>14 mm</td>
<td>4.5</td>
<td>26.1</td>
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<td>21.5</td>
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<td>35 mm</td>
<td>10.5</td>
<td>26.4</td>
<td>23.5</td>
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<table>
<thead>
<tr>
<th></th>
<th>Hours of relative humidity 95% and above</th>
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<tbody>
<tr>
<td></td>
<td>7 mm</td>
<td>14.4</td>
<td>24.0</td>
<td>24.0</td>
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<td></td>
<td>14 mm</td>
<td>7.2</td>
<td>24.0</td>
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<td>18.3</td>
</tr>
<tr>
<td></td>
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<td>0.0</td>
<td>24.0</td>
<td>15.0</td>
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</tr>
<tr>
<td></td>
<td>35 mm</td>
<td>4.0</td>
<td>22.0</td>
<td>16.0</td>
<td>15.0</td>
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</table>

<table>
<thead>
<tr>
<th>Weather Index</th>
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<th></th>
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<tbody>
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<td></td>
<td>7 mm</td>
<td>-5.4</td>
<td>14.4</td>
<td>10.7</td>
<td>9.0</td>
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<tr>
<td></td>
<td>21 mm</td>
<td>-9.3</td>
<td>11.5</td>
<td>5.5</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td>35 mm</td>
<td>-5.5</td>
<td>10.4</td>
<td>6.1</td>
<td>4.8</td>
</tr>
</tbody>
</table>

* 7 mm and 35 mm treatments were on one logger and 14 mm and 21 mm on another
No effect of the irrigation treatments was detected in plant growth, pegging and pod development. Any effect on the canopy environment was thus a direct effect of the irrigation treatment rather than a consequence of plant growth. Frequent irrigation resulted in higher and more stable canopy humidity. Frequency of irrigation had no detectable effect on canopy temperature.

Given the variations in irrigation scheduling of ORIA peanut crops and rainfall incidence throughout the valley application of the weather index to scheduling of fungicide applications would need to be based on data collected in the crop concerned. Suitable equipment for individual growers to monitor their crops need to be identified and possibly software written to facilitate the adoption of this method by growers.
Preliminary results from the Croplands Erosion Research Project (CERP)

Dilshad, M.
CCNT

Understanding the impacts of landuse practices on hydrology and soil erosion is vital to successful development of agriculture in the semi arid tropics of the Northern Territory. Preliminary results show that conventionally tilled bays produce more runoff and with higher peak discharge rates, and sediment concentration than the conservation tillage bays. The conventional bays also produce more runoff events and are generally the first to runoff in the season. The conventional (single spaced conservation bank, for example, had lost 75 mm of rain as runoff, after 1987/88 planting, before the conservation (single) bay produced any runoff. This was over 33% of rainfall since planting.
Preliminary results from the Croplands Erosion Research Project, Douglas-Daly
van Cuylenburg, M.
CCNT

As soil erosion is a major problem in the semi-arid tropics, it is essential that a conservation tillage system be used to minimise the high risk of water induced soil erosion. With the present level of structural soil conservation measures already implemented on Northern Territory croplands, additional erosional control may only be achieved by suitable agronomic systems. Grain sorghum was grown on four soil types under two tillage systems (no-till and conventional tillage) in the Douglas-Daly region of the Northern Territory. The trials were undertaken in order to compare the erosion occurring on these two tillage systems, with a view to promoting a system that minimises soil erosion. In addition, a number of other parameters were measured, providing information on the crop growth environment. The statistically analysed results indicate that the no-till plots had significantly higher available soil moisture and soil density. Furthermore, these plots had significantly lower soil surface temperature and soil movement.

Yields were substantially greater in the conventionally cultivated plots, and this was attributed to the higher weed incidence in the no-till plots.

The trials have shown that it is possible to achieve a number of benefits through a no-till cropping system. However, it is doubtful this system will be adopted by growers until further research is carried out to reduce the weed competition.
Progress in reducing the risk of poor emergence.

Abrecht, D.G.
CSIRO

Crop establishment is a major problem on sesqui-oxidic soils of the semi-arid tropics. The low water holding capacity of these soils together with high radiation loads increases the risk of exposure of seedlings to severe water deficits, high soil temperature and high physical impedance.

Ameliorating the physical environment of the seedling by surface mulch and improved slot geometry have both shown promise for enhancing seedling emergence. The objective of good planting practices in the semi-arid tropics is to limit seedling exposure to water deficits, high temperature and high physical impedance.

Surface mulch reduces the rate of drying, reduces soil temperature and delays development of strong surface seals by limiting energy input into the soil. In environments where seedling emergence and early seedling growth are strongly influenced by surface mulch studies have shown that the benefits of surface mulch to seedling emergence decline rapidly with distance from the edge of the mulch.

The environment of the seedling also depends on the depth of planting and the depth of soil covering the seed. Generally conditions become wetter and cooler with increasing depth. The depth of planting is most important in determining the duration of high soil water availability for the developing seedling. Preliminary studies have shown that the extreme temperature at the soil surface may be avoided by planting seed in a narrow slot with a minimum of soil cover. Increasing the depth of soil covering the seed reduces the rate of drying of the seed (soil mulch) but increases the time for which the pre-emergent shoot is in contact with hot soil. The optimal depth of soil covering the seed will depend on weather, soil factors and seedling factors and will be determined using a simulation model validated by limited field experimentation.
The effects of tillage system on soil physical characteristics and crop yield on a Fenton soil in the NT

Dalgliesh, N.P.
CSIRO

Previous research indicates that there are significant advantages in adopting a no-till system of cropping in the Top End of the NT. Surface mulches in conjunction with no-till improve plant growth and yield and reduce runoff and erosion. This trial investigates the long term effects of three tillage systems on soil physical conditions and crop yield.

