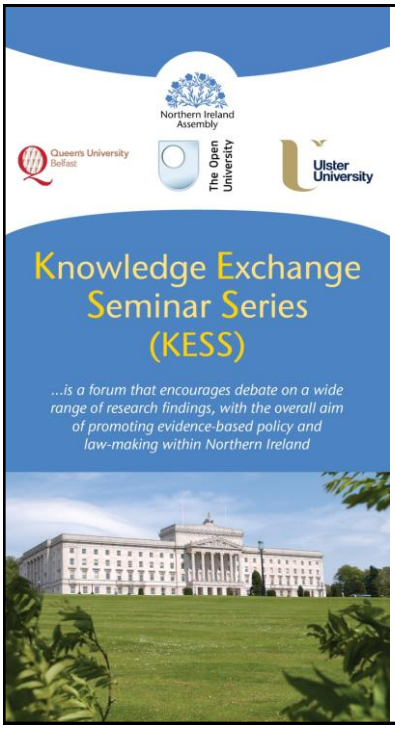


Maximising Production and Biodiversity in NI Agriculture

Prof Ian Montgomery, MRIA FRSB
Institute of Global Food Security,
School of Biological Sciences,
Queen's University of Belfast

Wednesday 18th May 2016

Presentation aims

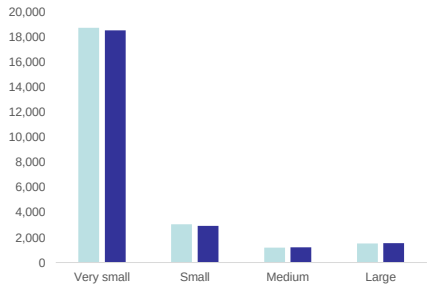
(a) demonstrate the common bases of the difficulties facing agriculture and environmental aspirations in NI

(a) identify potential, research-led solutions leading to a more ecologically sustainable and profitable form of agriculture in NI

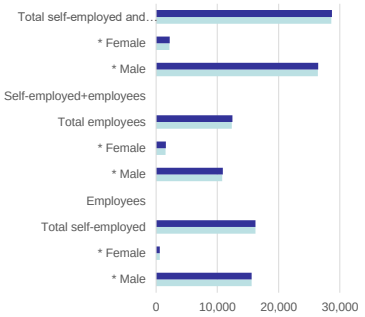
(a) provide a means of implementation that incentivises and facilitates audit of change leading to an increasingly robust rural economy during the 21st century

26,000 NI farms with 47,000 workers (41% full time): average area 41ha; 89% Small or Very small

NI farms NI by 'size' (level of employment)



Employment on NI farms



2014 (light) and 2015 (dark)

Source: Agricultural Statistics 2015

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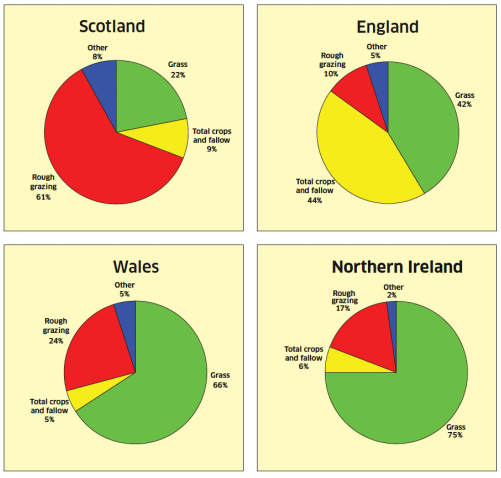

Comparative agricultural land use in England, Wales, Scotland and NI

http://www.gov.scot/Publications/2011/06/15143401/57

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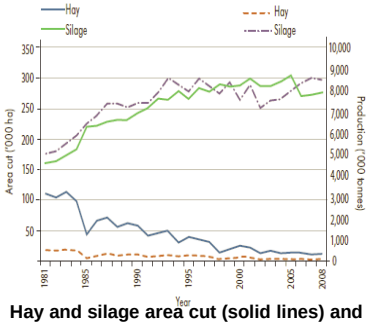
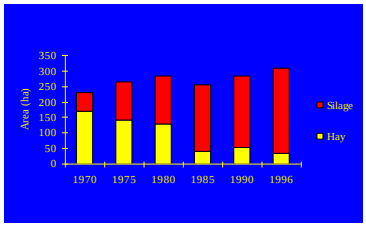
Changes in NI grassland management



