Teagasc: Heavy Soils Research Programme

Teagasc Animal and Grassland Research and Innovation, Moorepark, Fermoy, Co. Cork

UCC-MSc in Environmental Geology

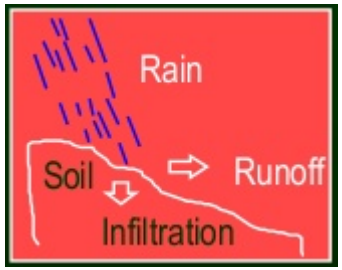
15/03/2018

Teagasc
Agriculture and Food Development Authority

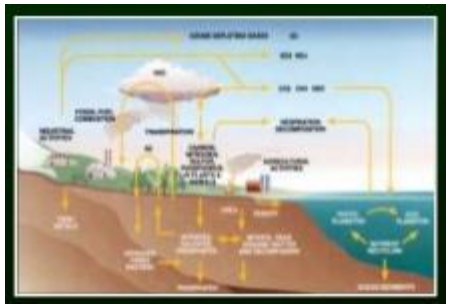
The Irish Agriculture and Food Development Authority

Functions of Soil

- Sustains plant and animal life below and above the surface



- Regulating and partitioning water flow-key link in hydrological cycle

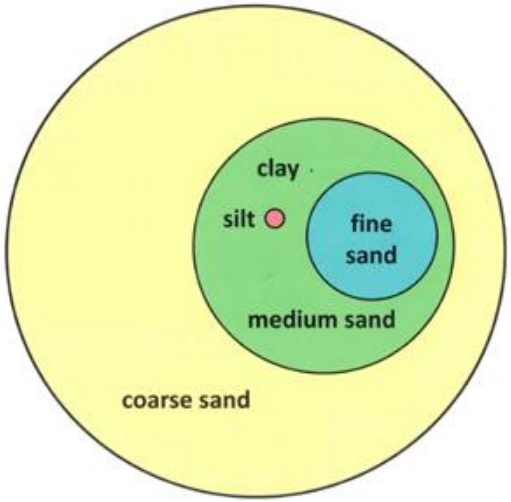


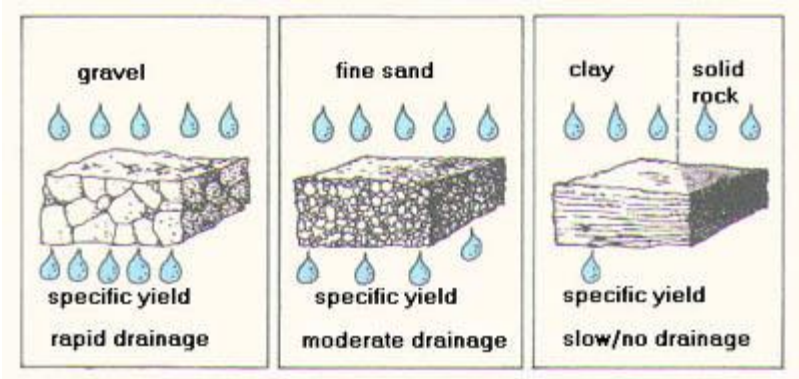
- Filtering, degrading, immobilizing and detoxifying
- Storing and cycling nutrients
- Providing support to structures