The three systems are:

1. Conventional
2. No-till with soil surface mulch
3. No-till with no surface mulch

Water infiltration at the end of the crop season was much higher in the conventional and no-till with surface mulch than no-till without mulch. These differences were apparent in both years although there was substantial variation in infiltration rates between years.

Despite similarities in infiltration rates the crop yield of no-till with mulch was twice that of conventional tillage and four times that of the no-till without mulch.
Effect of Tillage, Rotation and Nitrogen on the Growth and Nutrient Uptake of Maize and Soybeans

Thiagalingam, K., Gould, N. and Watson, P.

Effect of tillage (No tillage - NT and Conventional tillage - CT), Rotation (Continuous Maize - CM, Maize/Soybeans - MS, continuous soybeans - CS and Soybean/Maize - SM) and five nitrogen levels (0, 20, 40, 80 and 160 kg ha\(^{-1}\)) was studied over a four year period. The results presented are from the 1987-88 cropping (4th year of this experiment).

The results indicate a highly significant response to tillage with an average maize yield of 1.36 t ha\(^{-1}\) for CT and 2.83 t ha\(^{-1}\) for NT giving a 108% yield increase for NT. At harvest the maize plant height, cob number and plant population were 12, 60 and 19% higher than that of CT plots. Maize plants at 29 days after sowing revealed that NT plants had a 38% higher dry weight/plant than CT plants. Plant N, P, K, S and Cu concentrations were similar for both NT and CT. However total nutrient uptake of N, P, K, S, Zn and Cu for NT were 25, 41, 38, 37, 11 and 46% higher than CT indicating a better nutrient availability and utilization in the NT system.

NT plots at sowing had 73, 20 and 15% higher moisture than CT at 0-5 5-10 and 10-15 cm depth with a surface cover ranging from 667, 1362, 2172 and 3686 kg ha\(^{-1}\) for CS, MS, SM and CM rotations within the NT system. Soybean yields were 1.76 and 2.39 t ha\(^{-1}\) for CT and NT giving a 30% yield advantage for NT. The established soybean population was 63% higher than that of CT.

Estimated weed dry matter yield at harvest was 237% greater for CT maize than NT maize and 293% greater for CT soybeans that NT soybeans.

The above results indicate that in an year with high drought, NT yields were increased due to better surface cover, greater plant emergence and establishment, better moisture and nutrient utilization and less competition from weeds.
Problems and Potential of Peanut Production in the Northern Territory.

Flint, C.
DPIF

The applied research program at DDRF started in 1981/82 and has investigated various aspects of peanut production agronomy including response to irrigation, cultivar evaluation, calcium nutrition, growth regulant application, and the response of digging efficiency to hilling, bedding, irrigation and the like. Dryland yields have ranged from 3.0 to 4.5 t/ha.

Commercial peanut production in the Douglas Daly commenced in 1983/84. The number of farmers peaked in 1986/87 at 5 growers on 390 ha, but average grower yields remained low at around 1.5 t/ha NIS. Observation of grower practice suggested the biggest problem was efficient harvesting (digging) of the average 3.0 to 3.5 t/ha NIS in the ground. Late harvest appeared the main reason, usually due to delays incurred in the repair of diggers damaged by residual tree stumps in the ground, and in some cases faulty diggers.

Thus in the 1987/88 season the sole peanut farmer, of 110 ha, was encouraged to blade plough his paddock (which had been properly cleared), his crop closely monitored, and assistance given when necessary. Comparison of the timely digging of 30 ha with the research programs digger, and the late digging with the farmers own machine, clearly demonstrated that given stump-free land and appropriate digging at optimum maturity a high yielding (3.1 t/ha) and profitable (gross margin $1,200/ha) peanut crop can be realised, even in this dry season.

This grower followed recommended practices when appropriate, and it now seems feasible that grower adoption of research generated 'recommended practices', in a stump-free paddock, will result in a high harvested peanut yields.

Current research is now focusing of peanut agronomy under reduced or zero tillage options in rotation with sorghum and the stubble grazing of cattle.
The Effect of Surface Management on Growth and Yield of Soybean.

Bateman, R., and Berthelsen, J.
DPIF

A sustainable farming system in the Douglas Daly region is dependant on containing soil erosion to an acceptable level. In conjunction with a system of graded banks and a stable water disposal method, mulch retention by means of zero tillage reduces soil erosion.

It is well documented that the retention of a mulch blanket also enhances crop performance. The alteration of soil characteristics including higher infiltration rates, a reduction of surface soil temperature and improved soil moisture in the upper layers of the soil contribute to improved crop growth.

The behaviour of soybean grown under conventional and zero till surface management systems was monitored as part of the Croplands Erosion Research Project.
The Effect of Tillage, Rotation and Nitrogen on the Emergence and Establishment of Soybeans from 1984-88.

Gould, N., Thigalingam, K. and Watson, P.
DPIF

The effects of tillage (No tillage - NT and Conventional tillage - CT), rotation (Continuous soybeans-CS and Soybeans/Maize rotation - S/M) and five nitrogen levels (0, 20, 40, 80 and 160 kg ha\(^{-1}\)) N applied only during the maize phase of the rotation) on soybean emergence and establishment were studied over a low year period. The results presented are a summary of that 4 year period.

The study was initiated due to the constant decline in commercial soybean production during the 1984-88 period. The reason for this decline was thought to stem from poor seed quality and vigour leading to poor crop establishment. This problem was thought to be associated with high soil temperatures and soil crusting.

The results show a significant response to no-tillage in improving crop establishment with 65% increase in plants ha\(^{-1}\) at establishment and a 42% increase at harvest over the 4 year period. The average increase in yield as a result was 21% from 1.95 t ha\(^{-1}\) to 2.37 t ha\(^{-1}\).

