Searching for sustainable land management strategies aimed at decoupling greenhouse gas emissions from economic performance

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Project Aims

- Evaluating ways of decoupling GHG emissions from economic performance using bioenergy crops as a land use.
- Use Scotland, with particular emphasis on the North-East, as the case study.
- Use two models to gain a greater understanding of processes involved.
- A greater understanding of land use strategies and the broader link between socio-economic activity and GHG emissions.

A Multi-disciplinary approach

- Socio-economic:
  - Developing a survey (e.g. Theory of Planned Behaviour)
  - Economics and policy
  - Land use
- Soil science
  - Biophysical
  - Land use
- Computer modelling
  - Agent-based modelling
  - Biophysical modelling

ALL INTERLINKED.

Background

- Climate change has become the most important global environmental problem we face. CO_2 / N_2O / CH_4
- Selected land use was energy crops:
  - Energy crops have been suggested as a means of reducing GHG emissions
  - Uptake of energy crops in developed countries has been slow.
- Aim to identify social, economic and other barriers to the uptake of energy crops and to model socio-economic processes and associated GHG emissions.

Bioenergy

Bioenergy encompasses:

- liquid biofuels
- energy crops including biomass crops.

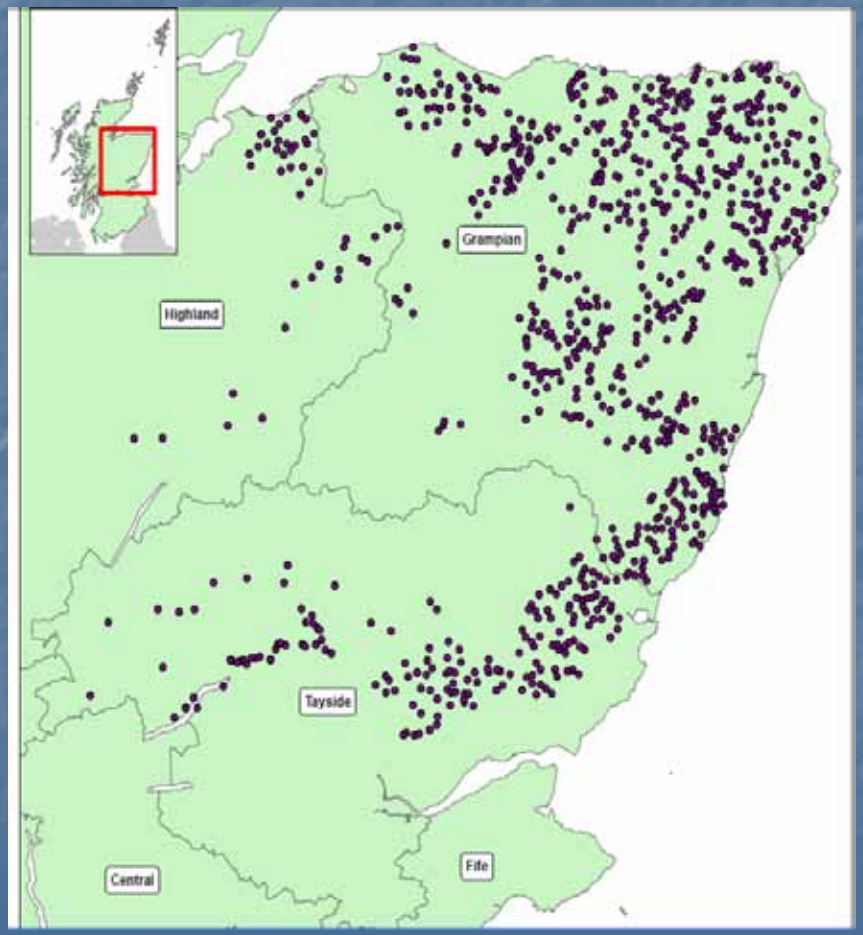
- Much evidence that biofuel crops do not actually mitigate against climate change globally.