- Determine type and level of agricultural production

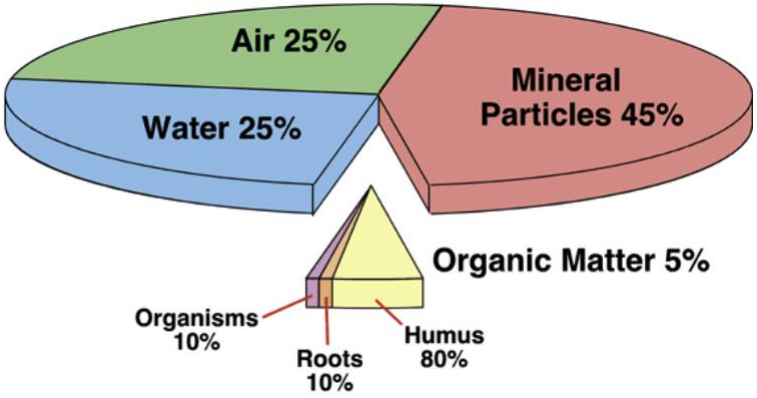
Soil Physics

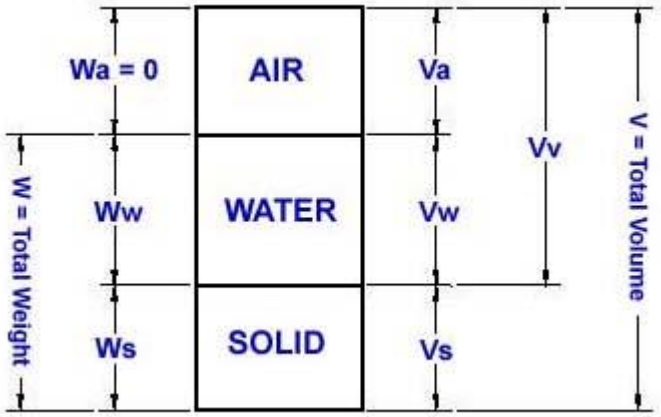
Soil physics addresses **physical properties and processes of soil**. Properties such as texture, structure, density, surface area, and aggregate stability are addressed along with water-content and potential **leading to the water retention character of soil**. Processes involving transport of heat, solutes, gasses and of course water are characterized





Soil Phases





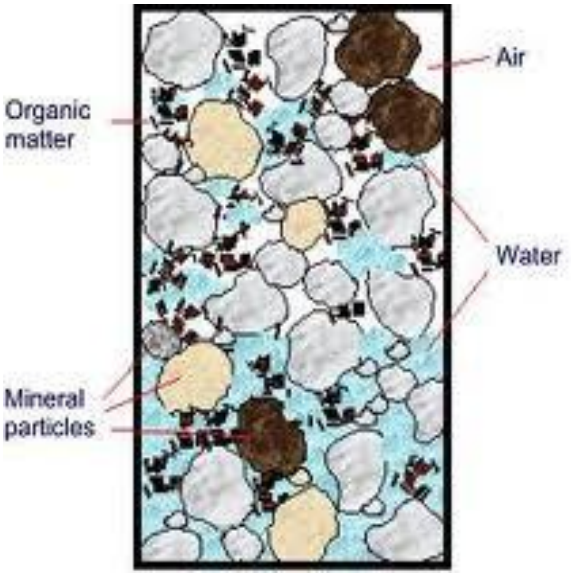
- **<u>Soil solids</u>** and **<u>pore space</u>**
- Air and water phases occupy the pore space and are complimentary
- Pore space in a saturated soil is filled with water.
- Crops require a minimum 10 -15% air filled pore space for water and nutrient uptake

Soil Solids

Soil solids consist of mineral and organic materials

Organic Material (<10% in mineral soils)

- Stores water and nutrients
- Binds mineral particles



Mineral Particles

- Sand, silt and clay (plus larger particles - gravel, stones, etc.)
- **Size (Texture) and arrangement (Structure)** of solid particles bear huge influence on water movement

Soil Horizons

- **The action of soil forming processes as influenced by soil forming factors gives rise to distinct soil horizons**

- These layers are assigned letters which define their characteristics. The main horizons identified are:

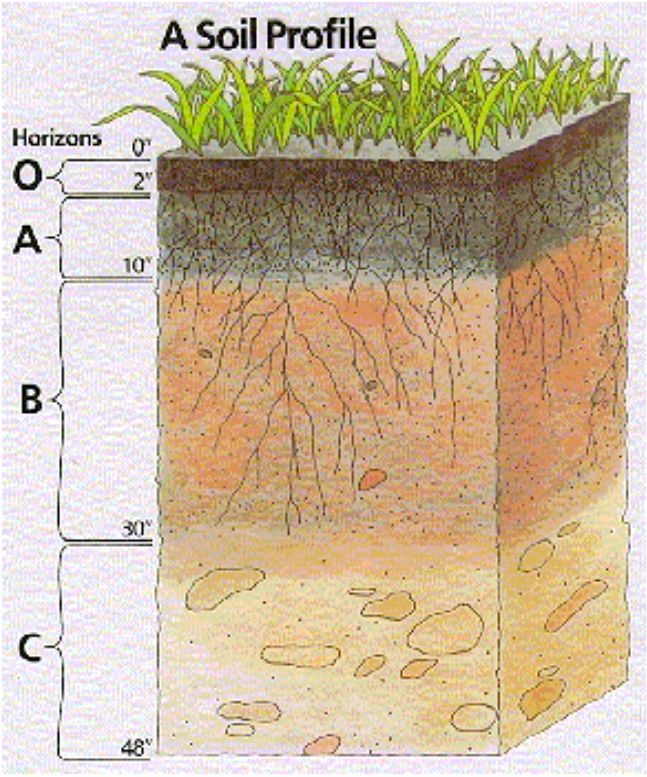
  - O: An organic horizon

True Soil

  - A: Mineral horizon formed at or near surface
  - B: Formed by material removed from A horizon or the alteration of the parent material