These increases could be related to the influence of improved soil moisture content at sowing and surface cover through the growing stage of the plant which ameliorates the effects of high incident radiation and high intensity rainfall.

The soybean/maize rotation for both tillage treatments was generally found to have higher levels of surface mulch and higher soil surface moisture than the continuous soybean systems, with the general results being higher populations at emergence and establishment and higher yields.

No significant effect was found of nitrogen level on population or on yield.
Overview of Entomology in the Ord River Irrigation Area.

McFadden, P.
WADA

Background

In parallel with the development of cropping in the ORIA, the history of Entomology has not been without problems. The decline of the cotton era under the pressure of Heliothis resistance is testament to this.

The development of a range of cropping enterprises has diluted the monoculture basis for massive single species build-up, but the problems of providing economic levels of insect control are essentially the same.

The agricultural insect pest complex is of indigenous origin and to date there is an absence of introduced species that are significant pests in other areas of Australia.

Insecticides form the basis of control measures and despite the introduction of a range of egg and larval parasites no long term control has been achieved.

Insecticide usage requires management to maintain their long term viability as they are basically a non renewable resource. With the cost of development and registration of a new insecticide being in excess of $12 million few new products are available.

The development of sustainable insect management must consider the range of cultural, physical, biological and chemical control options in contrast to the more readily available "squirt gun" entomology.

New generation biological insecticides will become available and further options in broadacre integrated pest management will be developed.

Current Programmes

The range of commercial crops and their associated pest complexes currently research or monitored is as shown in Table 1.

Much of entomology is reactive work to insect problems that are only realised when a crop reaches semi-commercial or commercial scale plantings. Many a false impression has been gained of insect pest potential from small scale plots designed to resolve agronomic details, or from a limited number of seasons observations.

Our aim is to provide growers with insect identification and management guides based on available information. These have been prepared for the major crops of maize, soybeans and peanuts. Further guides will be developed as other crops gain significance.
## Future Prospects

- Current developments in the use of improved strains of *Bacillus thuringiensis* against Lepidoptera is gaining Australia wide interest.
- The use of naturally derived insect repellants and growth hormone disruptors is an area of interest.
- Improved monitoring methods (eg. pheromones) and predictive modelling will be developed for early warning systems.

### Table 1.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Season</th>
<th>Establishment</th>
<th>Pest Stage</th>
<th>Reproductive</th>
<th>Research/Monitoring</th>
<th>Establishment</th>
<th>Vegetative</th>
<th>Reproductive</th>
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</thead>
<tbody>
<tr>
<td>Maize/Sorghum</td>
<td>Dry</td>
<td>Soil insects (adults)</td>
<td>Locusts</td>
<td>Amyworm</td>
<td>M/R</td>
<td>R/M</td>
<td>M</td>
<td>M</td>
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<tr>
<td></td>
<td></td>
<td>Soil insects (larvae)</td>
<td>Amyworm</td>
<td>Heliothis</td>
<td>R/M</td>
<td>M/R</td>
<td>M</td>
<td>M</td>
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<td></td>
<td></td>
<td>Cutworm</td>
<td>Heliothis</td>
<td>Aphids</td>
<td>M/R</td>
<td>R/M</td>
<td>M</td>
<td>M/R</td>
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<tr>
<td>Sunflower</td>
<td>Dry</td>
<td>Soil insects (adults)</td>
<td>Heliothis</td>
<td>Heliothis</td>
<td>M/R</td>
<td>R/M</td>
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<td>Spodoptera</td>
<td>Rutherglen bugs</td>
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<td>Tobacco looper</td>
<td>Thrips</td>
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<td>M/R</td>
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<td>R/M</td>
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<td>M/R</td>
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<td>Soybeans</td>
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<td>-</td>
<td>Loopers</td>
<td>Pod suckers (6 species)</td>
<td></td>
<td>M/R</td>
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<td>Heliothis</td>
<td>Stem borer</td>
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<td>R/M</td>
<td>M</td>
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<td>Locusts</td>
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<td>M/R</td>
<td>R/M</td>
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<td></td>
<td>Spodoptera</td>
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<td>M/R</td>
<td>R/M</td>
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<td>Heliothis</td>
<td>M/R</td>
<td>M/R</td>
<td>M</td>
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<td>Seed web moth</td>
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<td>Bananas</td>
<td>Both</td>
<td>-</td>
<td>Grasshoppers</td>
<td>Mites</td>
<td>-</td>
<td>M/R</td>
<td>R/M</td>
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<td>Nematodes</td>
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<tr>
<td>Mango/Cashews</td>
<td>Both</td>
<td>Giant Termite</td>
<td>Mango Tip Borer</td>
<td>Fruit spotting bug</td>
<td>R/M</td>
<td>H/R</td>
<td>M/R</td>
<td>M/R</td>
</tr>
<tr>
<td>Cucurbits</td>
<td>Dry</td>
<td>Pumpkin beetle</td>
<td>Pumpkin beetle</td>
<td>Aphids+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Misc.</td>
<td></td>
<td>Giant Termite</td>
<td>Giant termite</td>
<td>Fruit Piercing moth</td>
<td>M/R</td>
<td>M/R</td>
<td>R/M</td>
<td></td>
</tr>
</tbody>
</table>


Forage Sorghum - Irrigation Scheduling Requirements

Shackles, R., Ellett, S., and Sherrard, J.H.
WADA

Maximisation of forage sorghum production and quality is dependent on optimising irrigation scheduling so as to avoid water stress, waterlogging, and delayed harvesting. Additional benefits may result from reducing soil moisture at harvest, thus reducing soil structural degradation from movement of machinery over wet ground. Scheduling based on a prescribed number of days between irrigation, rather than based on evaporation or soil moisture deficit has been found more appropriate, with a 42 day production cycle throughout the season suitable for optimum utilisation of plant and labour. A number of treatments based on this scheduling method were assessed during the 1987 dry season. These were:

1. Irrigation at 7, 28 days from cutting
2. Irrigation at 7, 21, 33 days from cutting
3. Irrigation at 7, 17, 25, 33 days from cutting
4. Irrigation at 7 days from cutting
5. Irrigation at 7, 17 days from cutting

Yield data indicate that a similar response can be expected for treatments 1, 2, 3 and 5 when harvested at 42 days from cutting. While yield differed little between these treatments, there was a tendency towards an improved yield response from 2 irrigations per cycle during the middle of the dry season and 4 irrigations late in the season, in response to changing evaporative demand.