Hay and silage area cut (solid lines) and production (dashed lines) from 1981 to 2009



Agricultural Statistics, DARD

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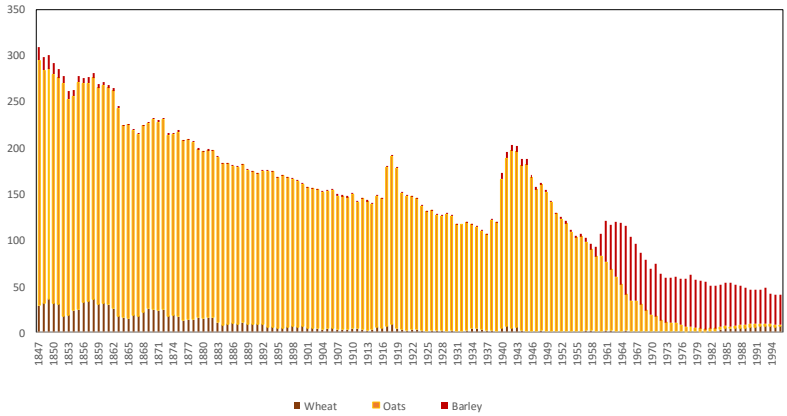
Cereal production for NI counties 1847-1995



Source Central Statistics Office, Dublin

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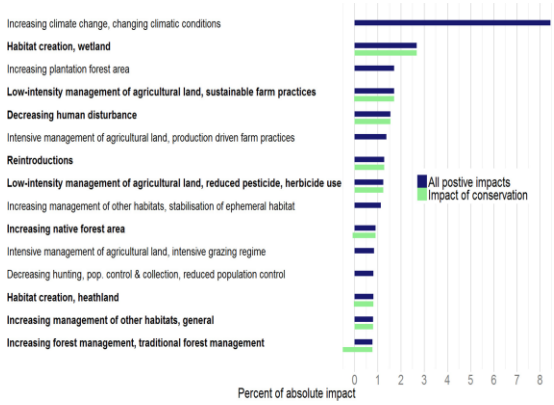
Causes of biodiversity loss

The most important broad drivers of species' population changes, 1970–2012

Positive (green) and negative (blue) impact for each broad driver of change accounting for 2% or more of the total, in the three major taxonomic groups (insects, plants and vertebrates)

Burns F, Eaton MA, Barlow KE, Beckmann BC, Brereton T, Brooks DR, et al. (2016) PLoS ONE 11(3): e0151595.



Impact of specific drivers classified as conservation measures in relation to all positive impacts on UK species

Specific drivers of change with positive impacts accounting for at least 0.75% of absolute impact, showing the positive impact, including **conservation and non-conservation actions (dark blue)** and the impact of **conservation alone (light green)**.

Specific drivers categorised as conservation actions are shown in bold.

Burns F, Eaton MA, Barlow KE, Beckmann BC, Brereton T, Brooks DR, et al. (2016) PLoS ONE 11(3): e0151595.

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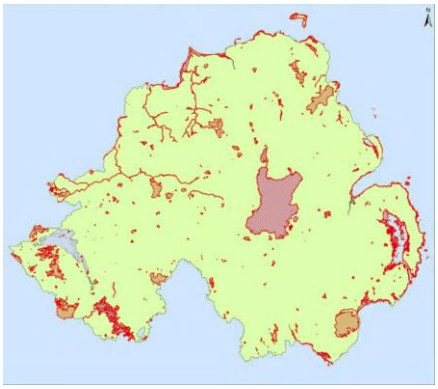
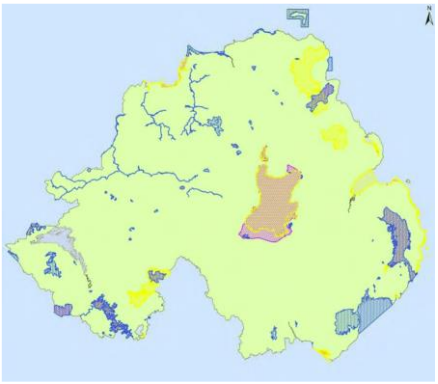
Areas of NI designated for conservation