Parent Material

  - C: Horizon with little evidence of soil formation activity
  - R: Bedrock



-Where complex, sub-horizons may be identified; A1, A2, A3
-Specific characteristics are identified by lowercase letters;
Ap (A mixed by cultivation), Ah (uncultivated A), Bg, Cu, etc…..


20
40
60
80
1
20
40


20
40
60
80
1
20
40

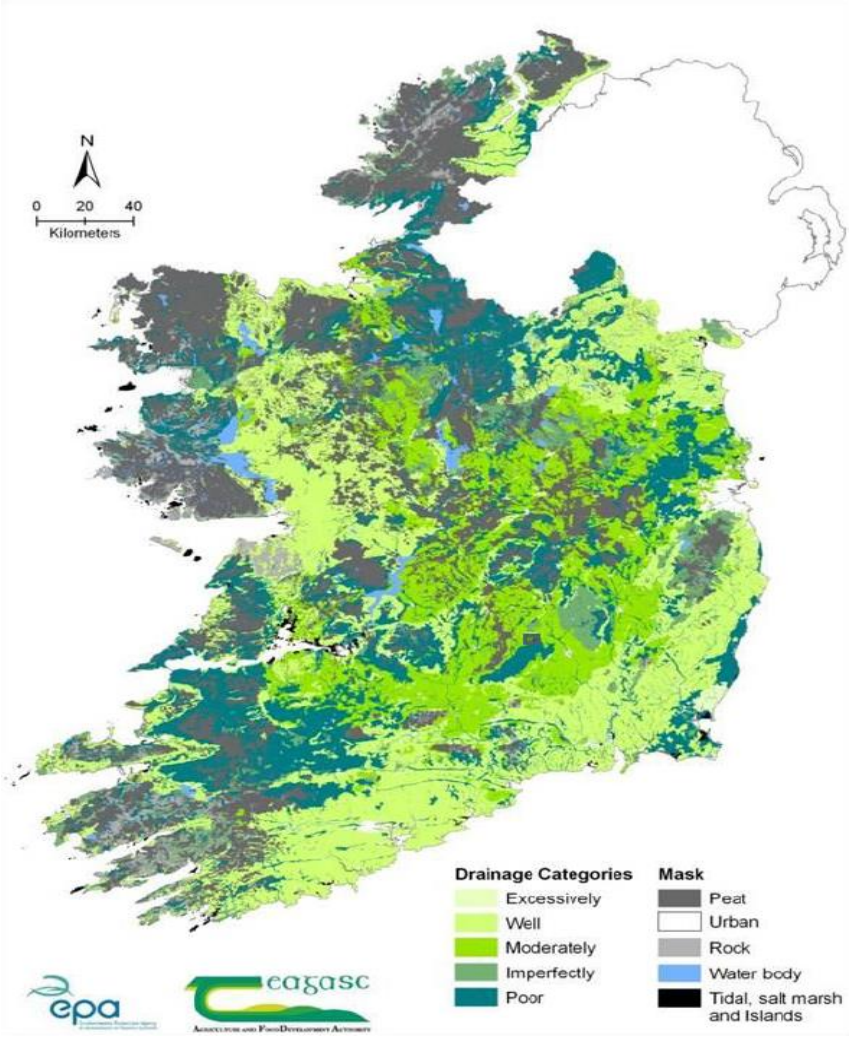

20
40
60
80
1
20

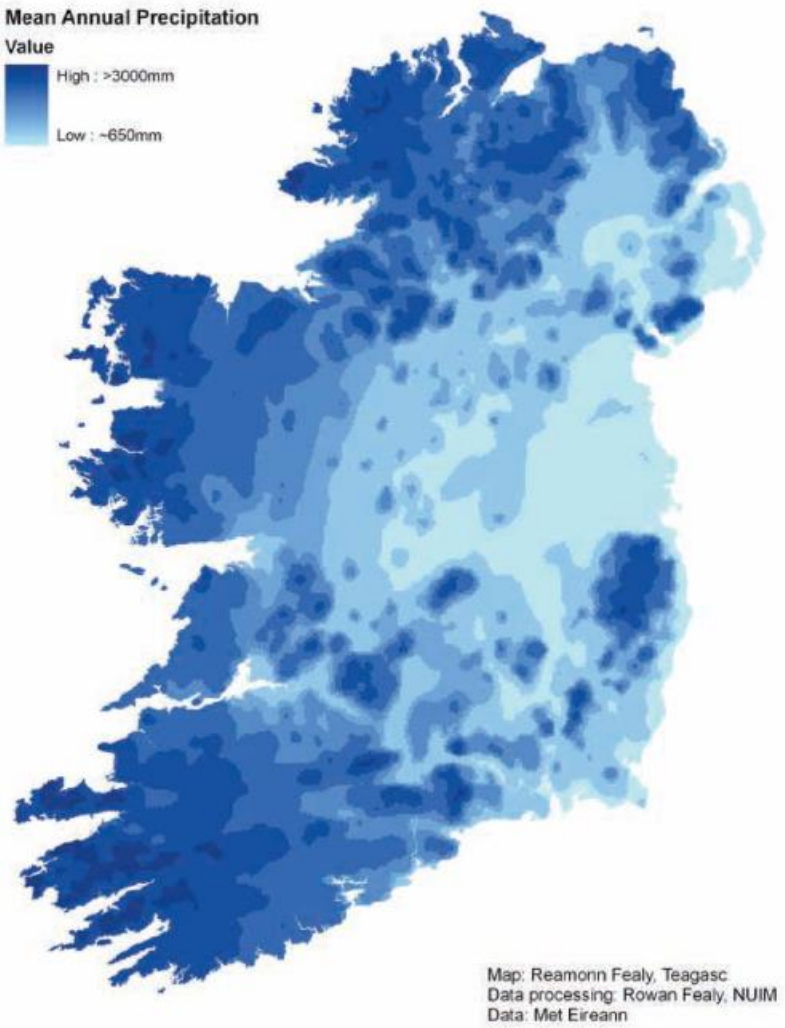

20
40
60
80
1
20

Teagasc
Agriculture and Food Development Authority

