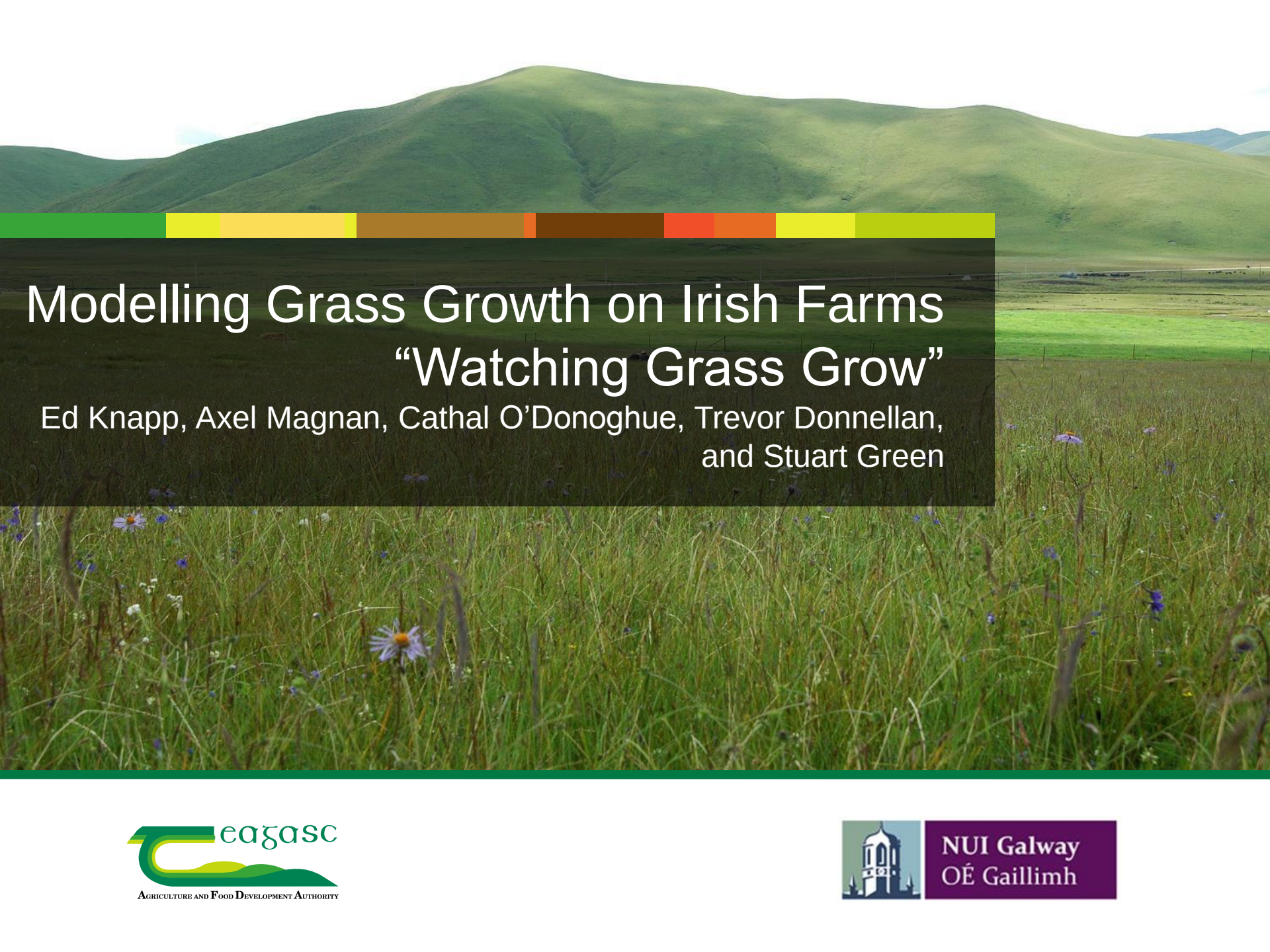

Modelling Grass Growth on Irish Farms
"Watching Grass Grow"

