

### Searching for cost synergies between market and non-market objectives in Northern Australia: can we improve the efficiency of biodiversity Investment?

TEAM:  
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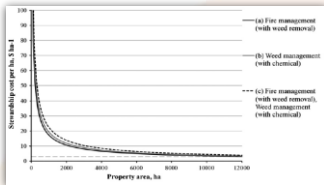
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### Summary of issues

- Limited budgets mean that those who seek to "protect biodiversity" must find ways to make their dollars stretch further (i.e. they need to get "value for money").
- So they need to look at both the COSTS and the BENEFITS of conservation.
- This project focuses on COSTS.
- COSTS depend on CONTEXT. For example,
  - it may be cheaper for graziers to fence streams than for cane farmers (since graziers are likely to own the 'right' type of equipment and have the 'right' expertise);
  - It may be cheaper for large property owners to control weeds than for small property owners to do so (since the small properties might be 'infected' by neighbouring properties more often) .
- So this project will look at the cost of achieving particular biodiversity objectives IN DIFFERENT CONTEXTS.

### Input vs output costs

- Evidence suggests per-hectare costs of land-management activities are lower for large properties.

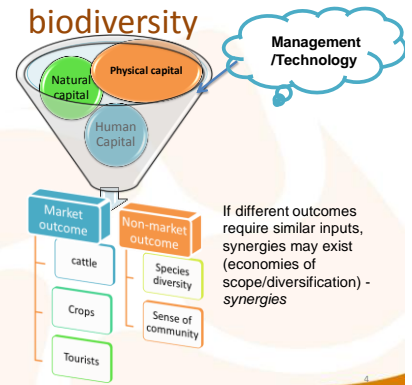


- But this is about the cost of actions aimed at promoting biodiversity .
- What about the costs of biodiversity itself ?

**Cost of biodiversity = F ('inputs' required to achieve it)**

Adams et al. 2011

### Multiple inputs required for biodiversity



But those same inputs can be used for other things

If different outcomes require similar inputs, synergies may exist (economies of scope/diversification) - synergies

## Synergies between agricultural and environmental outputs

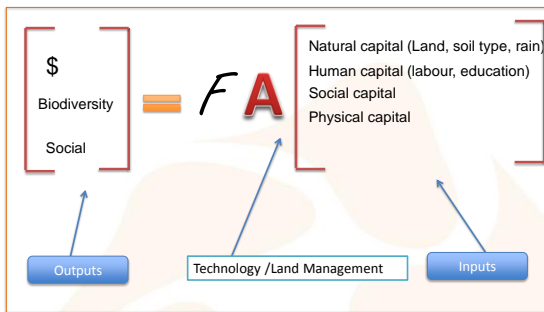
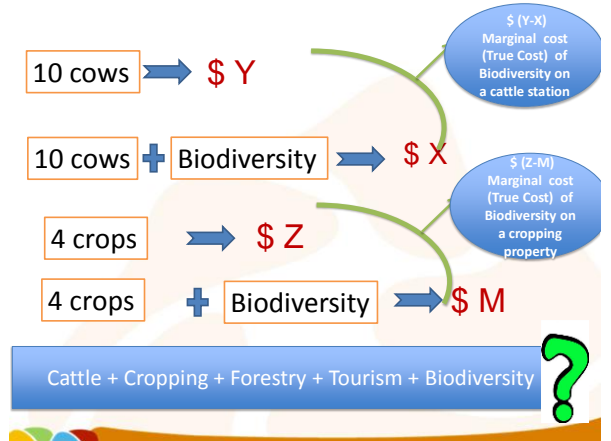
Measures of second order partial derivatives between outputs

| Output combination                  | Estimated measure | Standard error | t-value |
|-------------------------------------|-------------------|----------------|---------|
| Livestock and crop outputs          | 0.0071*           | 0.0021         | 3.31    |
| Livestock and environmental outputs | 0.2672*           | 0.0033         | 79.90   |
| Crop and environmental outputs      | 0.0720*           | 0.0040         | 18.03   |

