Production of a national Irish paddock map for intensive grasslands

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Ceagasc

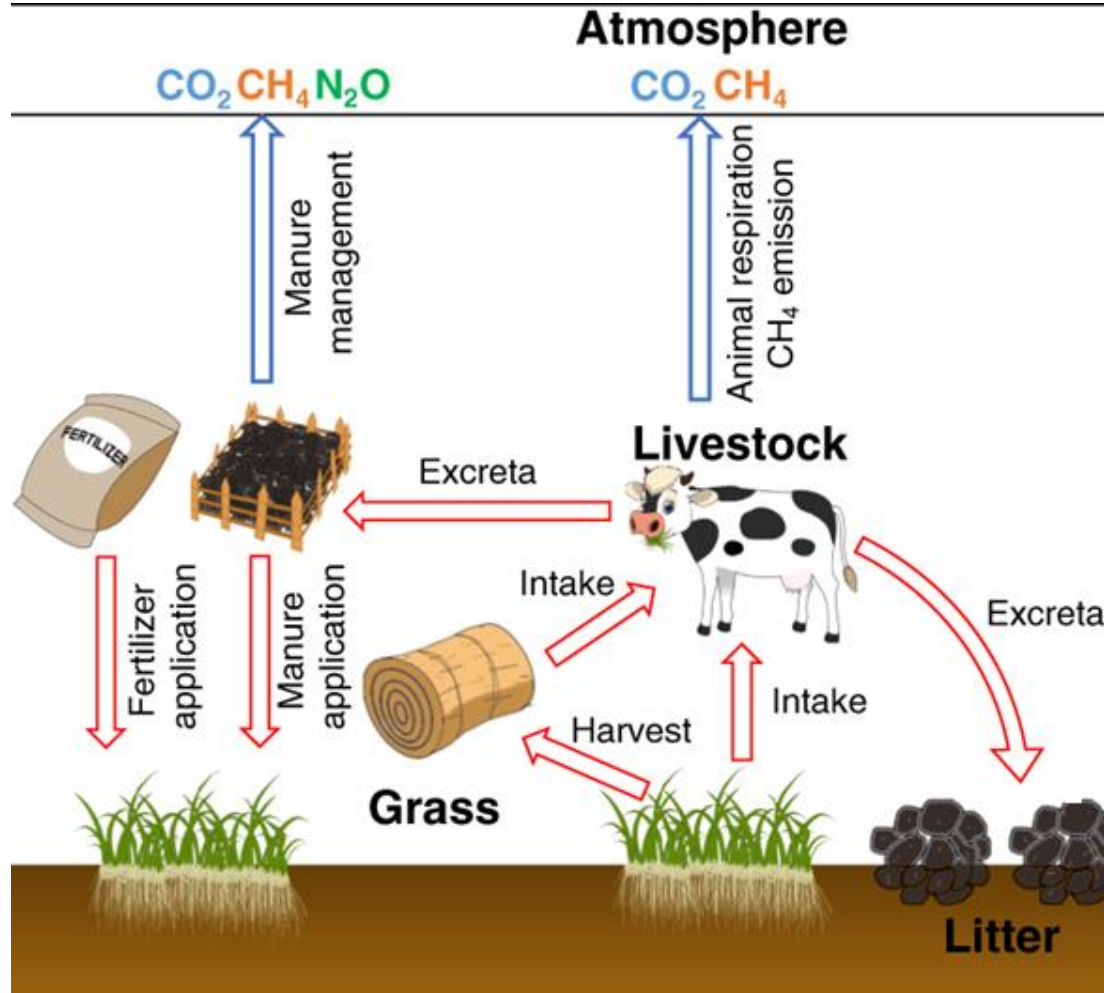AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY

Irish grassland

Primary land cover or 92% of AAU

Very diverse

Very dynamic

Irish grassland

GHG contributions:
High input/ stocking rate
Frequent mowing/grazing
Reseeding
Drainage
Hedge removal