Treatment 5, in which 2 irrigations were applied early in the production cycle while resulting in a similar response at day 42, achieved this by a greater rate of dry matter production early in the production cycle and with reduced production later in the cycle than for treatments 1-3. A trial to be conducted during 1988 will examine means by which the initial increased growth rate could be maintained until late in the production cycle, resulting in a further yield enhancement. Treatment 5, even without further yield enhancement retains the advantages of similar yield to other more conventional irrigation scheduling systems, requires only 2 irrigations, and ensures that the ground is sufficiently dry at harvest for machinery movement, without damaging soil structure.

The increased yield response for Treatment 5 was associated with a higher tiller population than for treatments 1-3. Tiller number remained constant for treatments 4 and 5, and declined for treatments 1-3 between cycles 2 and 5. Tiller height results, sampled 29 days into cycle 4 also indicate that increased growth rate for treatments 4 and 5 was associated with increased tiller height early in the production cycle.
Depth of soil moisture extraction also varied with irrigation frequency and crop water requirement but was largely from within the 0-130cm depth. High irrigation frequency resulted in a progressively wetter profile with subsequent irrigations, and while not reducing production was not beneficial and resulted in wetter soil at harvest. The decreased growth rate late in the cycle for treatments 4 and 5 could not be totally attributed to water stress in all cycles since a high rate of water use continued until late into cycle 3, as also occurred for treatment 5 in cycle 4. It is possible however, that increased water use from depth where nutrients may be limiting, could partially be responsible for reduced growth rate late in the production cycle for treatments 4 and 5.
Water management of Maize in the ORIA

Sherrard, J.H, Shackles, R. and Ellett, S.
WADA

Research on water management of field crops is directed towards the development of irrigation scheduling systems as a means of improving water use efficiency, and increasing crop yields and quality.

Development of irrigation scheduling systems requires information on when to irrigate and how much water to apply, and generally, irrigation systems which result in increased crop water use will increase productivity.

Trials conducted over the last two seasons have emphasised the importance of minimising the inundation period at irrigation in the maize crop where inundation for 8 or 16 hours significantly increased grain yield when compared with 24 hours inundation treatments.

<table>
<thead>
<tr>
<th>Year</th>
<th>Inundation Period (hrs)</th>
<th>Grain Yield (kg/ha) @ 10% m/c</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>1986</td>
<td>7516</td>
<td>7667</td>
</tr>
<tr>
<td>1987</td>
<td>7620</td>
<td>7400</td>
</tr>
</tbody>
</table>

The reason for a similar yield response when inundating for 8 or 16 hours was not apparent since a reduced inundation period should reduce the waterlogging effect at irrigation and enhance crop water use, particularly from deeper within the root zone. A trial conducted this season with treatments including 4, 8 or 16 hours inundation at irrigation indicates that although the soil profile is significantly drier with reduced inundation, the rate of crop water use has only been increased marginally.

A trial is underway on a bed system to examine the effect on grain yield of irrigation of alternate furrows, and at a range of deficits, also as a means of reducing the waterlogging effect at irrigation. Results already obtained indicate a significant increase in rate of crop water use using this method, when compared with the conventional system of irrigating all furrows.

Other research conducted on maize this season using the neutron moisture meter has revealed a consistent sharp decline in rate of crop water use late in the irrigation cycle for infrequently irrigated maize, indicating a refill point at which irrigation should occur. Further research already underway to calibrate the neutron moisture meter should then allow irrigation scheduling of maize on this basis on similar soil types.
Cropping in the Douglas Daly - 6 years on

Bateman, R.
DPDF

Cropping in the upper Douglas Daly is looked at in terms of where the industry is at after six seasons, 1982/83 to 1987/88.

In this time, the areas cropped has increased while the proportion of grain grown increasing. The current position of the industry is assessed in terms of constraints and opportunities. Conservation cropping techniques has the potential to have the greatest impact on maize and soybean performance. Fertilise cost component of cropping is discussed.

Data on the annual area sown, average and test yields for the six crops grown along with constraints and opportunities are presented.

Peanuts and soybeans are two crops with a product in high demand, good price and few growers. Mungbean production has oscillated widely. Maize area has increased with yield decreasing compared to sorghum where for increasing area, yield is static. Sesame has only been grown for half the period and shown a dramatic increase in area for a declining yield.

Test strip yield show that in all season these crops are capable of reasonable yields but on farm management limits production.
Progress in the Development of Late Maturing Photoperiod Sensitive Mungbeans for the Northern Territory

Yeates, S.
DPIF

Late maturing photoperiod sensitive mungbeans are considered as a means of both extending the sowing period and avoiding harvest rains. Since no such varieties exist an attempt to breed late maturing lines was initiated in 1982.

Variety trials over the past five years have found that at an early January sowing, the late maturing line 1179 produced superior grain quality than the cultivar King in all years. However, despite a higher five year mean grain yield 1179 was significantly (0.05) lower yielding than King in three of five years.

Unexpectedly late maturing lines sown in late January produced significantly (0.05) higher or equivalent grain yields in all years. Grain quality was also improved. In addition, greater plant height appears to increase harvest efficiency at later sowings.