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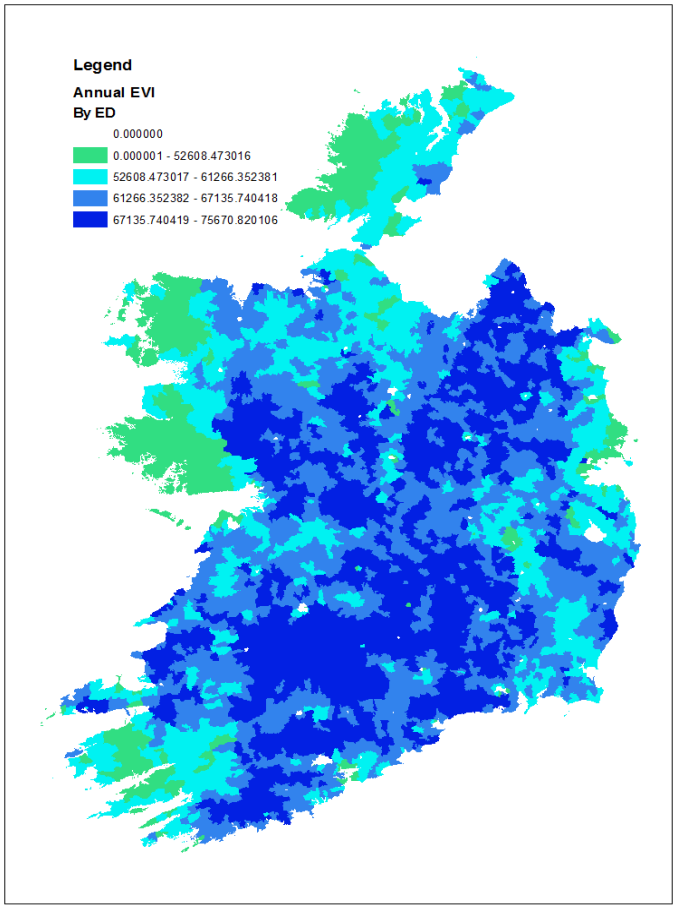
Purpose

- How to minimise cost and increase efficiency?
  - Grass growth is seen as the key to profitability and sustainability
  - Can remote sensed data, the enhanced vegetation index (EVI), be used to measure grass?
  - How is EVI related to agronomic conditions such as weather and soil?
  - How does this relationship change from region to region

Literature

- Irish grass growth potential
  - Low feed costs (Finneran et al., 2010)
  - Grass can supply >70% of livestock dietary requirements (Dillon et al., 2005)
- Irish grass growth models
  - Often developed on research farms (Hurtado-Uria et al., 2013)
  - Include temperature, rainfall, and soil characteristics (Hazeu et al., 2011)
  - Can be improved with spatial data (Schulzke and Kaule, 2001)

Data and Methodology



- Enhanced vegetation index (EVI) data along with soil and weather data was mapped against 90,994 farm locations in Ireland
- Random effects models were used to relate EVI to geoclimatic data
- Cluster analysis was used to develop grass growth condition zones

Selected Summary Statistics

Variable	Mean
Annual Cumulative EVI	6.4
Monthly Rainfall (mm)	98.3
Temperature	8.3
Altitude (m)	87.3
Slope (%)	3.5
Distance to sea (km)	29.9

- Other control variables
  - Soil type and texture
  - Electoral district stocking rate and mean farm size

Structure of Models

- Random effects model used to regress geoclimatic variables on vegetation growth from 2002 to 2015
- $EVI_{itm} = \alpha + w'_{itm} + g'_i + t_i + u_{itm}$

	Annual Observations	Monthly Observations
Individual Farms (n=90,994)	Explain annual feed availability on the farm	Chart grass growth curve through the growing season
Electoral Divisions (n=2,919)	Add Census of Agriculture variables (e.g. stocking rate)	Control for unobserved heterogeneity

Farm Level Results

Monthly

- Overall r-squared = 0.50
- 13,169,638 observations
- Rainfall has a positive effect in current month, but negative in lag months
- Grass growth is highest in May, June, and July lowest in December

Annual

- Overall r-squared = 0.47
- 1,265,670 observations
- Silty, rendzina soils performed best; rocky or peaty soils were worst
- Farms without steep slopes, further inland, and further south had highest EVI scores

Electoral District Results

Monthly

- Overall r-squared 0.68
- 422,887 observations
- All weather variables highly significant

Annual

- Overall r-squared = 0.70
- 40,680 observations
- Highest explanatory power
- Controls for noise caused by farm level differences in management

Regional Analysis

- R-squared ranged from 0.55 to 0.73
- Geoclimatic effects are broadly similar across regions
- Optimal stocking rate ranged from 2.5 LU/ha in the south to <1 in northwest

Conclusions

- EVI can be a measure for grass growth on a national scale
- Agronomic conditions vary widely across Ireland
- Farm management data is key to model improvement
- Future research
  - Supply and demand of feed energy on Irish farms
  - National and local grass yields

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Agriculture and Food Development Authority