Climate warming from managed grasslands cancels the cooling effect of carbon sinks in sparsely grazed and natural grasslands
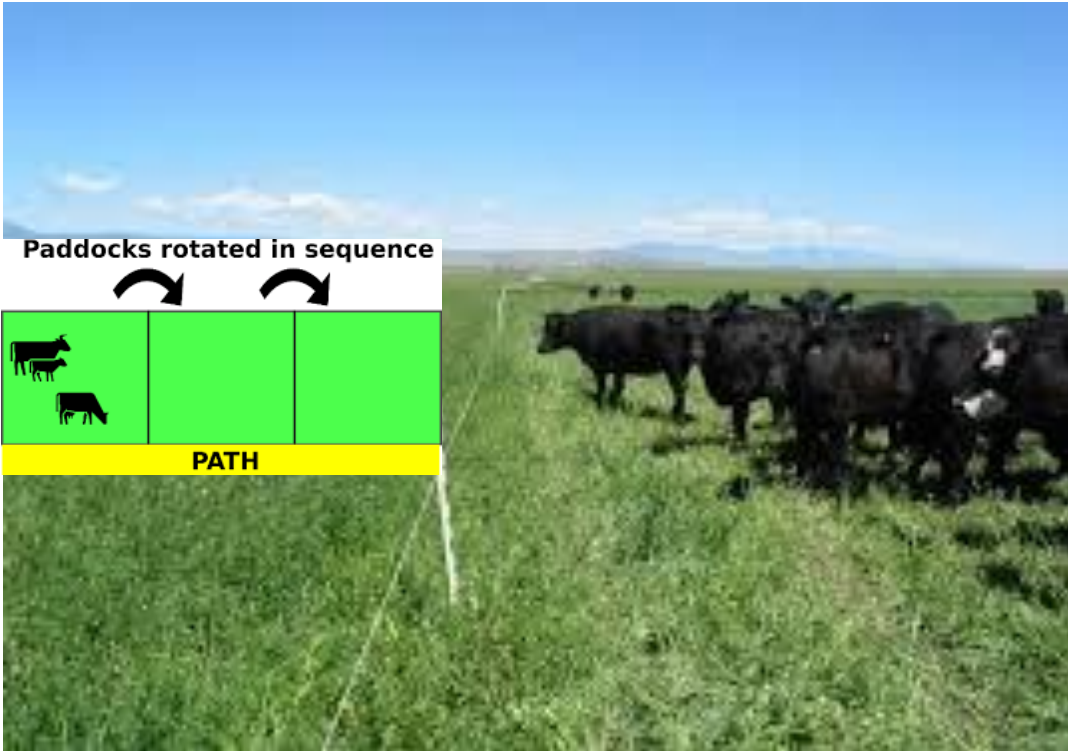https://www.nature.com/articles/s41467-020-20406-7/figures/1

AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY

Irish grassland

Currently, there's no existing spatial data on where very intensive farms are.

Teagasc

AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY

Paddock mapping

Rotational grazing in paddocks is a strong indicator of very intensive management.

Paddock is a fenced subdivision of a field.

Usually temporary fencing, but can be stable over time.

Size is variable = herd size x daily allowance / grass cover

Example: (100 cows x 26 kg per cow) /1,400 kg/ha = 1.85 ha paddocks

Paddock mapping

Methodology - Datasets
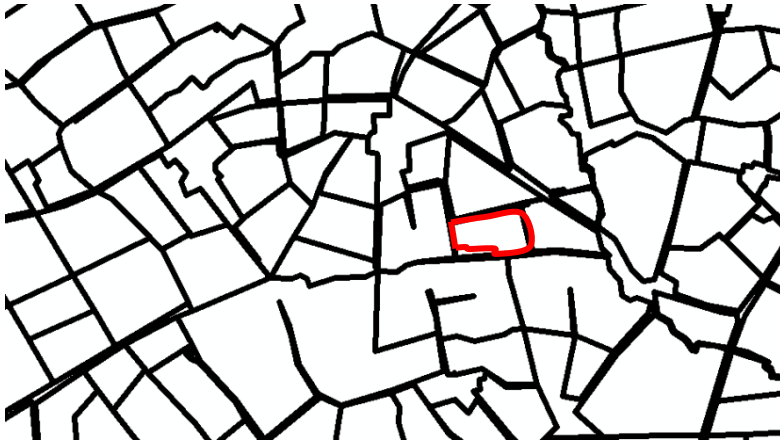
OSI Prime 2 polygons