A longer sowing period seems likely with late maturing lines. Since sowing can be earlier than commercial cultivars without increasing the risk of weather damage, and at later sowings at least equivalent yields and grain quality can be expected.

Later maturing mungbean lines are more susceptible to plant lodging particularly at early sowing dates. Current research is considering this problem. Reduced plant population, phosphate management and lodging risk, based upon growth models, are now under consideration.
Summary - Kenaf/Fibre Crop Investigations in the NT

Sturtz, J.
DPIF

A Task Force in the NT Department of Industries and Development is proceeding with investigations preparatory to a second stage assessment of the feasibility of developing a kenaf-based pulp/paper industry in the NT.

Activities cover:

- agricultural investigations
- marketing investigations
- industrial development (processing) investigations

Agricultural investigations in the past season included:

- experiments at Douglas Daly, Katherine and Berrimah for crop growth model development (joint project with CSIRO)

- seed increase of a range of lines of kenaf, sesbania and sunn hemp at Berrimah and Douglas Daly. Seed increase of lines needing regeneration is being done by CSIRO, Brisbane on behalf of the Department. Included are roselle lines that failed to establish in the NT. WADA is increasing seed of a line of sunn hemp at the Ord.

- preliminary larger-scale production of kenaf at Tipperary Station. Two areas, each 1 ha in size, were grown on Blain and Tippera soils.
Effect of Alternative Herbicides and their Time and Rate of Application on Broadleaf (Ludwigia sp.) and Sedge (Cyperus sp.) Weeds and the Growth and Yield of Rice.

Diczbalis, Y.
DPIF

A range of cheaper alternative herbicides were tested for their efficacy toward Ludwigia sp. and Cyperus sp. weeds relative to the commonly used Propanil + Biothencarb herbicide mixture in a wet season dry sown lowland rice crop NTR 587.

The treatments included four hormonal acting herbicides, Dicamba, MCPA, 2,4-D and a Dicamba + MCPA mix (Banvel M R), applied at early tillering, 20 days after sowing (DAS), at a lower than recommended rates (200, 400, 600, 80 + 340 g ai/ha). Three of these herbicides, MCPA, 2,4-D and Banvel M were also applied at mid tillering (35-42 DAS) at recommended rates (750, 840, 160 + 680 g ai/ha). The herbicide Bentazone was applied at 400 g ai/ha at 20 DAS. These treatments were compared with a Control (no herbicide) and a application (20 DAS) of Propanil + Biothencarb, (2880 + 1600 g ai/ha), a complete weed control treatment. Grass weeds were hand weeded from all plots.

There was a significant difference in weed control between the control and treated plots with no difference within treated plots. At 60 DAS the total weed dry weight per square metre was 323.3g and 1.1g for the control and herbicide plots respectively, with 90% of the dry weight in the control plots being contributed by Ludwigia sp. At 120 DAS (rice harvest) contained 520g/mE2 of Ludwigia sp..

Rice growth and yield were similar for all herbicide treatments. The mean yield of the treated plots, 5455 kg/ha was significantly higher than the control plots 1216 kg/ha. Panicle numbers/mE2 were significantly higher in the treated plots (mean= 435) than the control plots (291). Plant height did not differ significantly among treatments.
Weed control in sesame.

Bennett, M.
DPIF

The withdrawal of alachlor from the market has initiated research for alternative herbicides or methods of weed control in sesame.

One alternative is combining a new herbicide with a sesame population which smothers weeds without prejudicing yield. The new herbicide being applied at a sufficiently low rate, to minimise both phytotoxicity and chemical costs. If possible, the herbicide should not require incorporation, hence reducing potential soil erosion.

Various herbicides were investigated including a new formulation of alachlor. Concurrently various sesame populations and row spacings were tested.

Optimum sesame population and row spacing for maximum yield and minimal weed growth was 300 000 plants/ha on 48cm rows.

No herbicide was effective in translating weed control into a significant yield increase this year. This suggested that where grass weeds are minimal a well established sesame crop will successfully smother pigweed. Two of the more promising herbicides were metalachlor and the new formulation of alachlor.

Further research into grass control in sesame crops is required.
Preliminary Investigation of the Presence of Vesicular-Arbuscular Mycorrhizae (VAM) in a heavy and a light Tippera Soil.

Thiagalingam, K., and Watson, P.
DPIF

A preliminary investigation was initiated to assess the presence of VAM colonization on maize plants. Soil, plant and root samples were collected from healthy and poor plants (plants with Zn and P deficiencies) on Ooloo soil. The root samples were assessed for VAM by Dr J P Thompson of The Wheat Research Institute, Queensland. The results indicate that the % VAM colonization, length of VAM colonized fine roots and plant dry weight in healthy plants were 72, 363 and 167% higher than that of the poor plants. Total P and Zn uptake in healthy plants were 157 and 262% higher than that of the poor plants. This may be attributed to the higher percentage of VAM colonization in healthy plants enhancing the uptake of P and Zn.

In another study samples were assessed from a tillage, rotation and nitrogen experiment for VAM activity. The VAM colonization was 55.0 and 52.0% for conventional and no tillage treatments respectively indicating very little difference between tillage and VAM colonization.
Development of new crops for irrigated cropping in northern Western Australia.

Bonnardeaux, J.
WADA

At the time of this research, the stability of the Ord as an agricultural region depended on six to eight field crops and three to four horticultural crops. Therefore a research programme was launched to assist increase that stability by identifying and introducing suitable new crops in the region.

After considering the distances between the Ord River Irrigation Area (ORIA) and the markets, common sense dictated the researchers to concentrate their first screening on crops which could be easily processed or converted into a small volume, high value product. In addition, they examined the possibilities of producing off-season, high value crops. Market studies pointed also the importance of strategic crops such as annual crops used as sources of paper pulp. Therefore preliminary assessments were conducted mainly on crops falling in one of these three categories: small volume, high value crops; off-season, high value crops; strategic crops.

