ANADIA PROJECT CONCEPTS
Impacts of drought on wheat in Australia.

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Australia

MEETING OF THE ANADIA TASK FORCE
(ASSESSMENT OF NATURAL DISASTER IMPACTS ON AGRICULTURE)
(Castagento Carducci, Italy, 21-26 May 2006)
Introduction

- Value of wheat industry to Australia.
- Issues relating to rainfall variability.
- Links to ENSO - preparedness capabilities.
- Value of crop models – both in preparedness and in assessment.
- Case studies.
- Project concepts: some emphasis on preparedness issues.
Australia winter wheat

Winter wheat crop calendar for most of Australia

Legend
- **Major growing areas**: Green
- **Climate stations**: Small circles

(Source: ABARE)
Wheat:

• The largest enterprise in the Australian grain industry with annual gross value averaging A$4 billion.

• Amounts to 90% of total grain production in Australia (balance made up of barley, oats, sorghum, lupins, rice, field peas, triticale, maize, peanuts, sunflowerseed, soybeans, cottonseed, and other oilseeds). (AWB Ltd).
• By world standards a relatively small producer of grain with wheat and barley accounting for ~3% of annual world production.

• ~ 80% of Australian wheat is exported.

• However, Australia accounts for between 8% and 15% of world trade, making it one of the four largest exporters with the United States, Canada, and EU.

• Australia is currently the world’s 2nd largest wheat exporter behind the United States.
Value of wheat industry to Australia.

2004/05 production:
20,376 kilotonnes (20.376 million tonnes)

SA – 2,622kt
Vic – 2,055kt
Tas – 25kt
Qld – 1,100kt
NSW – 6,780kt
WA – 7,705kt (DAFF)
Variability of Annual rainfall

Coefficient (%)

Country

Australia  S. Africa  Germany  France  NZ  India  UK  Canada  China  USA  Russia

(Love, 2005)
Impacts of ENSO on Australian wheat production (N Nicholls)
Wheat Yield – Average In Season SOI Value

- **Yield** (t/ha)
- **Year (x-axis)**
- **Average SOI May–Oct (y-axis)**

- **Red Line**: Yield – BOGAN Shire
- **Blue Line**: Average SOI May–Oct
‘Major impacts of the given disaster on the given crop in the pilot project’

- **Strong shifts in 1982, 1994, and 2002 - El Niño-induced droughts led to production of less than 10 million tonnes.**

- **Example: 2002 drought - resulted in Australian wheat production drop from 24.9 m tonnes in 2001 to 9.7 m tonnes in 2002.**

- **AWB National Pool deliveries were reduced from 19.6m tonnes to 4.5 m tonnes.**

- **Growers extremely reliant on the revenue generated from the little wheat they were able to produce.**
• Flow-on impacts to townships, community well-being.

• Considerable cut in export supplies and lower market competition.

• Impacts have *significant flow-on effects to the rest of the economy* - no significant dampening of agricultural instability by the non-farm sector of the economy, both contribute to the impacts of climate variability on the economy.
Impact of El Niño on yields: probability of exceeding long-term median wheat yields for each wheat producing shire (= district) in Australia. (Example of output for July 2001 and July 2002, respectively).
Preparedness: climate forecast outputs:
Forecasting the Australian wheat crop: a fully integrated agrometeorological system to improve preparedness for the wheat industry

Rainfall up to date and Climate Forecast

Simple Agro-climatic model

Geographical Information System

Crop Outlook

Spatial Statistics

Drought Probability

(Stewart, 2003)
Preparedness capabilities: providing probabilities of exceeding long-term median wheat yields for every wheat producing shire (= district) in Australia. (Example of output for July 2001 and July 2002, respectively).
1 March 2003

Poor Crop Alert - chance (%) of current crop falling below the Worst 10% of all years
Improved preparedness and more efficient loss assessment capabilities: key linking role of modelling.