Areas of Special Scientific Interest (ASSI), March 2012



Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites, March 2012

Source: Evidence to Opportunity: A Second Assessment of the State of Northern Ireland's Environment 2013

NI Environmental condition

- 33% of monitored rivers and 5 of 21 freshwater loughs were regarded as 'good' or better
- 1,310 confirmed pollution incidents (16% high or medium severity) with agriculture, industry, domestic sources and NI Water responsible for 26.9%, 18.5%, 18.3% and 16.3% respectively
- A third of 'features' in ASSIs in 2015 were deemed in unfavourable condition
- Significant loss of ground nesting and farmland birds such as the yellowhammer, corncrake, lapwing and skylark
- Wet meadows are all but gone with small fragments only remaining

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Categories of ecosystem services – what did the environment ever do for us?

provisioning – the products obtained from ecosystems such as food, fibre and fresh water

regulating – the benefits obtained from ecosystem processes such as pollination and control of climate and water, both quality and quantity

cultural – the non-material benefits obtained from ecosystems such as spiritual or religious enrichment, cultural heritage, recreation and tourism, or other aesthetic experiences

supporting – ecosystem functions that are necessary for the production of all other ecosystem services including soil formation and the cycling of nutrients and water

Problems inherent in NI agriculture

Weather and climatic factors
Prevailing meteorological conditions: wind, rain, temperature
Climate change: adaptation, mitigation

Land issues
Localisation of 'best' agricultural land
Land prices
Increasing area of non-productive, marginal land
Dereliction, fire, illegal dumping
Farm area and fragmented holdings/ownership
Soil degradation: compaction, loss of carbon and soil biodiversity
Field size and shape

Biosecurity: pathogens, pests and pollutants
Diseases and pests of crops and livestock
Disposal of wastes (nitrates/phosphates/ slurry)
Accumulation of pesticides
Pollution of water and soil

Social and economic factors
Low incomes based on CAP subsidies
Limited home market
Lack diversity in crops, livestock
Part-time, aging farmers
Safety on farms
Access to the countryside
Social isolation
Scattered rural population; infrastructure, services
Resistance to change
Planning

Conservation issues and problems inherent in NI

Weather and climatic factors
Climate change: adaptation, mitigation
Carbon sequestration, emission limitation
Impact of renewable technologies
Disturbance: extreme events

Land issues
Habitat loss, degradation, fragmentation and connectivity
Poor land management: fire, soil compaction, erosion
Landscape/habitat homogenisation

Biosecurity: pathogens, pests and pollutants
Invasive alien species
Genetic admixture: loss of genetically adapted local populations
Plant (tree) pathogens
Water and soil contamination: enrichment, eutrophication
Bioaccumulation of toxic organic compounds
Sensory (noise) pollution

Social and economic factors
Pooling resources towards common goals
Making conservation pay
Putting a value on ecosystem services
Influencing decision takers
Education
Conflicts with recreation
Access to biodiversity
Planning

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Major areas of concern: congruence of issues related to agricultural production and environment

Land ownership
Farm size
Landscape management
Production
Marketing
Farm incomes
Diversification
Ecosystem services
Eutrophication
Biosecurity
Resistance to change
Stress

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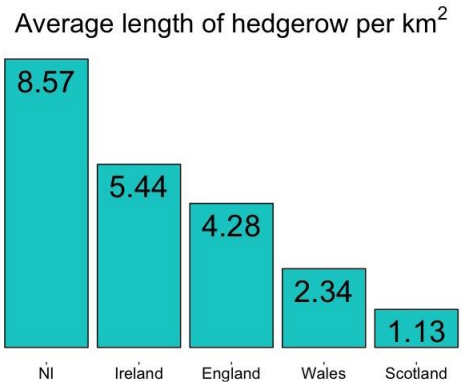
CAP in NI