- The benefits of a Scottish programme with particular emphasis on biomass energy production is not so clear and could provide benefits.

Data Gathering

- Details of 1000 farmers collated.
- ‘Farming and Bioenergy Survey’ designed
- telephone interviews
- postal survey (750)
- online survey
- Currently 200 approx. responses.
- The responses were then organised to aid analysis.

Survey Area


Highland
Grampian
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Central
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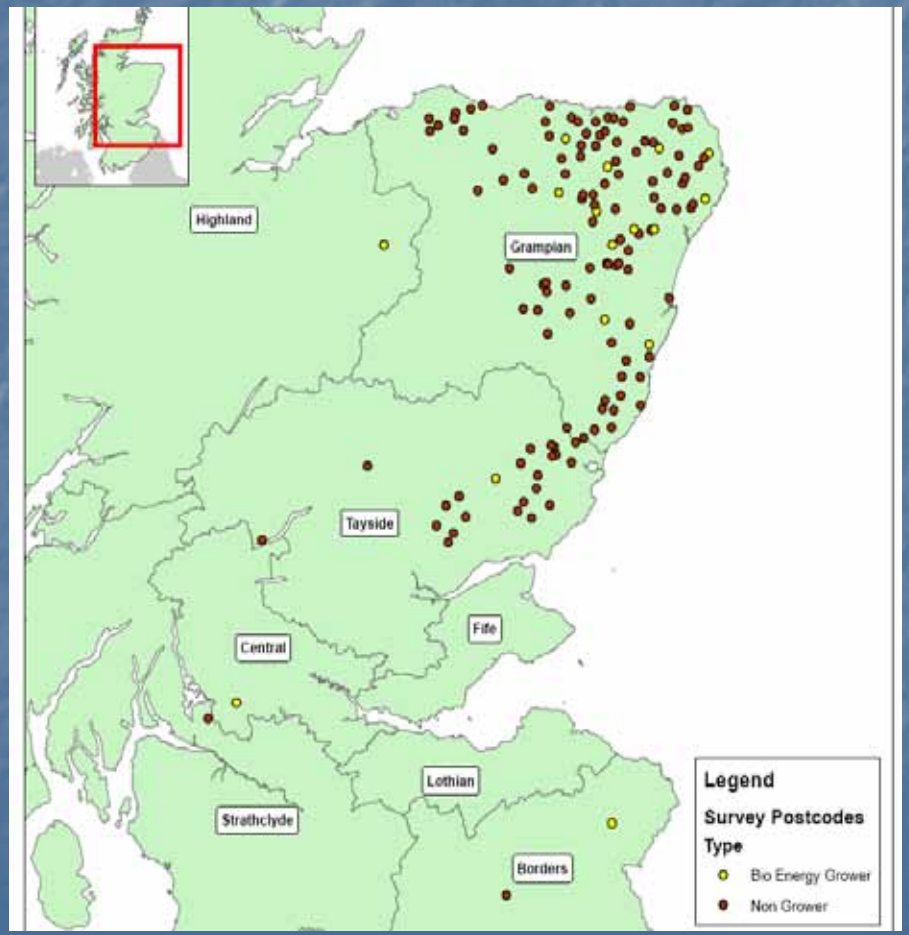
Highland
Grampian
Tayside
Fife
Central
Lothian
Strathclyde
Borders
Legend
Survey Postcodes
Type
Bio Energy Grower
Non Grower

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NATURAL ENVIRONMENT RESEARCH COUNCIL

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FARMING AND BIO-ENERGY SURVEY

This questionnaire is designed to gather information for a research project being carried out in conjunction with the University of Aberdeen and the Macaulay Institute to identify sustainable land management strategies aimed at reducing greenhouse gas (GHG) emissions whilst still being economically viable.

This project will improve the understanding of influences affecting the uptake of bio-energy crops, e.g. SRC willow, Miscanthus and oilseed rape, as well as forestry projects, as an alternative or in addition to conventional farming practices. The project also aims to evaluate general attitudes regarding environmental issues amongst the landowner/farmer community, with particular focus on climate change.