\* Significant at the 0.01 level of significance

Fleming et al (2010)

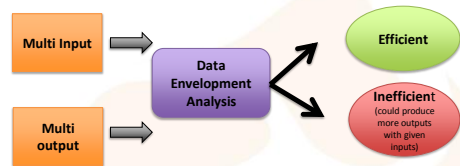
Synergies => cannot estimate costs separately because required inputs are inseparable



If two different types of outputs both require similar inputs → producing multiple outputs may be advantageous (economies of scope/diversification)

Otherwise maybe not – perhaps better to specialise (and aim for economies of scale instead)

## Identifying efficient properties



- What are the characteristics of the 'inefficient' properties? (e.g. large/small; diversified/specialise; Indigenous owned; freehold)
- Are there some types of land management practices frequently associated with efficient/inefficient properties?

Table 5  
Marginal effects of variables in the inefficiency effects models

|                 | Cereal        | Dairy          | Sheep          | Beef             | Poultry         | Pig            | General cropping | Mixed          |
|-----------------|---------------|----------------|----------------|------------------|-----------------|----------------|------------------|----------------|
| Time            | 0.001 (0.97)  | -0.005 (14.97) | -0.001 (2.19)  | -0.001 (3.36)    | -0.0004 (1.07)  | -0.001 (2.80)  | 0.001 (0.47)     | -0.002 (5.64)  |
| Debt ratio      | -0.046 (3.98) | -0.032 (9.64)  | -0.018 (2.30)  | -0.020 (3.43)    | -0.001 (0.33)   | -0.009 (3.02)  | -0.020 (3.36)    | 0.003 (1.16)   |
| REGM            | -0.045 (4.53) | -0.033 (12.70) | 0.011 (2.49)   | -0.004 (2.79)    | -0.005 (1.73)   | -0.0003 (1.51) | -0.028 (4.34)    | -0.013 (3.92)  |
| Subsidies GM    | -0.066 (3.03) | 0.043 (12.43)  | -0.011 (2.55)  | 0.002 (2.75)     | -0.007 (0.79)   | -0.0001 (0.06) | -0.305 (4.04)    | -0.005 (3.58)  |
| Farmer age      | -0.001 (4.32) | -0.0004 (8.16) | -0.0002 (2.13) | -0.0003 (3.33)   | -0.0001 (1.25)  | -0.0002 (0.47) | -0.0001 (0.71)   | -0.0003 (4.75) |
| LFA             | 0.078 (5.08)  | -0.011 (9.20)  | 0.004 (1.74)   | 0.011 (3.59)     | -0.007 (1.24)   | -0.005 (1.72)  | 0.037 (4.04)     | 0.002 (1.07)   |
| Area            | 0.0003 (5.39) | 0.0002 (5.53)  | -0.0001 (2.03) | -0.000004 (1.14) |                 |                | 0.0002 (4.28)    | 0.0001 (6.07)  |
| Herd size       | 0.0004 (0.31) | 0.00002 (2.60) | 0.001 (3.36)   | 0.0000004 (1.08) | 0.000004 (3.00) |                | 0.033 (4.33)     | 0.013 (5.56)   |
| Turnover ratio  | 0.007 (4.58)  | 0.023 (12.86)  | 0.004 (2.10)   | 0.020 (3.65)     |                 |                | 0.033 (4.33)     | 0.013 (5.56)   |
| Specialisation  | -0.117 (4.31) | -0.051 (10.65) | -0.084 (2.69)  | -0.068 (3.74)    | -0.036 (1.39)   | -0.011 (2.21)  |                  |                |
| Livestock ratio |               |                |                |                  |                 |                |                  | -0.048 (5.97)  |
| RSE dummy       | 0.023 (1.45)  | 0.002 (1.43)   | 0.002 (1.10)   | 0.010 (3.57)     |                 | -0.008 (1.97)  | -0.003 (0.27)    | 0.005 (3.51)   |
| SEAST           | -0.003 (0.77) | -0.038 (11.50) | -0.005 (1.50)  | -0.001 (0.84)    | 0.010 (2.26)    | 0.0002 (0.19)  | -0.007 (1.24)    | -0.014 (5.06)  |
| NEAST           | 0.008 (2.24)  | -0.007 (3.40)  | 0.007 (2.38)   | 0.012 (3.65)     | 0.013 (2.44)    | 0.003 (2.62)   | 0.018 (4.01)     | 0.010 (5.29)   |
| EANG            | 0.022 (4.91)  | -0.039 (11.11) | 0.019 (1.80)   | -0.003 (1.09)    | -0.010 (1.26)   | 0.003 (2.77)   | 0.040 (5.25)     | 0.019 (5.52)   |
| NWEST           | -0.063 (2.96) | -0.021 (9.52)  | 0.006 (2.40)   | 0.002 (1.69)     | -0.00003 (0.01) | 0.001 (0.47)   | -0.018 (2.05)    | -0.005 (2.77)  |
| SWEST           | -0.016 (2.46) | -0.029 (11.70) | -0.003 (1.31)  | 0.002 (2.07)     | -0.001 (0.17)   | 0.004 (3.02)   | -0.020 (2.52)    | 0.001 (0.07)   |
| WALE            | -0.028 (1.67) | -0.010 (5.97)  | 0.0003 (0.19)  | -0.008 (3.00)    | -0.0005 (0.05)  | -0.005 (1.47)  | -0.051 (2.47)    | -0.005 (3.13)  |