- Payments on farms >3ha and fields >0.1ha
- Maximum hedge width allowable ‘2m from centre at base’
- ‘Gappy’ hedges are allowed where no gap exceeds 5m
- Exemptions under the ‘three crop rule’
- Annual value of CAP at ca. £250M
- 2015 combined total budget DARD/DOE £386M

Field boundaries - Hedges



NI hedges are a major agricultural and ecological asset

114,000 km of hedgerow; a third contain ash and ca 58% all hedgerow trees are ash with an estimated 2.9 million ash trees in total

Source: Siobhan Porter, Flor Spaens QUB

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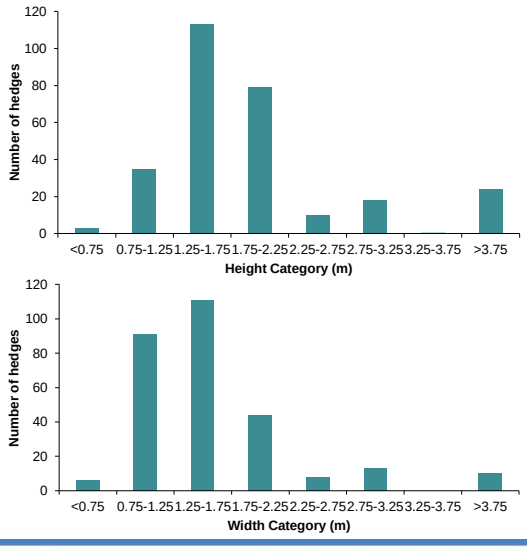

Hedgerow characteristics

Land use:
- 250 (88.3%) hedges by pasture
- 33 hedges next to arable land or orchards

Hedge management:
- 12 cut only on the side
- 130 (45.9%) cut on side and top
- 50 recently cut top and side
- 209 (73.9%) cut 2 or less years
- 17 (6.0%) not managed

Woody species:
- 13.4% only one species
- 83.4% one dominant species
- Average number of species 3.4
- Maximum number of species 10

Source: Carol Finlay QUB

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Management impact on hedgerow biodiversity – levels of management

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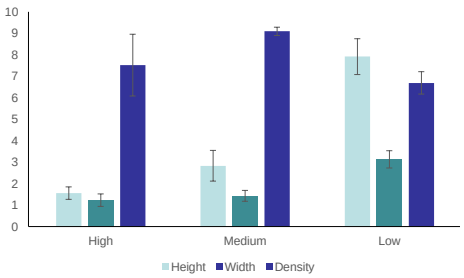
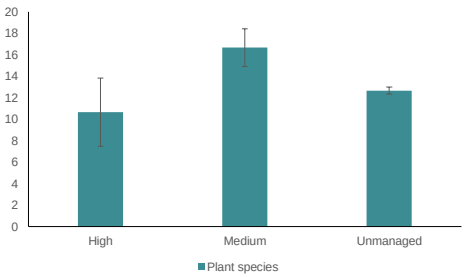
Knowledge Exchange Seminar Series (KESS)

Fermanagh hedges – effect of management on species rich hedges

Mean height, width and density (scale 1-10)



Mean number plant species



Source: QUB unpublished data

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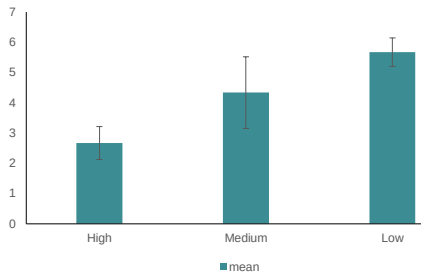
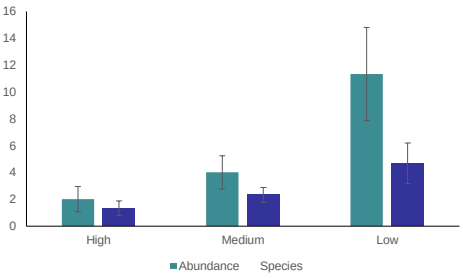
Fermanagh hedges – effect of management on species rich hedges