SECTION D - *Awareness of Bio-energy Crops*

Question 4.1
Do you have confidence in the UK Government's bio-energy legislation being effective going forward in achieving a stable and growing market for bio-energy?

☐ Yes ☐ No

Question 4.2
What level of contribution towards the establishment costs of bio-energy crops would have to be available through subsidy support to make you seriously consider growing a bio-energy crop(s) on your farm?

0-10%	11-25%	26- 50%	51-75%	76-100%
☐	☐	☐	☐	☐

Question 4.3
What are your views on the following mechanisms enabling you to grow a bio-energy crop in the future?

Scheme	Extremely negative 1	2	3	4	5	6	Extremely positive 7
Subsidy/Grant	☐	☐	☐	☐	☐	☐	☐
Tax incentives	☐	☐	☐	☐	☐	☐	☐
Credit trading (cap and trade system allowing credits to be sold to high polluters)	☐	☐	☐	☐	☐	☐	☐

Question 4.4
Have you ever sought information on growing bio-energy crops? (If **not** go to **Question 4.5**)

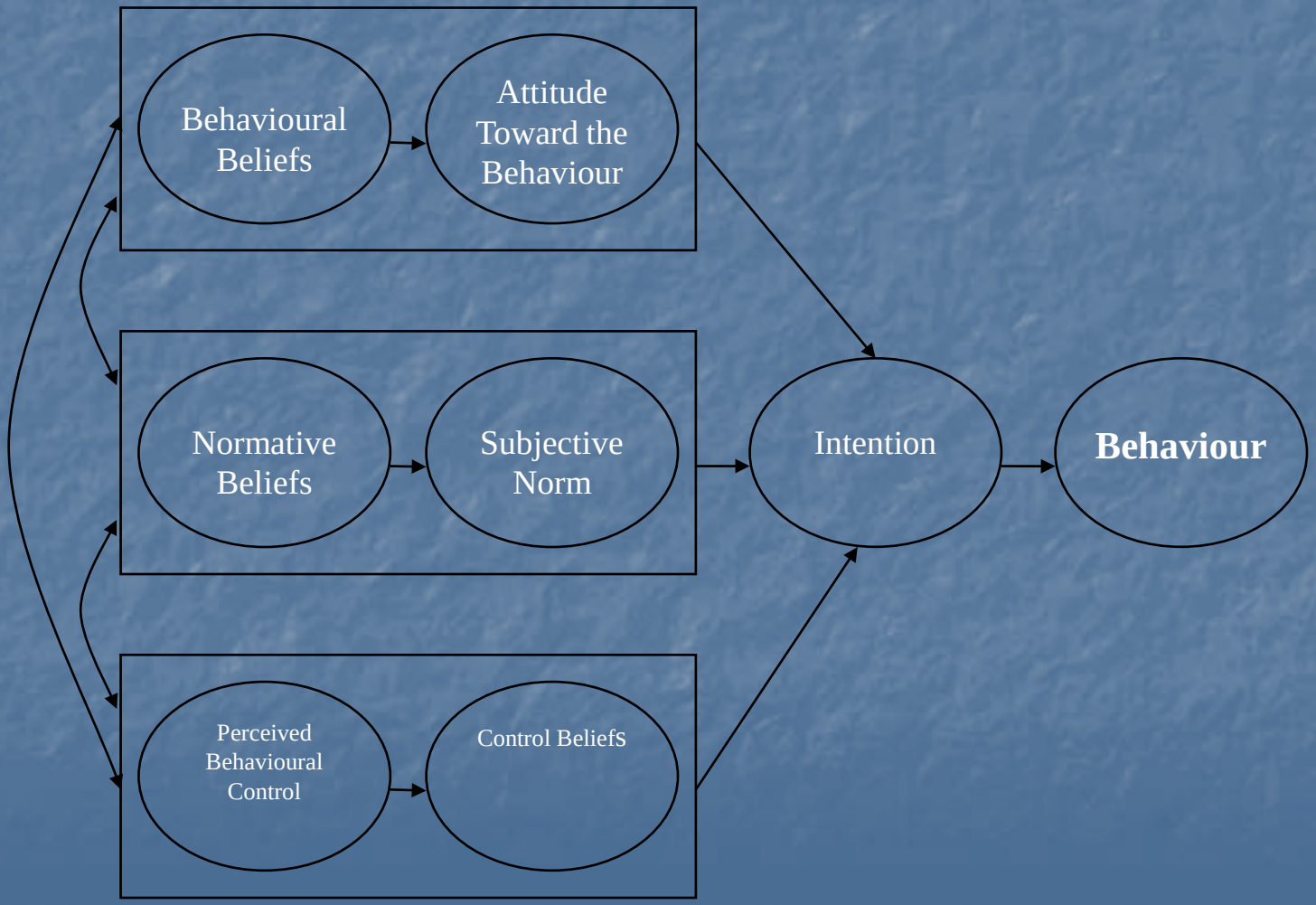
Was this information easy to access?