The Irish Agriculture and Food Development Authority

Irish Landscapes

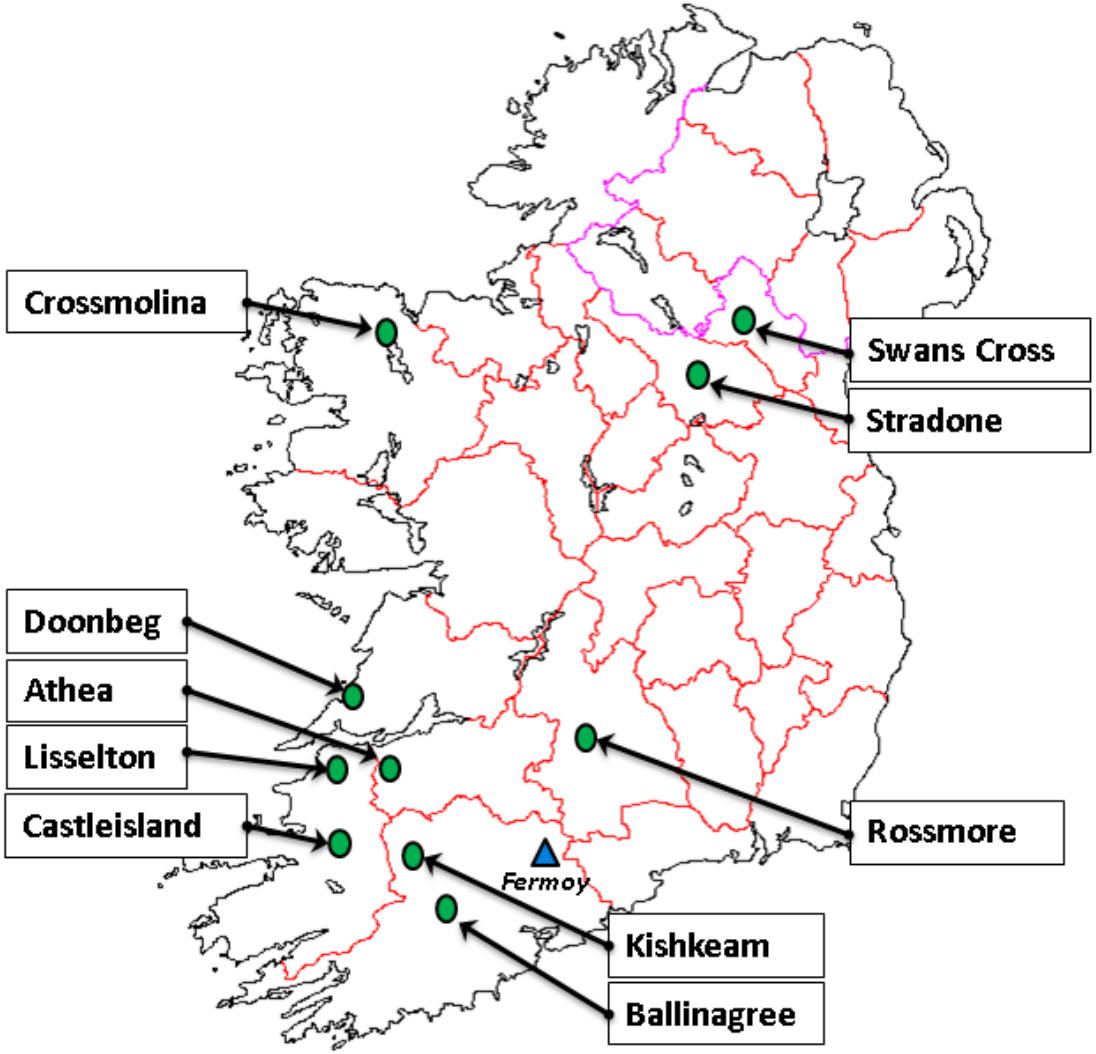




teagasc
Agriculture and Food Development Authority

The Irish Agriculture and Food Development Authority

Heavy Soils Programme Farms



Background

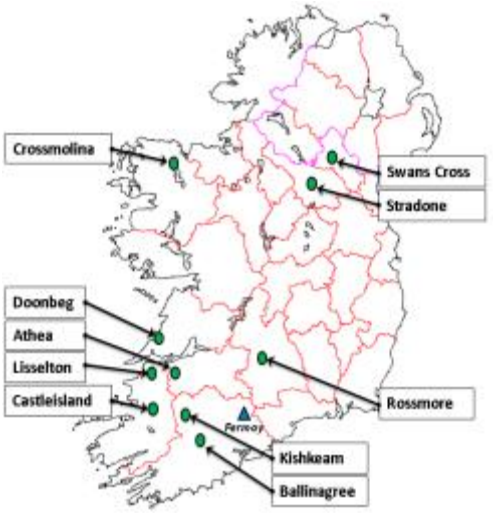
- The Heavy soils programme aims to increase profitability, improve productivity and decrease volatility on farms with poorly drained soils.

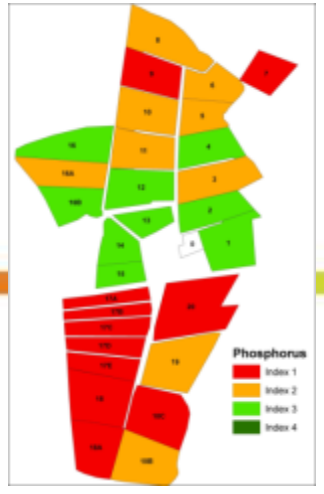
- The programme has 10 commercial farm participants; in 8 Counties.

- Focus areas include land drainage, soil fertility and nutrient cycling, soil characterization, grassland management, fodder reserves, farm infrastructure and farm profitability.

- Farms are subjected to intensive monitoring. The data being generated allows for analysis of farm systems and the development of strategies to achieve programme aims

- Collaboration between AGRIP, CELUP and Advisory with support from Co-ops (Kerry, Dairygold, Tipperary, LacPatrick)