Providing base objects
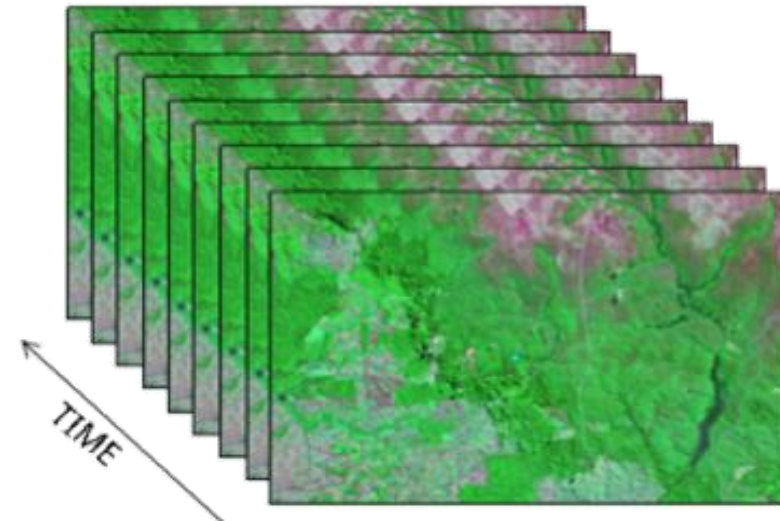
Sentinel 2 MSI images

Spectral data

if $p \leq 0.05$; then #modes > 1 (pixel density distribution is multimodal)

If %multimodal images for a FOI is > threshold (e.g. 25%), label = paddocks

Date 1: Unimodal   Date 2: Multimodal

```
modetest(data,mod0=1,method="ACR",B=500,lowsup=-Inf,uppsup=Inf,
submethod=NULL,n=NULL,tol=NULL,tol2=NULL,gridsize=NULL,alpha=NULL,
nMC=NULL,BMC=NULL)
```

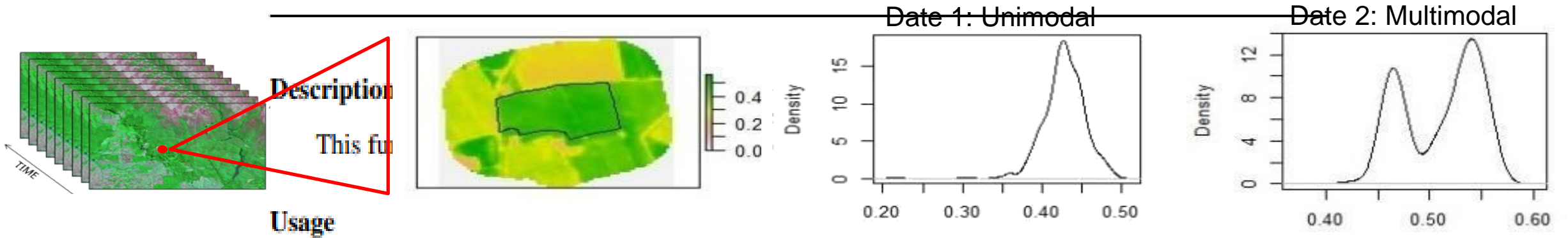| ExtractID	Date	Month	Year	p.value	sample.size	Class
Extract_1000016	2017	5	2017	0.289	116	U
Extract_1000016	2017	5	2017	0.342	116	U
Extract_1000016	2017	6	2017	0.2	116	U
Extract_1000016	2017	9	2017	0.3	116	U
Extract_1000016	2017	9	2017	0.742	116	U
Extract_1000016	2018	4	2018	0.045	116	M