Note: t-statistics in parentheses.

## Geographic Scope



- Analytical techniques are very data hungry, so will survey a random sample of landholders across the entire TR Region collecting information on 'inputs', 'outputs', and 'technology'
- Supplement information set with data on biodiversity 'outcomes'; and some natural capital 'inputs' (e.g. soil type)

## Will have better information on

- Characteristics of 'efficient'/'inefficient' farms
  - Which ones are 'best' at promoting biodiversity?
- Types of outputs which 'go well together' (e.g. cropping and grazing; grazing and horticulture?)
  - Which ones go best with biodiversity?



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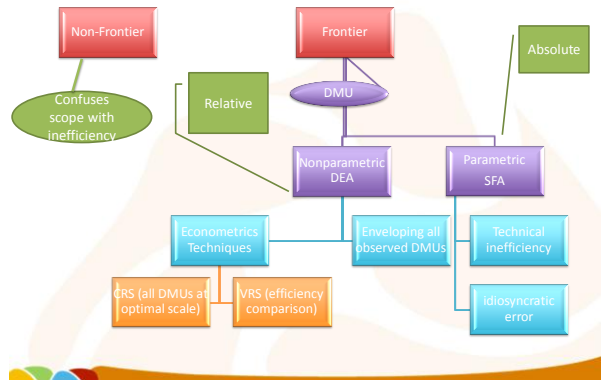
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# Appendices

## Estimation Techniques



### Parametric or Nonparametric ?

- ❑ Significant weakness of the SFA : it requires **a priori specification** of the underlying production **technology**, with the potential for mis-specification of the functional form.
- ❑ SFA has also been criticised on the basis that it inevitably employs strong assumptions for decomposing the **inefficiency and error terms**
- ❑ DEA avoids explicit **functional form** of the production technology
- ❑ DEA avoids strong assumptions by empirically deciding the **shape and location** of the frontier.
- ❑ DEA also naturally handles disaggregated inputs and outputs, does not require **price or cost data**, is computationally convenient and so is highly flexible.
- ❑ Shortcoming of DEA is its inability to account for **white noise**, by assuming all deviations from the efficient frontier are due to inefficiency

However, Sample size /data permitting we will try to adopt both methodologies and compare