Mean number wood mice



Mean bird abundance/species



Source: QUB unpublished data

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Fermanagh hedges – effect of management on species rich hedges

Sweep nets

Management	High	Medium	Low
Acari			
Aranae			x3
Collembola			
Coleoptera*	abs		
Col: Staphylinidae		abs	abs
Diplopoda		abs	x4
Diptera*			x2
Gastropoda			abs
Hemiptera*			
Hymenoptera (NP)		abs	abs
Hymenoptera (P)*			x2
Lepidoptera			
Opilones			x4
Trichoptera	abs		abs

Source: QUB unpublished data

Pitfall traps

Management	High	Medium	Low
Acari		abs	x3
Aranae			
Chilopda	abs	abs	
Collembola	abs		
Coleoptera*			x15
Col: Staphylinidae			
Diplopoda			x2
Diptera*			x7
Gastropoda			x2
Hemiptera*			x4
Hymenoptera (NP)	abs		
Hymenoptera (P)*			x16
Isopoda		abs	abs
Nematoda		abs	abs
Oligochaeta		abs	abs
Siphonaptera	abs	abs	
Opilones	abs		
Trichoptera		abs	abs

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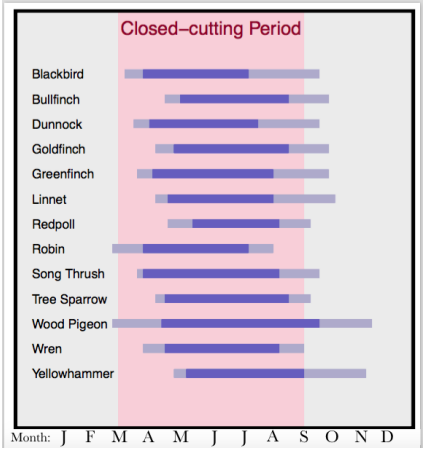

Estimated nesting times throughout the British Isles in **dark purple (most likely)** and **light purple (90% of records)**.

The 'closed-cutting' period in summer should be maintained; August is still an active breeding time for many hedgerow bird species most notably the Yellowhammer

Food supply of wintering birds is also affected by hedge management

Source: Siobhan Porter, Neil Reid (QUB); David Leech (BTO)

Fields – grass production

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Development of aerial imagery to remote measurement of hedgerow as % land area

Original image

Spectral analyses filtering

Source: Carol Finlay QUB

Target area put through filters.

Development of aerial imagery to remote measurement of hedgerow as % land area

Area of Woody vegetation = 0.04206 km^2 4.206%

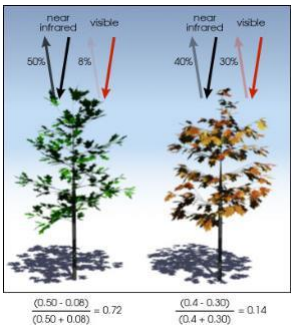
Specialised imagery – not yet available for NI

Development of simple 3-band imagery (Askoy et al. 2010) simplified using current GIS software.

Source: Carol Finlay QUB

NDVI- Normalized Difference Vegetation Index

Normalized Difference Vegetation Index -always between 1 and -1
Need 4 band images that include a red band and a near infra-red band
Calculation:



(Near IR minus Red)

---------divided by---------

(Near IR plus Red)

What is NDVI?

Simple answer:

health of vegetation

Source: Carol Finlay QUB

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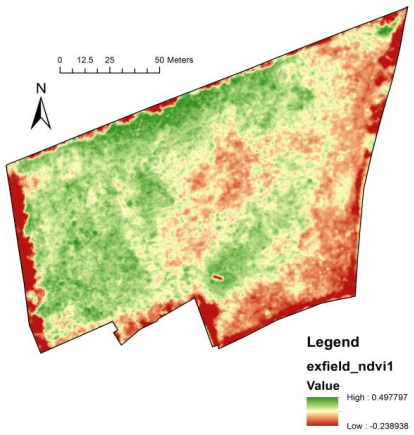
NDVI- Normalized Difference Vegetation Index