- Simulate management scenarios
- Evaluate outcomes/risks relevant to decisions

**Agricultural Production Systems Simulator (APSIM) simulates**

- yield of crops and pastures
- key soil processes (water, N, carbon)
- surface residue dynamics & erosion
- range of management options
- crop rotations + fallowing
- short or long term effects
Performance of APSIM-wheat against yield data from (a) 100 plant breeding experiments from 23 locations over several seasons ($R^2 = 0.6$); (b) experimental results from soil fertility studies at a single site in Queensland over 8 years, 5 N levels and 2 surface management regimes ($R^2 = 0.8$) and (c) results from (b) in a dry year

The value of crop simulation models (APSIM)
Median wheat yields and standard deviations by April/May SOI phase

- Con neg
- Con pos
- Rap fall
- Rap rise
- Near '0'

Yield (t/ha)
Application of plant breeding programs

- Ideally climate forecast systems may give some forewarning of the likely mix of test environments for the seasons ahead.
- Could be used to advantage if trying to select for specific traits that only become evident in certain environment types.
It is possible to identify the relative frequency of environment types

Changes in the frequencies of environmental types effect overall yield likelihood and magnitude of the $g*e$ – This is important in weighting the representativeness of the selected environments.

Overall ratios of yield:

- Mild terminal: 37
- Severe terminal: 35
- Mid-season: 28

M-T:S-T:M-S

Effect of Polysora Rust on maize in North Queensland, Australia: ability to better withstand impacts of TC Larry?

Pacific 901 versus AT1
Climate derivatives: innovative climate risk management for the wheat industry using derivative trading

Roger Stone, Lexie Donald, Queensland Department of Primary Industries and Fisheries
Preparedness issues: effective delivery of information to farmers – participative approaches
Assessing impacts

NDVI

Crop simulation modelling

Ground assessments (extension officers – industry specialists)
The National Agricultural Monitoring System:

- Publicly available climatic, production, and commodity information for agricultural industries at national, state/territory, and regional scales – online and at your fingertips.
- User-friendly and easy to read maps and graphs available for local regions throughout Australia.
- Reports can be generated for a range of purposes, including seasonal conditions, regional profiles, and drought assessments.
- Designed to streamline the application and assessment processes for Exceptional Circumstances (drought assistance), initially for dryland/broadacre industries.

www.nams.gov.au

The NAMS is a collaborative project between Australian, State, and Territory governments.
Monthly vegetation greenness anomalies from September 2004 to August 2005. Colours describe the difference from the average greenness derived from the 14-year record of satellite data.
Analysis of Vegetation Greenness from Satellite Normalised Difference Vegetation Index (NDVI) is based on data collected from satellite, and provides an indication of vegetation condition.

Annual time traces for vegetation greenness of agricultural land in the Exceptional Circumstances application region.

Annual time traces for vegetation greenness of agricultural land in the Exceptional Circumstances application region.
Example

Policy level - when is a drought an exceptional drought?

Simulated Wheat Yield 1950+

Simulated Wheat Yield 1890+
Challenges: Links to policy: the need for an interdisciplinary approach - the RES AGRICOLA concept (Meinke et al., 2001). Aim to convert insights gained into climatic processes via systems analysis and modelling into the socio-economic feasibility of decision options. (after Meinke and Stone, 2005).
Pilot proposal for wheat industry and farmers. Objectives

- Improved preparedness (1) through use of integrated forecast systems: rainfall/yield/economics - emphasis on the extreme aspects of rainfall/yield distributions and a systems approach.

- Improved preparedness (2) through use of more appropriately focussed plant breeding programs.

- Improved preparedness (3) through use of improved financial systems for agricultural industry chain (eg ‘climate derivatives’).
Activities:
1. Production and evaluation forecasts of potential yield ahead of the season (and updated throughout the season).