### A bit more methodological background

#### Information we hope to collect from landholders

- Background information about the property/land
  - Where? How big? How much land is set aside for which types of uses? Who owns/manages? etc
- Information about the previous year's 'outcomes', including:
  - Commercial 'outcomes' (e.g. money earned from grazing, cropping, forestry, etc);
  - Other 'outcomes'... (Overall quality of life, perceptions of 'health' of the land, relationships, autonomy)

12. How satisfied are you with each item below? (tick one box in each row)

|   | Neutral                  |                          |                          |                          |
|---|--------------------------|--------------------------|--------------------------|--------------------------|
|   | Very satisfied           |                          | Very unsatisfied         | Not Applicable           |
| The income (dollar returns) from this land  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| The physical condition ('health') of this land (including pastures, water courses, wetland, flora and fauna)                    | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| The relationships you have with your family, with those who live on this land with you, and with others in your local community | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Your ability to make decisions about and to 'control' what is happening on this land  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Your overall quality of life  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

### A bit more methodological background

15. How much do you agree or disagree with each of the following statements? (tick one box)

|  | Strongly agree           | Neutral or unsure        | Strongly disagree        | Not Applicable           |
|--|--------------------------|--------------------------|--------------------------|--------------------------|
| I think rainfall (on this land) will be higher in 2013 than it was in 2012.  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I think interest rates and other costs will be lower in 2013 than they have been during 2012                                   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I think that the prices I receive for my product(s) will be higher in 2013 than they were in 2012                              | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I understand what government rules, regulations and policies will allow me to do (or not do) on my land in the next 2-5 years. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

- Information about expectations (
- Information about various land-management practices

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17. Do you, or have you ever used fire as a management tool on this land (e.g. for green pick, to open up country, to control weeds and/or for hazard reduction)?

- No  Yes  
 If yes, approximately what % of your property was deliberately burned (as part of a management decision) for weed control or hazard reduction ...

|                     | 0%                       | 1-25%                    | 25-50%                   | 50-75%                   | 75-99%                   | 100%                     | Do not know              |
|---------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| In 2012?            | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| About 5 years ago?  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| About 10 years ago? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| About 20 years ago? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

21. Has any of part of this land been set aside for purely conservation purposes (e.g. areas that have been fenced off, and stock excluded)?

- No  Yes ...  
 If yes, please tell us which types of habitat (e.g. wetlands, water courses) have been set aside for purely conservation purposes, and approximately how large each area is

| Type of habitat | Area excluded nowadays (hectares) | Area excluded about 2 years ago (hectares) | Area excluded about 5 years ago (hectares) | Area excluded about 10 years ago (hectares) | Area excluded about 20 years ago (hectares) |
|-----------------|-----------------------------------|--|--|---|---|
| e.g. wetlands   | 15ha                              | 10ha                                       | 25ha                                       | 0   | Do not know                                 |
|                 |                                   |  |  |   |   |
|                 |                                   |  |  |   |   |

28. Approximately how likely were you to change stocking rates in response to changes in land-cover/pastures.....

|                     | Not at all               | Sometimes                | Almost always            | Do not know              |
|---------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| In 2012             | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| About 5 years ago?  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| About 10 years ago? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| About 20 years ago? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

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### Analysing the data using DEA (cont)

- Looks for farms, which when compared to others could
  - Produce more output(s) with the same inputs; or

| DMU Name | Output Slacks | Income | Bio- | social |
|----------|---------------|--------|------|--------|
| Area 1   | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 2   | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 3   | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 4   | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 5   | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 6   | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 7   | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 8   | 9100.00       | 2.63   | 0.00 | 0.00   |
| Area 9   | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 10  | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 11  | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 12  | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 13  | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 14  | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 15  | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 16  | 291.62        | 0.00   | 2.41 | 0.00   |
| Area 17  | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 18  | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 19  | 0.00          | 0.00   | 0.00 | 0.00   |
| Area 20  | 0.00          | 0.00   | 0.00 | 0.00   |

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