Teagasc
Agriculture and Food Development Authority

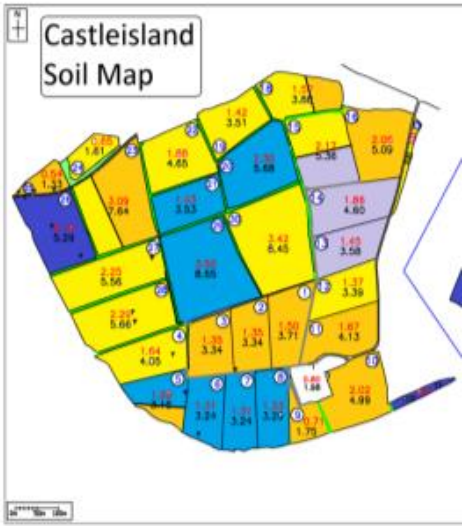
Soil Surveying/Mapping

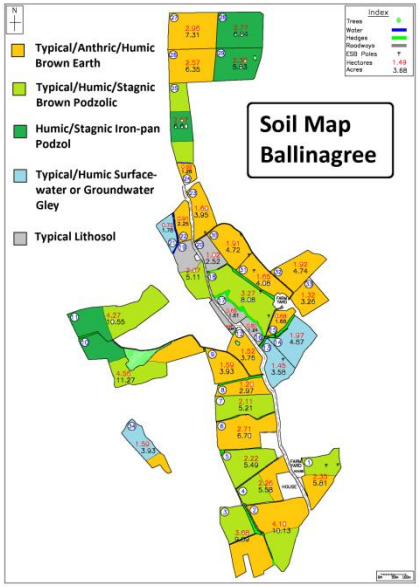
- Soil augers (40 per farm) and test pits (4 per farm)
- Soil description and sampling
- Lab analysis of soil physical and chemical properties

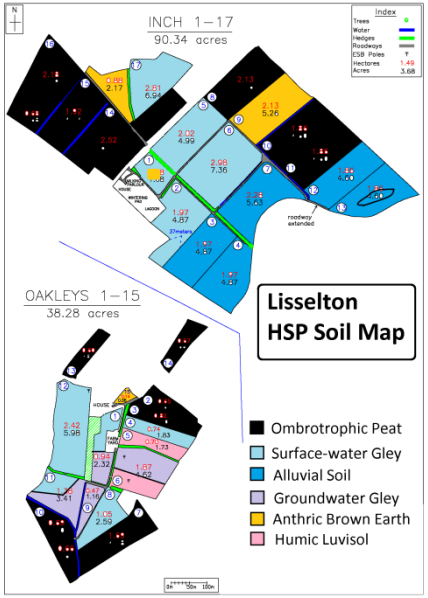
- Soil type and horizon specific characterisation and soil sample archive
- Paddock scale soil maps and summary reports

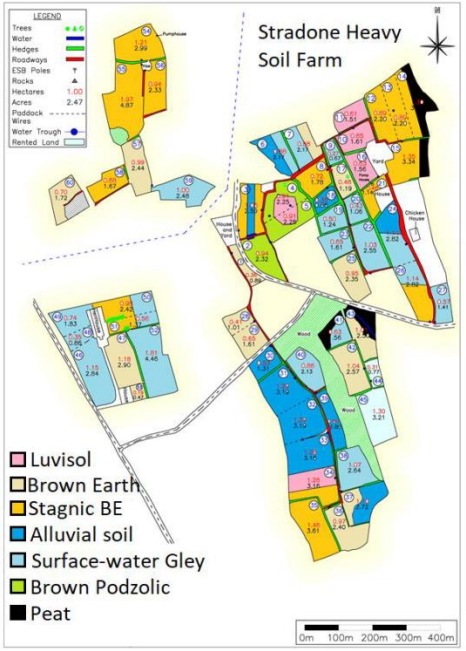
- Contextualise all other data and underpin future work.