2. Development of case studies of farmer use of climate forecast and crop modelling systems - development of initial stage of draft preparedness system for farmer and community.
3. Investigation/evaluation of more focussed plant - wheat breeding programs – G*M*E.

4. Investigation/evaluation of a climate derivatives product for wheat industry.

5. Initiation of participative approach with wheat farmers and other sectors on the wheat value chain on the methodology and potential incorporation of preparedness system.

6. Final report: includes recommendations for potential application in other world regions.
Summary

• Need to develop more tailored climate forecast systems suitable for natural disaster planning.

• Use of crop simulation models: paddock and regional scale for both preparedness and assessment purposes.

• Use of remote sensing and expert ground-truthing in assessment (also value of crop models for this purpose).

• Innovative climate derivative systems.

• Incorporation of a systems approach.

• Project basis ‘3-point plan for improved preparedness’.
Thank you.
How ANADIA case study results can influence the disaster relief policies in the pilot project region?
• Input into national and state drought policy (policy informing role).
• Input into the National Agricultural Monitoring System (NAMS).
• Use in damage/impact assessment by insurance and other agencies.

How preparedness strategies could be developed to assist the farming community affected by the disaster in the pilot project region?

• Incorporation of project development and outputs into farmer-participative R&D programs (e.g. ‘Yield Prophet’; Managing for Weather and Climate Workshops).
• Inclusion of private agricultural risk insurance agencies as potential input into their assessment processes.
Derivative example

Cap Payout

Viticulturalist receives payment if index is greater than strike i.e. $50,000/mm above average

Average rainfall i.e. 74mm

Acceptable loss

Strike i.e. 80mm

Viticulturalist retains all profit if index is less than strike

mm of Rain
discussion of the different measurements that should be made to assess the impacts.
Probability of exceeding Median Rainfall for August / October based on consistently negative phase during June / July

Probability of lowest quartile of Rainfall based on Positive SOI phase.
The value of a participative approach

How much Nitrogen to apply given current low soil moisture levels and very low probability of sufficient in-crop rainfall?

Which variety to plant given low rainfall probability values and high risk of damaging frost and anthesis?
APSIM: precise daily time step model that mathematically reproduces the physical processes taking place in a cropping system.
Probability of lowest quartile of rainfall based on ‘Consistently Negative’ SOI phase.

Shows increased chance of low rainfall
Median June to Oct Rainfall (190)

Consistently negative April/May SOI Phase

The key integrating role of modelling.

Integrated climate /crop simulation forecast systems applied to decision making (N levels, variety choice).
The National Monitoring System is a shared website of Australian, State and Territory Governments. It provides a single set of up to date information on Australian agriculture. Its primary purpose is to provide core information to support Exceptional Circumstances applications and assessments.

The elements of this website include historical production data, modelled pasture and crop production, climate data and remotely sensed information. This information is available from regional through to national levels.

Enter Here

Information may be accessed as maps
   click here to learn about producing maps
or via
National, State and Regional reports
   click here to learn about producing reports
Results

5 Phase SOI System

- $P(X>UQ)$ for Oct-Nov
- ‘Climatological’ probability $= 0.25$

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Probability significantly different from 0.25 at $\alpha = 0.1$. 
Adapted: Corbally & Dang 2002b:109
Welcome to the National Agricultural Monitoring System 'live pilot'

The National Agricultural Monitoring System (NAMS) 'live pilot' contains a range of climatic and production information, initially for dryland/broadacre industries, for over 600 regions throughout Australia.

The purpose of the 'live pilot' is for the public to rigorously test the NAMS website; users are encouraged to provide feedback to help make it a better system.

To view NAMS reports and/or analyses, please follow the instructions below.

Choose a region, select a report or data for analyses, then view your results.

1. Choose a Region
   Explore Australia, then select regions for further reporting and analyses.

2. Select Reports or Analyses
   Choose from a report, or climatic/agricultural data sets, and more.

3. View Results
   View results online or download a copy.

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