Definitely not 1	2	3	4	5	6	Definitely 7
☐	☐	☐	☐	☐	☐	☐

Was the information helpful to you?

Definitely not 1	2	3	4	5	6	Definitely 7
☐	☐	☐	☐	☐	☐	☐

Theory of Planned Behaviour



Socio-economic Analysis:

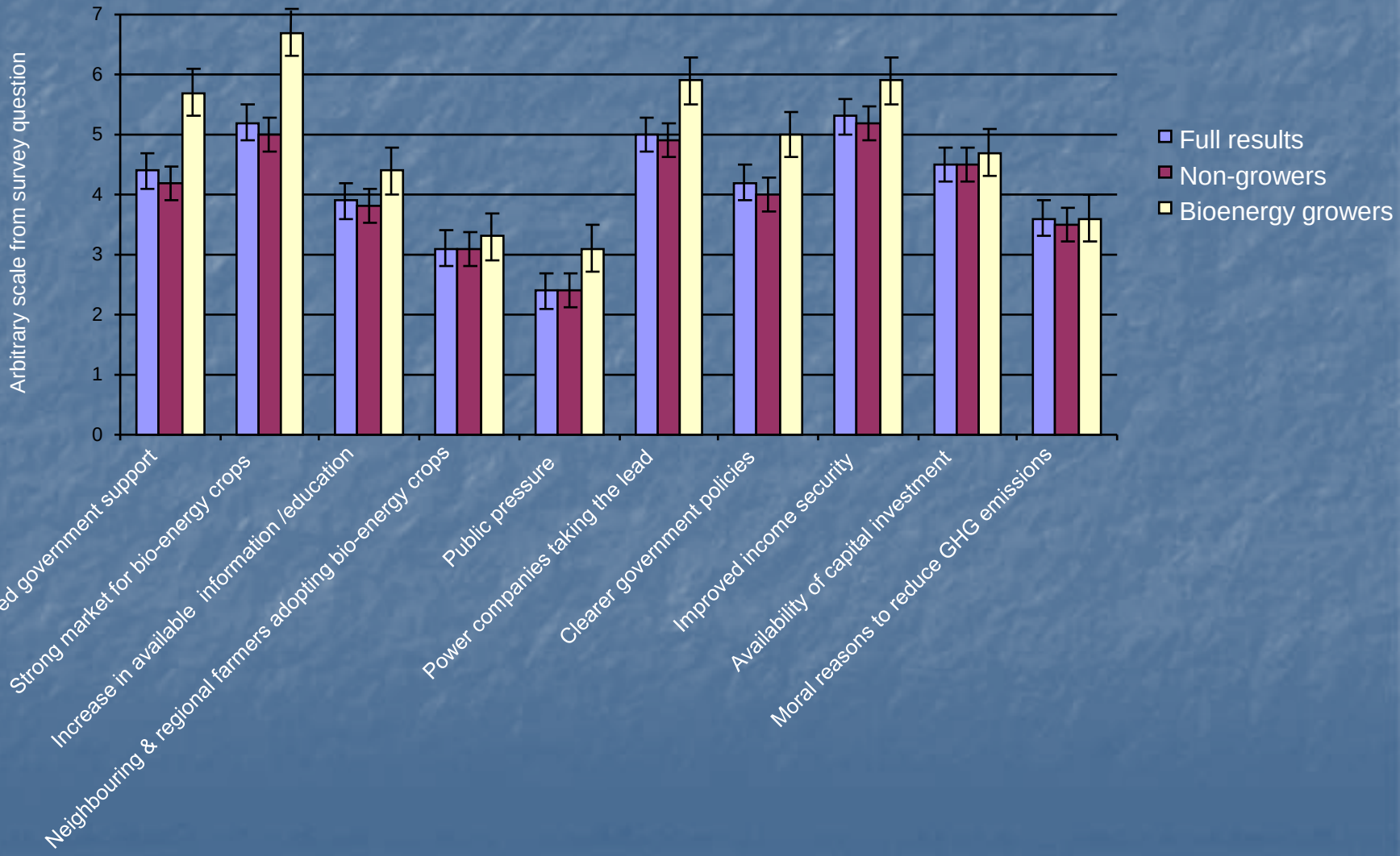
Demographics and farm size:

- Bioenergy growers were younger and more had received tertiary education.
- Average number of generations in farming was 3 (grandparents).
- Farm size of bioenergy growers was 53% larger.
- Bioenergy adoption ranged from 1 to 280ha.
- Incomes were higher from farmers who adopted bioenergy crops

Attitudes and Awareness

- Key findings:
- Main drivers for deciding to grow bioenergy crops are economic.
  - Improved income levels /diversity
  - Power companies driving adoption
- Bioenergy growers were more aware of other farmers growing bioenergy crops.
- Farmers rated climate change lowest compared to other environmental concerns.
- Farmers believed there was a level of ‘uncertainty’ in policy, with governments failing to fully understand the agricultural sector when developing policy.
- Information sought on growing bioenergy crops: 70% BEG vs 22% NG
- Subsidy system most attractive to farmers.

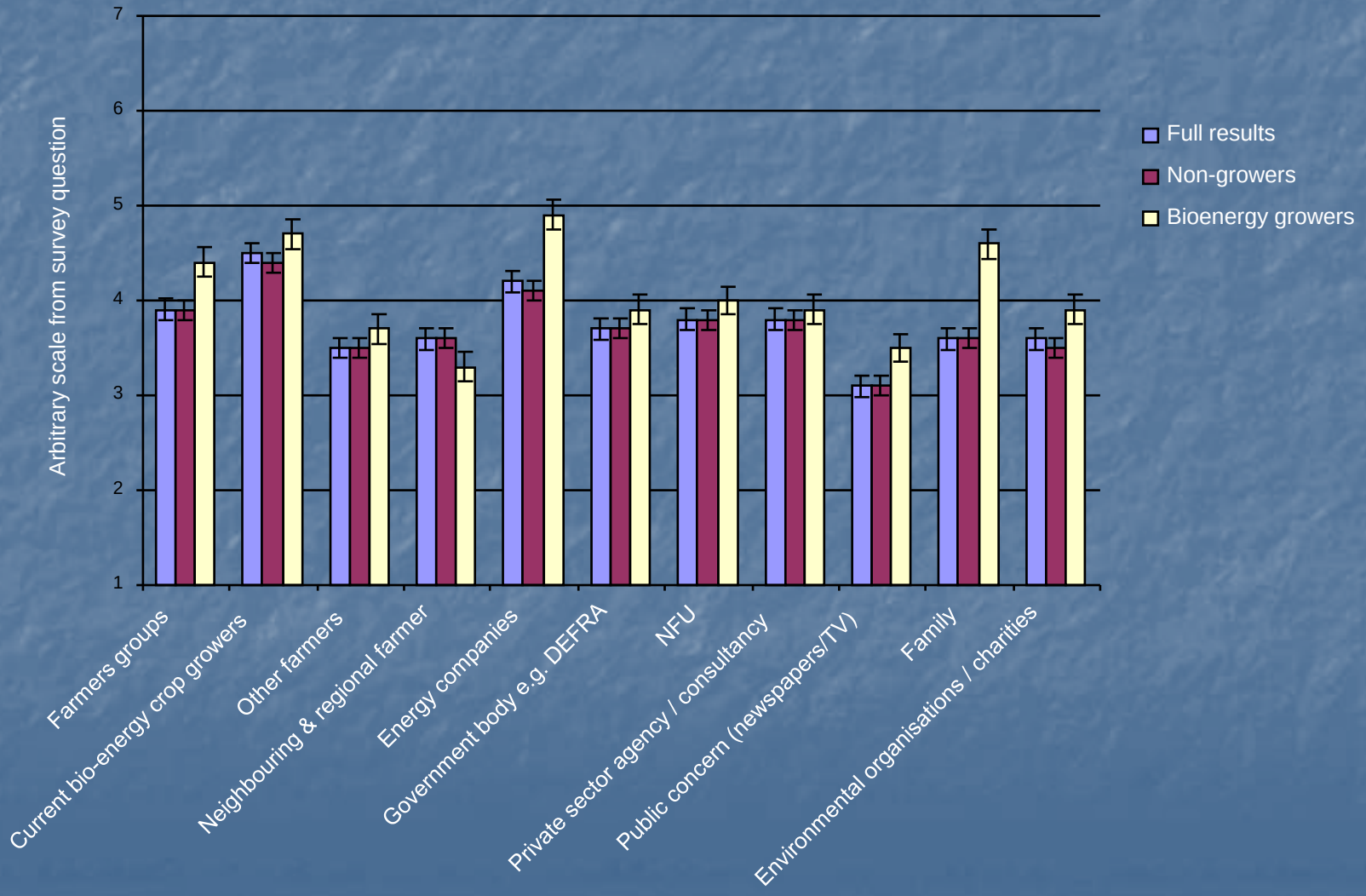
The influence of a range of factors on a farmers' decision to grow a bioenergy crop.