Source: Carol Finlay QUB

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NI farmland landscapes

Small fields, large hedgerows.
Average field size = 1.4ha
7.96% woody vegetation

Large fields, small hedgerows.
Average field size = 2.6ha
6.58% woody vegetation

Source: Carol Finlay QUB

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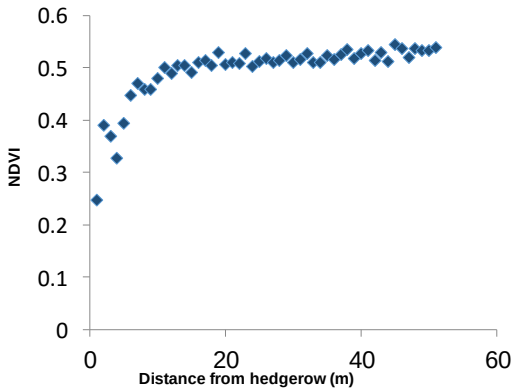
Grass Productivity: distance to hedge (m)



Source: Carol Finlay QUB

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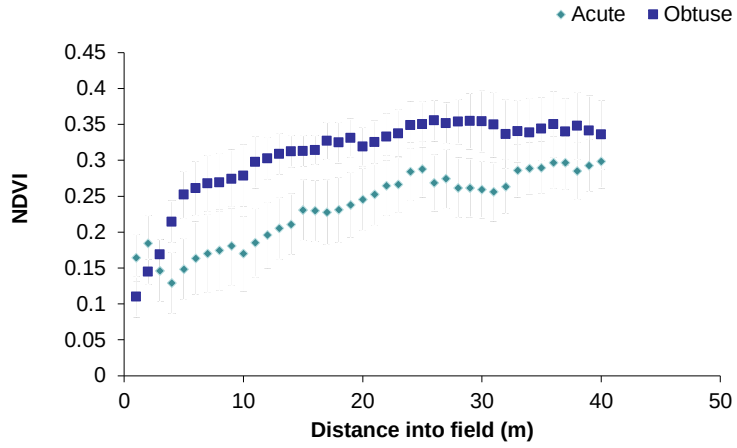
Grass Productivity: distance to hedge in acute (<90º) and obtuse (>90º) corners



Source: Carol Finlay QUB

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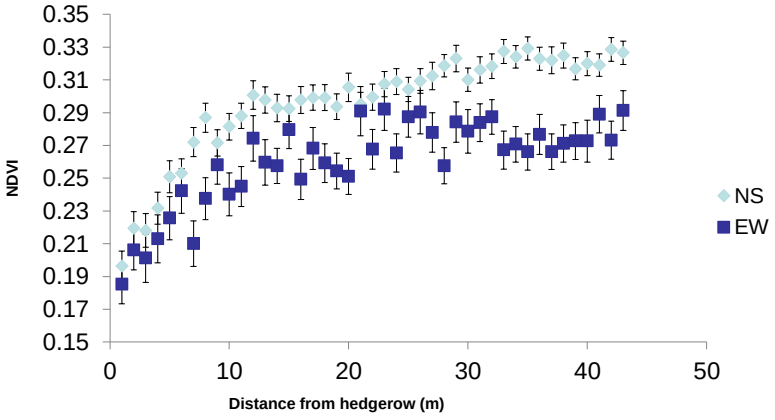
Grass Productivity: distance to hedge and orientation of hedge