Ameijeiras-Alonso, J., Crujeiras, R. M., & Rodriguez-Casal, A. (2021). multimode: An R Package for Mode Assessment. Journal of Statistical Software, 97(9), 1–32. https://doi.org/10.18637/jss.v097.i09

$$\frac{\#multimodal}{total\ \#images}$$

≥ 0.25 — Y — Paddocks

≥ 0.25 — N — Not detected

Results – Preliminary study

| Wavelength | G | R | RE1 | RE2 | RE3 | NIR | NIR | SWIR1 | SWIR2 | | |
S-2 Band	3	4	5	6	7	8	8a	11	12	NDRE	NDVI
$M \geq U$	63.3%	70.4%	80.9%	75.4%	81.4%	74.4%	**80.4%**	**77.9%**	**81.9%**	77.7%	72.4%
%$M \geq 40$%	71.9%	79.4%	80.9%	**80.4%**	**82.9%**	83.4%	79.4%	74.9%	80.9%	85%	80.4%
%$M \geq 35$%	76.9%	85.9%	**81.9%**	80.4%	81.4%	83.9%	80.4%	73.9%	78.9%	86.5%	83.4%
%$M \geq 30$%	80.1%	83.4%	77.9%	76.4%	82.9%	86.4%	79.9%	75.9%	76.4%	**88.1%**	85.4%
%$M \geq 25$%	83.4%	**87.9%**	77.4%	76.9%	79.9%	**88.4%**	76.4%	73.4%	75.4%	87.6%	**87.9%**
%$M \geq 20$%	83.4%	87.8%	77.4%	76.9%	76.4%	88.4%	76.4%	73.4%	73.4%	87.6%	87.9%
%$M \geq 15$%	**85.4%**	86.9%	68.3%	70.4%	72.5%	87.4%	72.4%	67.3%	67.3%	81.3%	86.4%

Highest OA per band (column) highlighted in **bold**. Best overall is highlighted in **bold**.

G: green band; R: red; NIR: near infrared; RE: red edge; SWIR: shortwave infrared; M: no. multimodal images, U: no. unimodal images. %M: percentage of multimodal images.
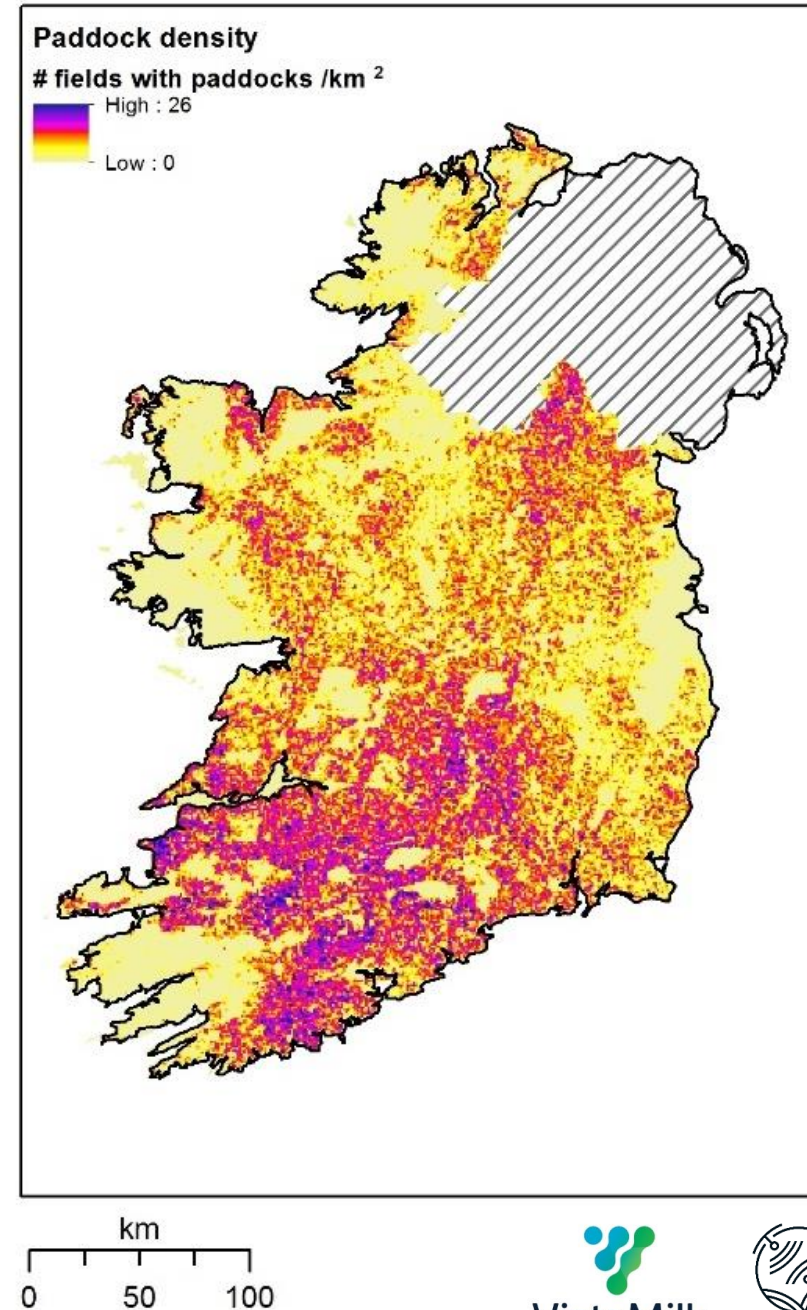
ISCRAES 2022