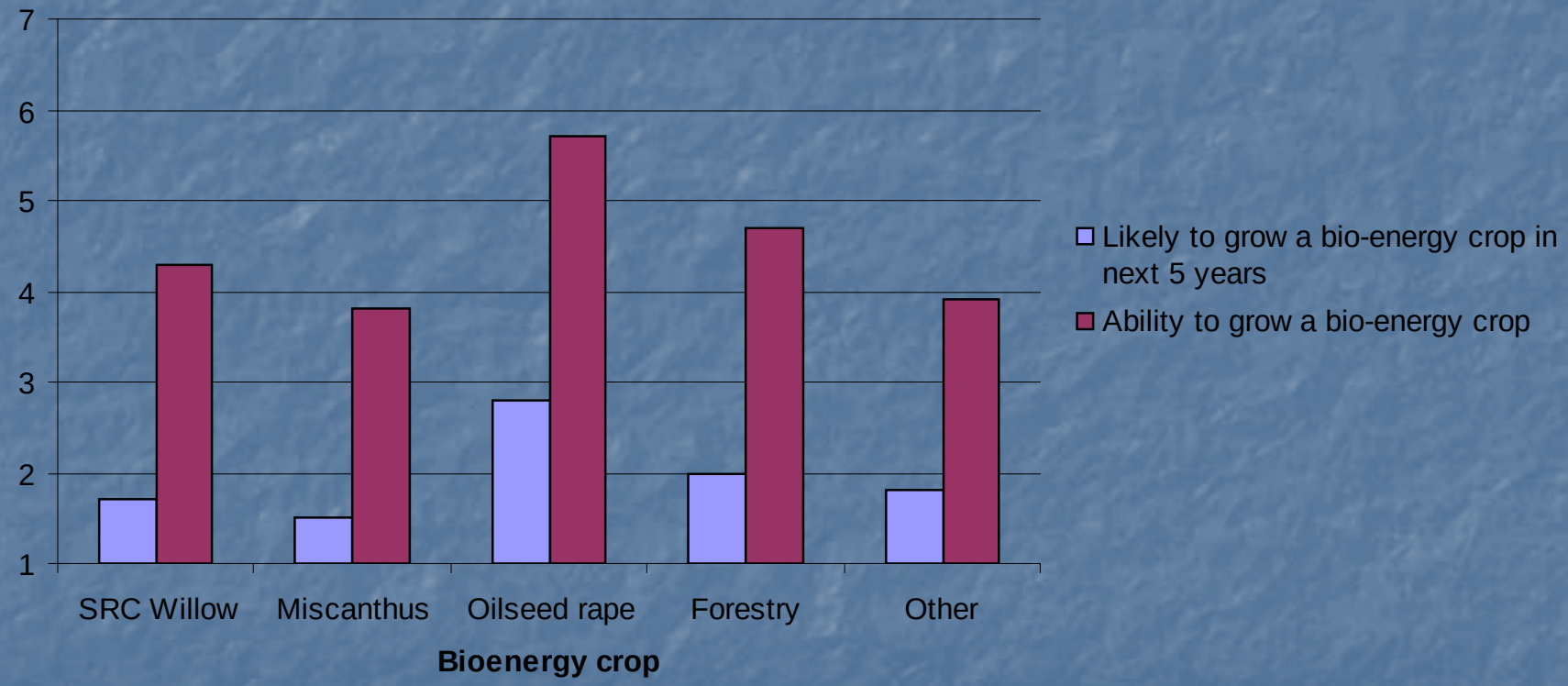
Compromising Revenue

Level of revenue compromised	Full results	Non-growers	Bioenergy growers
< 5%	21 (54%)	19	3
<10%	15 (38%)	12	3
<25%	2 (5%)	1	1
<50%	1 (3%)	-	1
	22%	**18%**	**38%**

Extent to which various groups/organisations would encourage growing a bioenergy crop.



Comparison of the likelihood of growing an bioenergy crop against the difficulty of growing the crop



Models Used in the Project

- PALM (People and Landscape Model):