In the final level of selection the high temperatures of the local environment and the availability of water all year-round had to be an asset for the selected plants.

The following suitable crops were identified:

<table>
<thead>
<tr>
<th>Category</th>
<th>Crop Selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic crops</td>
<td>Kenaf</td>
</tr>
<tr>
<td>Small volume, high value crops</td>
<td>Essential oil plants</td>
</tr>
<tr>
<td>Off-season, high value crops</td>
<td>Asparagus</td>
</tr>
</tbody>
</table>
Plantago ovata research and commercial developments.

Riley, I.T.
WADA

Plantago ovata is a broad-leaved herbaceous annual grown for its water absorbing seed coat or husk. Most people are familiar with the weedy Plantago species called plantains. In Australia Plantago husk is used in a range of pharmaceutical preparations, such as laxatives and appetite suppressants. Plantago husk has been used for centuries in traditional medicine both in the Indian subcontinent and Europe. Currently the total world supply of this commodity originates from India.

Over the past four years in the Ord River Irrigation Area the Department of Agriculture has been developing agronomic methods for the production of Plantago. The work was initiated by a pharmaceutical company producing Plantago based products in Australia and elsewhere in the world. The work was subsequently funded by the Australian Special Rural Research Fund in association with that company. The Ord River Irrigation Area is ideally suited to the cultivation of Plantago as it requires tropical conditions with furrow irrigation on heavy soils and negligible chance of rain during seed maturation.

In 1988 we were able to provide, on the basis of a three year experimental programme, a set of guidelines for full commercial evaluation of this new crop to Australia. Four growers have been contracted to produce 130 ha of Plantago this year. The crops have varied in land preparation, sowing date, populations, irrigation management and pest infestations. The results of this commercial evaluation phase will indicate more clearly its potential as an alternative crop for the ORIA.

The prospects for the crop look good. To satisfy only Australia's demand production of up to 1,000 ha/annum would be required. There are also strong markets in Europe and North America. Demand is only likely to grow, especially with ageing populations in the developed world and increased consumer preference for natural rather than synthetic products. Yields of between 1-2 t/ha are possible with prices ranging for $A 700 to as much as $A 2,000/tonne to import seed from India.

Further work is required to reliably achieve the yield potential of the genetic material we are currently growing. If this can be done by commercial growers in the next few years there are encouraging prospects for a soundly based new agricultural industry for irrigated cropping in Northern Australia. The future of the industry would be further assured by the identification or breeding of higher yielding lines.
Previous Research

The trial work that has been conducted over the past three dry seasons included trials in the following areas

* Establishment methods - sowing method, sowing rate, planting date, soil types, irrigation
* Nutritional requirements (nitrogen and trace elements)
* Weed control
* Thrip damage potential
* Harvesting methods
* High yielding genetic selection potential

On the basis of this work preliminary recommendations for commercial scale production were developed and are available to potential growers. These recommendations will be modified to incorporate any significant findings from this year's experimental programme or commercial experience.

Current Research

The main objectives of the current experimental programme are to further develop agronomic methods, provide the basis for chemical registrations and further indicate the potential for genetic improvements. The trials that can been seen during the field day are as follows

* Irrigation methods for establishment (FWI 8a)

Purpose - To find the minimum irrigation requirements for Plantago establishment. As the seed is broadcast the water must move through the bed by capillary action to moisten the seed on the surface. Previous results have shown maximum establishment with irrigation on day 1 and 2 or day 1 and 3. There was no data to indicate the minimum irrigation required as 24 h irrigations had been used in that work.

Treatments - (1) Beds with irrigation after sowing (day 1) for 6, 12 and 24 h and on day 3 irrigation for 3, 6, 12 and 24 h. (2) Flat with irrigation after sowing at high and low application rates.

Preliminary results - with irrigations on day 1 and 3 provided the bed surface has become wet for the full length of the run no further benefit was had by extended irrigation. In this experiment no difference was found between the shortest and the longest combination of watering. Establishment on the flat was reduced especially where the seed was covered by water, however, in this trial plant population per hectare was comparable, though it was less than the bed top density. At harvest any land utilisation or harvesting efficiencies for cultivation on the flat will be determined.
* Nitrogen placement and application timing (FWI 6a centre)

Purpose - Previous indications were that deep placement of nitrogen fertiliser in bands was inappropriate for this small-seeded, slow-growing and shallow-rooted crop. If soil nitrogen status was low the plant could become nitrogen limited before the roots had reached the fertilised zone.

Treatments - Nitrogen fertiliser (urea) placed either shallow or 7cm deep, incorporated or banded, single (80 kg N/ha pre-sowing) or split (40 kg N/ha pre-sowing and 40 kg N/ha at flowering) application.

Preliminary results - Shallow placement of urea, particularly at the high rate, inhibited Plantago germination and caused some seedling mortality. Urea applied in bands results in variable nitrogen nutrition across the beds. Early dry matter production was superior with deep placement of urea probably mostly due to the effect of shallow urea on plant population.

* Thrip control (FWI 6a, northern end in wheat buffer)

Purpose - Thrips have been shown to reduce yields by inhibiting seed set and reducing seed size, they also affect seed milling qualities. There is no data to indicate variation between chemicals or time of application.

Treatments - Thiodan and Folimat first applied 1, 2, 3 and 4 weeks after flowering with either a single or a double application (the second application two weeks after the first). Plots grown within a wheat buffer to limit thrip movement between plots.

Preliminary results - Thiodan has reduced thrip populations more effectively than Folimat. The effect on seed set and quality and the optimal application time will not be known until samples taken at maturity are assessed.

* Genetic selections (FWI 6a, in wheat buffer).