Results – National map

>1 million fields nationally
>20 million individual images

304,570 fields labelled paddocks
Approx. 43% of fields mapped were classed
as paddocks.

Density map (expected counts) up to 26 fields
per km^2

Golden Vale and surrounding Mid-West
Region captured well, as well as smaller
intensive districts elsewhere.

Paddock density
fields with paddocks /km ^{2}

High : 26

Low : 0

km

0   50   100

Results – National map

ISCRAES 2022

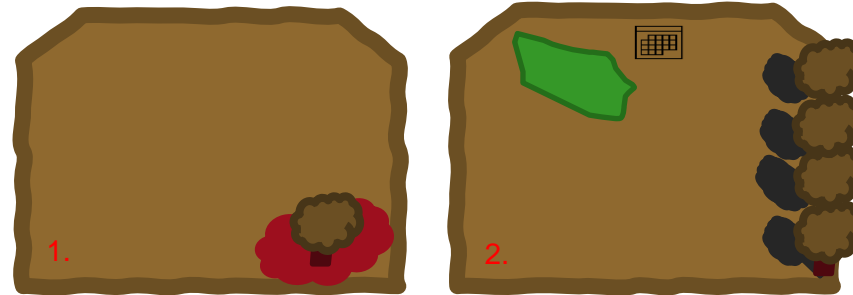|	oa	sens	spec
BORDER	78%	92%	59%
MIDEAST	80%	86%	75%
SOUTHWEST	84%	81%	86%
MIDLANDS	86%	86%	86%
WEST	87%	87%	86%
SOUTHEAST	85%	84%	86%
MIDWEST	90%	84%	95%
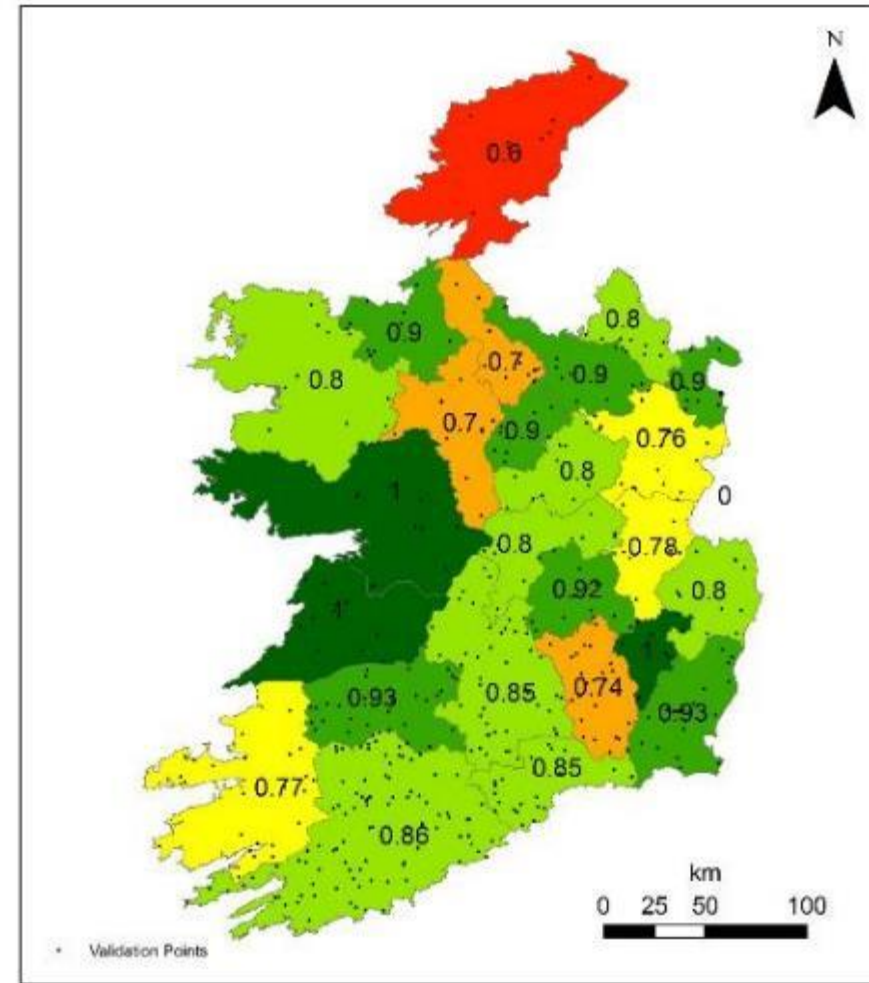
National Paddock Map - overall accuracy by county