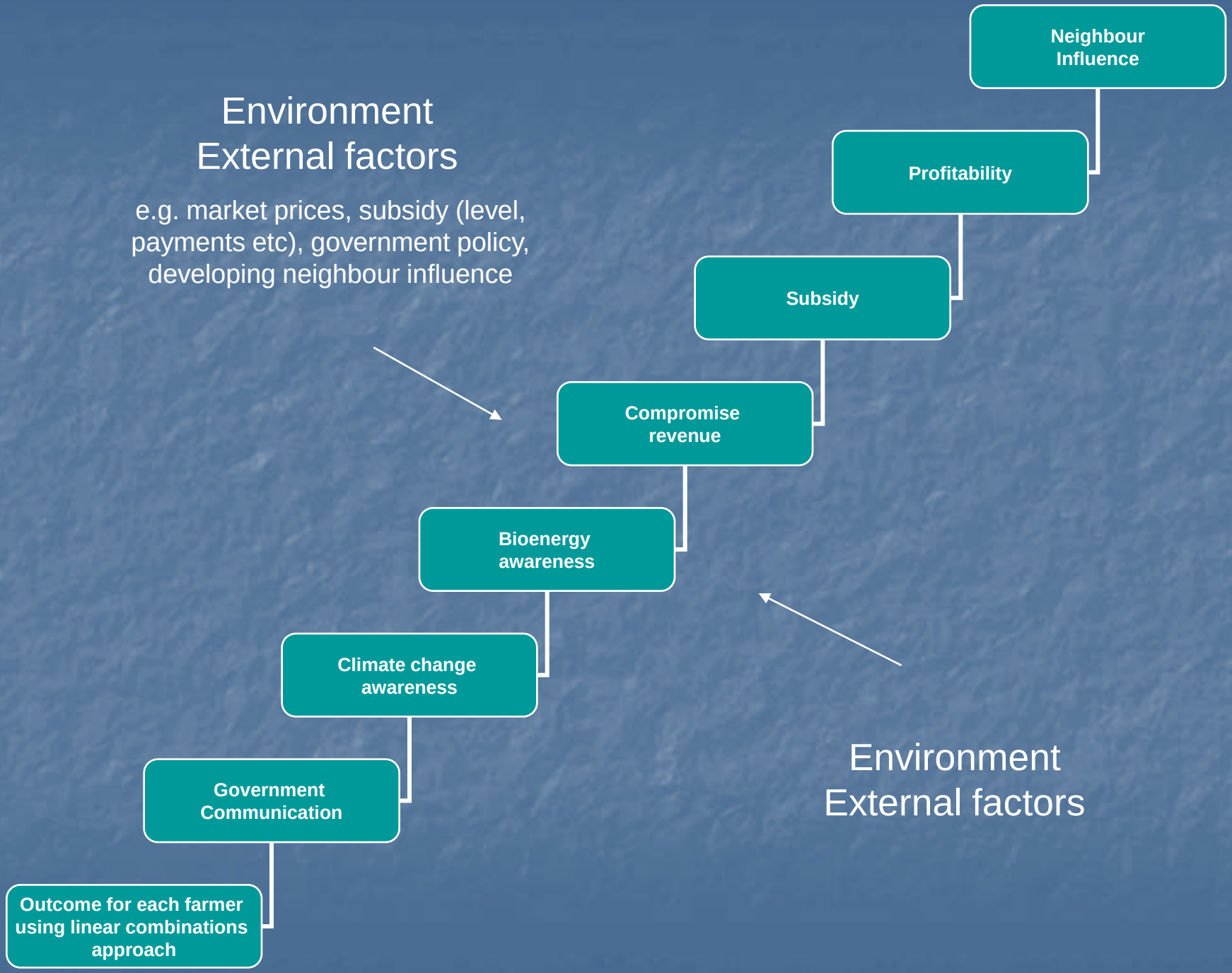
- The ‘Bioenergy model’ set within the framework of PALM.
- Based on object-orientated programming.
- A number of internal and external factors will be implemented:
- Economics (e.g. compromising revenue)
- CC awareness (attitudes)
- Neighbourhood influence – how do we define a neighbour?
- Government (policy initiatives)

Agent-based Modelling

- ABM originates from the field of artificial intelligence (AI).
- Been identified as providing a promising approach to integrate social, economic and biophysical processes.
- Uses virtual agents:
  - Social interaction (communication and exchange)
  - Decision making (individual variation)
  - Interaction and co-evolution between agents and their environment.
  - Population level adaptation

Environment
External factors

e.g. market prices, subsidy (level, payments etc), government policy, developing neighbour influence



Environment
External factors

Models Used in the Project

- ECOSSE (Estimating Carbon in Organic Soils – Sequestration and Emissions model).

- developed to provide credible SOC values for organic soils which form the majority of soil types in Scotland, (Smith,. *et al*. 2007).
- measures C and N dynamics in organic soils to determine:
  - the percentage of soils that can be considered organic
  - estimating the amount of organic carbon held within them.
- Used to model the biophysical (GHG emissions, carbon storage) resulting from output data from PALM.

Future Work

- Get ABM ‘bioenergy model’ producing robust output based on identified key factors (internal and external) and begin to produce scenarios.
- To conduct further interviews with farmers to see if they agree with modelling output (one form of validation).
- Assess the GHG emissions and sequestration potential under defined scenarios using ECOSSE.