Purpose - Maximum small plot yields have been 2 t/ha and larger areas 1 t/ha, the seed originates from land race populations in India and the proportion of plant dry matter converted to seeds is highly variable, so there is a need and potential for the selection of higher yielding lines. As Plantago ovata is an out-crossing species the production and maintenance of selected populations is a difficult task. This year we are evaluating the progeny of some high yielding parents and investigating the potential for self-pollinated seed production as a breeding tool.
Treatments - Plants from three seed source, bulk, 1986 and 1987 high yielding parents, were grown separated by a wheat buffer to promote pollination within the group. Two heads on each plant bagged before anthesis to induce self-pollination.

Preliminary results - None yet and full results will not be known until the progeny of these plants are assessed in 1989.

* Chemical residues purposes (FWI 6a, southern end)

Purpose - To provide chemical residue data for the establishment of MRLs (minimum residue limits) which are required for the registration of agricultural chemicals. As Plantago husk is subject to minimal or no further processing before being consumed, data of this kind is essential for confident use of chemicals in its production.

Treatments - Chemicals applied were Lorsban, Diuron, Paraquat, Thiodan, Folimat, Lannate and Sprayseed at recommended and double recommended rates with samples collected at three times and frozen until assayed.

* Bulk area plantings (FWI 4a and 5a)

The only other Plantago work being undertaken this season is the monitoring of various commercial crops. This includes plant populations, thrip levels, weed status and plant pathogens. Foliage samples for nutrient analysis have been taken and quadrat samples will be taken at maturity to determine yield parameters.
Banana Yield Estimation - Dealing with management scale research

Gardiner, H.G.
WADA

Introduction

Being a perennial crop, bananas present some very real difficulties when attempting to identify and reduce impediments to production. The history and physical structure of the plantation have significant and confounding influences on the outcome of research. The modification to the micro and meso environment created by the "plantation" effect and the scale of edge effects provide compelling reasons for conducting research into management factors on large blocks of bananas.

Estimating yield from larger blocks of bananas presents significant logistical problems if all bunches have to be weighed. Apart from the time required to physically weigh each bunch, remove the hands, discard the rejects and weigh both the rejects and the stalk, trial plants may well bunch and ripen over a lengthy time period requiring frequent revisits to the research site. This presents even more of a problem if the research is conducted with a cooperating farmer.

Field measurable bunch and plant characteristics, if strongly related to yield, can be measured during a single visit to the property. If combined with a small sample of bunches that are weighed, these measures may provide a precise estimate of yield. Seven properties have been surveyed to assess the generality of the relationship between yield and measurable plant and bunch characteristics.

Methods

Yield was measured on forty bunches harvested on a single day at each property by cutting the bunch weighing it whole and then deducting the weight of the stalk and reject bananas. For each bunch, the height of the stem (ground to crook), the number of hands and the number of fingers on each hand were recorded. Stepwise regression was used to decide on which variables would be included for estimating weight.

Results

Average weights of marketable bananas varied from 15.24 to 21.95kg (Fig 1). The nature of the regression equations varied between properties as did the precision of the yield estimates (Table 1).

Conclusions

No single equation will be satisfactory for predicting
yield, however, sufficient precision can be achieved with limited sampling commitment at each location to enable a double sampling approach to be employed. A small sample of mature bunches weighed on a particular date and combined with field measured bunch and plant characteristics on a much larger number of bunches will provide sufficient precision to permit the detection of differences in yield due to management strategies.

Figure 1. Average yield of marketable bananas from seven properties in the Ord River Irrigation Area.

Table 1. Regression equations and the precision of yield estimates (Precision is presented as the number of kg difference between treatments that could be detected to at probability 0.05 with a 95% certainty).

<table>
<thead>
<tr>
<th>Plantation</th>
<th>Regression Equation</th>
<th>Precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$y=0.146 \times \text{total finger no}$</td>
<td>2.3kg</td>
</tr>
<tr>
<td>2</td>
<td>$y=-9.745 + 5.823 \times \text{plant height} + 0.084 \times \text{total finger no}$</td>
<td>1.6kg</td>
</tr>
<tr>
<td>3</td>
<td>$y=-18.020 + 1.975 \times \text{no hands} + 0.361 \times \text{total finger no} - 0.024 \times \text{no hands} \times \text{total finger no}$</td>
<td>1.9kg</td>
</tr>
<tr>
<td>4</td>
<td>$y=-15.342 + 7.104 \times \text{plant ht} + 0.116 \times \text{total finger no}$</td>
<td>2.4kg</td>
</tr>
<tr>
<td>5</td>
<td>$y=-13.54 + 8.082 \times \text{plant height} + 0.101 \times \text{total finger no}$</td>
<td>1.6kg</td>
</tr>
<tr>
<td>6</td>
<td>$y=-22.037 + 7.745 \times \text{plant ht} + 0.285 \times \text{total finger no} - 0.012 \times \text{no hands} \times \text{total finger no}$</td>
<td>2.1kg</td>
</tr>
<tr>
<td>7</td>
<td>$y=-7.393 + 2.253 \times \text{plant ht} + 0.143 \times \text{total finger no}$</td>
<td>1.8kg</td>
</tr>
</tbody>
</table>
Evaluation of table grape production in the tropics.

Toohill, B.
WADA

A table grape programme commenced at the Ord River Irrigation Area in 1983 with a range of scion varieties, each planted on four different rootstock selections. By 1987 some of these varieties had been rejected because of poor fruit quality and/or poor vegetative growth.

An analysis of pruning weights in 1986 and 1987 was carried out for three varieties across all rootstocks, on each of two soil types. There was a strong correlation between rootstocks and a weak one between scions and between soils respectively, in 1986. A weak correlation was also apparent in the scion-rootstock interaction and the scion-soil interaction. None existed for the rootstock-soil and scion-rootstock-soil interactions. A similar result occurred in 1987 except that the soil and scion-rootstock correlations were also non-significant.