Results – National map
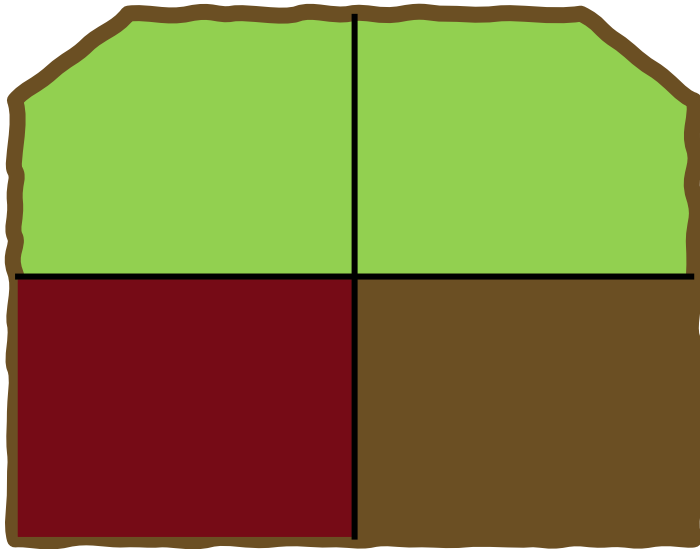
Example field with high likelihood of detection for multimodality

1. Persistent/permanent multimodality due to other LC features (scrub/ scattered trees). **Mitigation**: exclude fields with high % multimodal.

2. Multimodality due to impermanent LC feature (seasonal flooding). **Mitigation**: Exclude winter months.
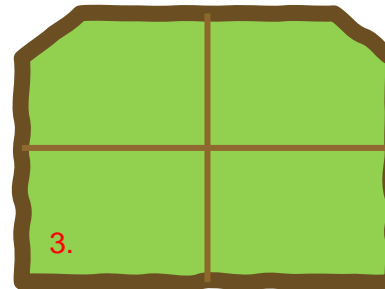
3. Unimodal even where paddocks occur.
Mitigation: Use other bands/ thresholds. Use S1 data.

Summary

Paddock management a good proxy for farming intensity

Using multimodality testing provides a high accuracy estimate of where paddock management occurs in Ireland

Testing of multimodality requires readily available datasets (Prime2, Sentinel 2) and does not require training of models

While overall accuracy is high, there are spatial variations

Acknowledgements

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