Source: Carol Finlay QUB

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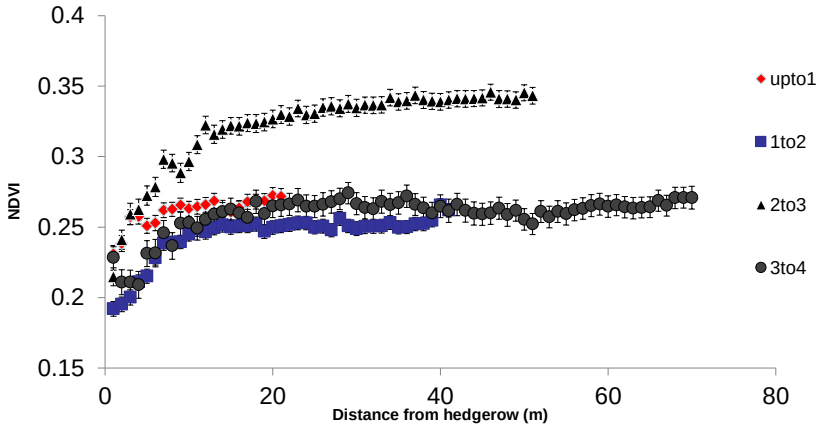
Grass Productivity: distance to hedge and field area (ha)



Source: Carol Finlay QUB

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Maximising production maximising biodiversity

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Maximising production and biodiversity at field level

- Field areas of ca.3ha best for production
- East-West oriented hedges and acute corners decrease production
- Wider hedges provide more biodiversity-related ecosystem services
- Sacrificing narrow hedges cut annually to create larger more regular fields with wider North-South hedges to maximise production and biodiversity
- NI hedges could add up ca. 7% land are under woody plant cover and hence contribute carbon

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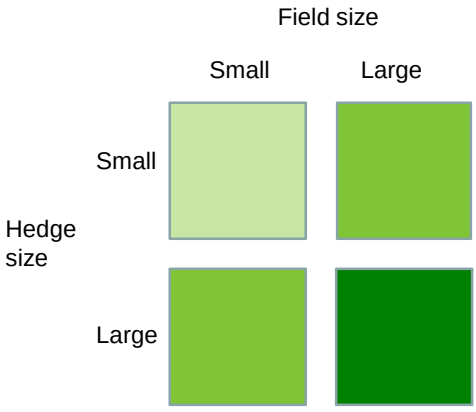

Large fields with large hedges best for production and ecosystem services

Field/Hedge Size

Small/Small Poor productivity/Poor Biodiversity
Small/Large Poor productivity/Good Biodiversity
Large/Small Good productivity/Poor Biodiversity
Large/Large Good Productivity/Good Biodiversity

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Five key 'Win-wins' for production, biodiversity and ecosystem services

1. Increased grass legume mixes
2. Crop rotation with vegetables, fruit, biofuels crops and cereals as well as grass
3. Maximise number of fields with optimal area and hedge orientation and management
4. Increased area of shelter belts of trees and farm woodland taking least productive agricultural land out of production
5. Reservoir and pond creation and restoration

Objectives for Integrated Agriculture-Environment Plan

Meeting 21st century needs in food production through sustainable ecosystems

1. **Economic sustainability**
2. **Increased market recognition**
3. **Larger, more robust farm businesses**
4. **Strengthened bio-security**
5. **Improved soil health**
6. **Enhanced environmental protection**
7. **Expansion of silviculture**
8. **Support for rural communities**
9. **Opportunities and risks of climate change**
10. **Development of expertise**

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Land sharing land sparing

1. Land sharing: integration of land use to meet the needs of production and biodiversity
2. Land sparing: separation of land uses with some areas given over to maximise production with appropriate levels of environmental protection to maintain ecosystem services
3. Often discussed with reference to continental areas with areas of 'wilderness'
4. Land sparing and sharing concept can extend down to the level of a field
5. Integrated plans maximising both production and ecosystem services must operate on multiple scales
6. Land sparing will predominate in some places and land sharing in others.

Mechanisms for change

1. Market forces: environmental and welfare standards, enabling promotion of a stronger, more profitable product
2. Planning and monitoring: at farm/field/farm unit levels using regular remote sensing surveys
3. Redirection of subsidies and existing grant support away from smaller to larger farm business units
4. Incentivise extensive systems and afforestation in less productive land areas and undersized farm units
5. Incentivise woodland and revise CAP prescriptions and exemptions in intensive systems

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Acknowledgements

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Dr Michael Meharg (NIEA)

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Mr Declan Billington, Thompson Feeds

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...is a forum that encourages debate on a wide range of research findings, with the overall aim of promoting evidence-based policy and law-making within Northern Ireland