There was a positive correlation between vine age and rootstock vigour from 1986 to 1987 generally, on both soil types for all varieties. The exception was Carolina Black Rose which declined slightly in vigour on the clay soil and on Harmony rootstock.

Carolina Black Rose on Harmony rootstock gave the best yields, exceeding those of all other rootstocks across both soils for this and all other varieties.

Yield for this combination was 50% greater on the clay than on the sand.

Carolina Black rose outyielded Muscat St. Vallier, with a maximum of 15.3 kg of fruit. Karli Sahabi was largely unfruitful.

An inverse relationship between rootstock vigour and yield is beginning to appear, with Schwarzmann and Harmony showing least vigour and Ramsey and Dog Ridge showing greater vigour.

Carolina Black Rose, Harmony and Schwarzmann outyielded the other two rootstocks and except for Schwarzmann where yield was similar on sand and clay, there was a 1 1/2 to 3 fold increase in yield on clay compared to sand. The same result occurred for the lower yielding Muscat St. Vallier.
Recent developments in grain sorghum breeding

Done, A.
CSIRO

The DTCP grain sorghum breeding programme has reached a stage where much material requires seed multiplication and extensive field testing before the commercial release of F₁-hybrid cultivars. It is appropriate that further development should be by the private sector, and the programme has therefore been sold to Ag-Seed Pty. Ltd.

The DTCP grain sorghums have been bred for Australian tropical wet season conditions, but Ag-Seed believes that they will be suitable for tropical environments in other countries. Results from Queensland also suggest that some hybrids could be suitable for sub-tropical areas where medium to late maturity is desired. Seed of experimental F₁-hybrids and their parents is currently being produced in the ORIA, for trials in the NT, central and northern Queensland, Colombia, and possibly India and the Sudan. This work is being funded jointly by Ag-Seed and DTCP. The Australian trials to be grown in the 1988-89 season represent the final year of a three-year testing programme on approximately 200 F₁-hybrids.

The F₁-hybrids presently being produced are in the medium to late maturity range, of both white and red grain types. They have moderate to good resistance to Cercospora sorghi, and most have some lodging resistance. Results so far indicate that they are better adapted for early planting than most currently available commercial cultivars, but that the advantage declines in later planting or where the wet season finishes early. The yield advantage of the DTCP sorghums, as compared with most commercial cultivars, appears to be 10 to 15 percent where they have the opportunity of a long growing season.

In addition to seed production, new pedigree crosses have also been made during the current dry season to incorporate resistance to sorghum midge (Contarinia sorghicola) and better resistance to grain moulds into the parent lines of future F₁-hybrids. Some pedigree crossing for midge resistance was also done during the 1986 dry season and the F₂ generation will be grown in Colombia during the 1988-89 wet season. Grain moulds were a major problem in the Douglas-Daly area during the 1987-88 wet season, and they are also important in other tropical areas. Grain mould resistance is apparently associated with the presence of tannins in the grain, which have undesirable nutritional effects in non-ruminants. It is not known whether grain mould resistance can be combined with acceptable nutritional quality, but at least one commercial F₁-hybrid, DK55, and one DTCP F₁-hybrid, Kal3881, show some grain mould resistance without visible evidence of tannins in the grain. If these cultivars prove to have low tannin
levels at grain maturity, then much emphasis will be placed on developing a wider range of types with similar grain mould resistance and tannin characteristics. These would incorporate other desirable features, such as resistance to lodging, sorghum downy mildew and sorghum midge.
FIELD VISIT NOTES
Maize Production in the ORIA

Sherrard, J., Shackles, R., and Ellett, S.
WADA

Maize has been planted to 1200 hectares of Cununurra clay during the 1988 dry season with average valley grain yield expected to be 7 to 8 tonne per hectare and valued in excess of $1.25 million. Last season 370 hectare under commercial production averaged 8.1 tonne per hectare, and included a number of bays which exceeded 9 tonne per hectare.

Research supporting the maize industry has been directed towards water management, hybrid selection, and crop nutrition. Other areas of importance in influencing maize production this season have included plant establishment and unusually high levels of insect activity.

Water management research will be discussed in another session.

Hybrid selection work over the last 2 or 3 seasons has included the assessment of approximately 50 hybrids introduced from the Eastern States, with research directed towards finding a suitable replacement for XL82, which presently predominates commercial maize plantings. Several of these hybrids which have consistently outyielded XL82 over this period have been listed below. These hybrids are also included in an assessment trial this season on the research station, and include hybrids planted for the first time on small commercial areas, for assessment of grain yield and field performance.

Maize Grain Yield (tonne/ha)*

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<td>(Bulk Area)</td>
<td>(Small Plots)</td>
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<td>10.5</td>
<td>10.3</td>
</tr>
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<td>XL73</td>
<td></td>
<td>10.1</td>
<td>7.5</td>
<td>6.5</td>
<td>11.0</td>
<td>10.9</td>
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* Grain yield at 10% moisture content determined from small quadrat analysis.
A survey of commercial maize crops during 1985 and 1986 revealed leaf nutrient deficiency at silking in a number of crops with N and Zn being most important. Further N deficiency has been observed in crops grown this season. To better understand zinc nutritional requirements. A trial is being conducted this season to assess the effect of various forms, levels and methods of application of zinc on maize grain yield.

Percentage of Crops Sampled with Low Level of Leaf Nutrients at Silking

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>S</th>
<th>Ca</th>
<th>Mg</th>
<th>Zn</th>
<th>Mn</th>
<th>Cu</th>
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<tr>
<td>1985(27)*37</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>1986(23)*</td>
<td>0</td>
<td>(26)**</td>
<td>4</td>
<td>9</td>
<td>4</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

* Number of bays sampled
** High level