Thank You

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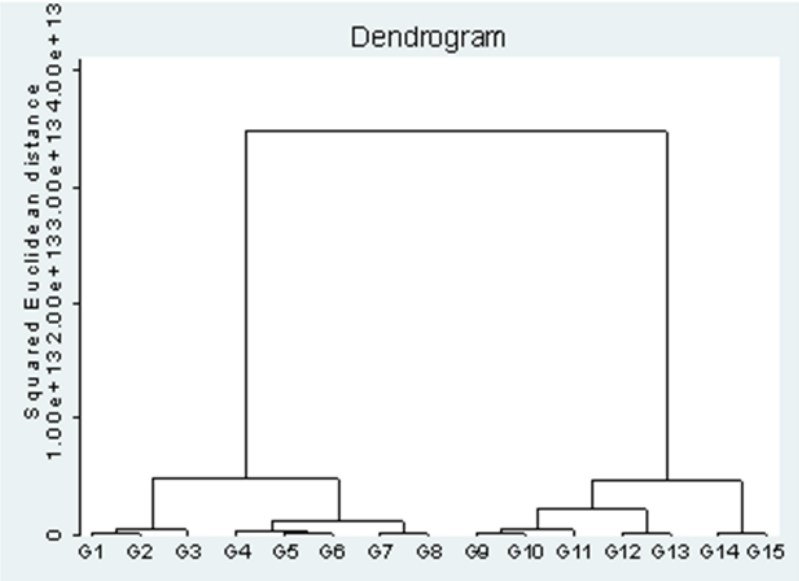
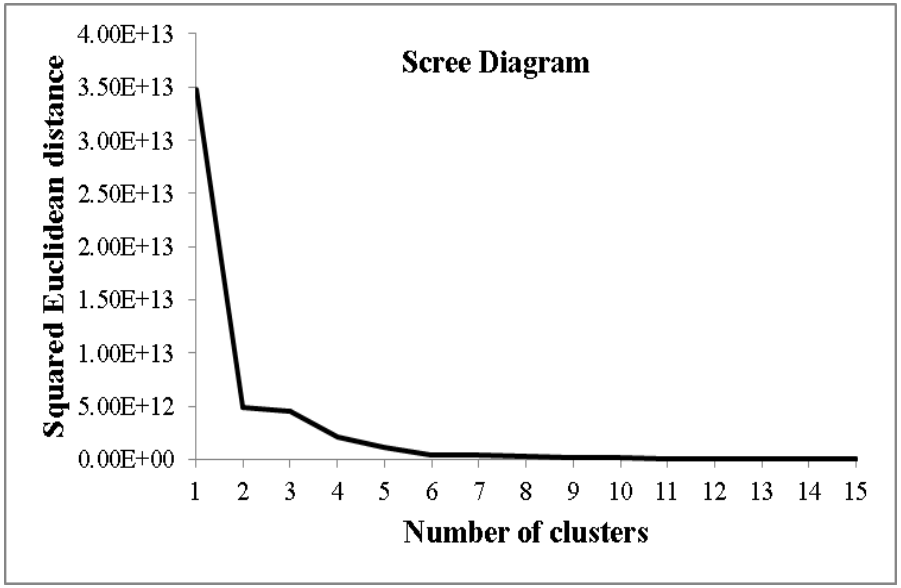
Hierarchical Cluster Analysis





	Cluster 1 (n=697)		Cluster 2 (n=1273)		Cluster 3 (n=564)		Cluster 4 (n=385)		**Full sample (n=2,919)**	
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	**Mean**	**SD**
Annual Cumulative EVI	6.5a	0.5	6.5b	0.5	6.5a	0.6	5.5c	0.7	**6.4**	**0.7**
Monthly Rainfall (mm)	97.4a	7.4	84.9b	8.2	113.9c	19.0	121.1	16.0	**98.3**	**18.4**
Mean Temperature	9.4a	0.4	9.1b	0.5	4.3c	0.9	9.5a	0.3	**8.3**	**2.0**
Principal Soil Type (Base Case = Grey Brown Podzolic)	Brown earth 0.5a	0.4	Grey brown podzolic 0.6b	0.4	Brown podzolic 0.5a	0.4	Gley 0.4a	0.4	**Grey brown podzolic 0.3**	**0.4**
Principal Soil Texture (Base case = Mixed)	Mixed 0.3a	0.4	Mixed 0.5b	0.4	Sandy 0.6c	0.4	Mixed 0.3a	0.3	**Mixed 0.3**	**0.4**
Altitude (Metres)	79.7a	54.5	90.1b	37.7	99.5c	56.0	73.9a	36.8	**87.3**	**46.7**
Slope (%)	3.6a	1.5	2.7b	1.1	4.2c	1.5	4.7	1.5	**3.5**	**1.6**
Mean Distance to Sea (Km)	15.9a	11.7	48.5b	22.1	16.3a	14.1	13.5a	13.5	**29.9**	**24.0**
Km north	208.5a	84.0	224.2b	57.5	87.4c	29.5	315.8	75.3	**206.1**	**92.2**
Mean Stocking Rate	1.2a	0.3	1.2b	0.3	1.3c	0.4	0.6	0.2	**1.2**	**0.4**
Mean Farm Size (Ha)	34.5a	12.4	36.9b	12.0	37.7b	11.6	27.9c	13.7	**35.3**	**12.6**
Note: a-c indicates means within a row differ (P<0.05)										

Annual Effect on EVI (Base Year 2002)