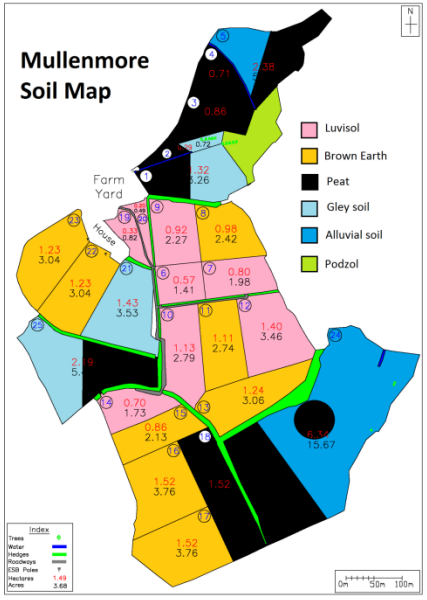
Soil Maps

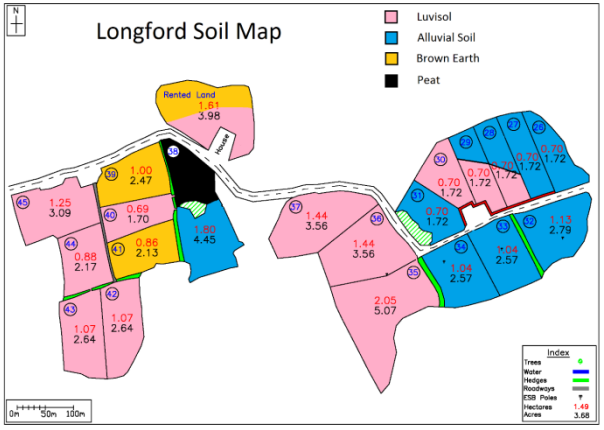

Castleisland
Soil Map

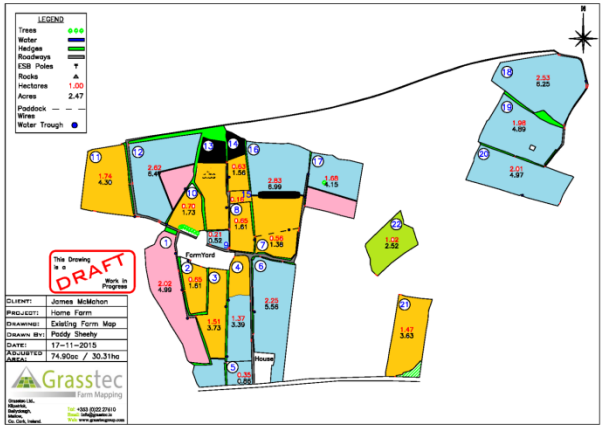

Soil Map
Ballinagree
Typical/Anthric/Humic Brown Earth
Typical/Humic/Stagnic Brown Podzolic
Humic/Stagnic Iron-pan Podzol
Typical/Humic Surface-water or Groundwater Gley
Typical Lithosol


INCH 1–17
90.34 acres
OAKLEYS 1–15
38.28 acres
Lisselton
HSP Soil Map
Ombrotrophic Peat
Surface-water Gley
Alluvial Soil
Groundwater Gley
Anthric Brown Earth
Humic Luvisol


Stradone Heavy
Soil Farm
Luvisol
Brown Earth
Stagnic BE
Alluvial soil
Surface-water Gley
Brown Podzolic
Peat


Mullenmore
Soil Map
Luvisol
Brown Earth
Peat
Gley soil
Alluvial soil
Podzol
Farm Yard

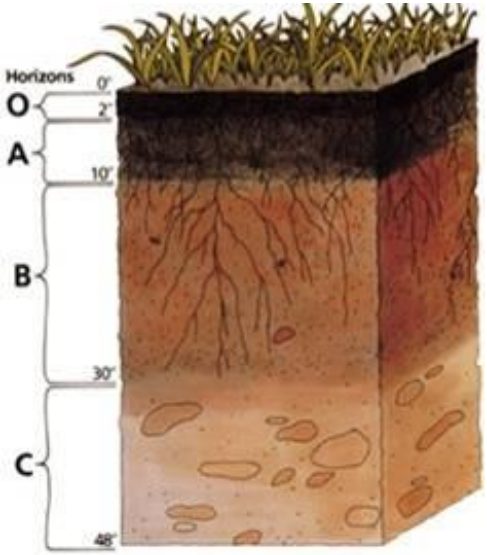

Longford Soil Map
Luvisol
Alluvial Soil
Brown Earth
Peat
Rented Land


DRAFT
Grasstec

Land Drainage

Definition:

“Ireland lies in the temperate zone, where the main role of drainage is the removal of excess water in the root zone of crops from surplus rainfall, while a secondary objective is to provide good trafficability for farm machinery and livestock”



Types of drainage system

- The depth and type of drain to be installed depends entirely on the interpretation soil characteristics.

- Two principle types are distinguished:

  - **Groundwater drainage system:** A network of deeply installed piped drains exploiting permeable layers

  - **Shallow Drainage system:** Where soil is heavy and infiltration of water is impeded at all depths and permeability needs to be improved

Groundwater Drainage System

- **A Groundwater drainage system is a network of field drains collecting groundwater which can move through soil layers of high permeability**
- They work by exploiting the natural capacity for movement of water at a certain depth in certain soils
- By “tapping” into this natural capacity for water movement the system works by lowering the watertable and reducing the amount of water stored in the soil

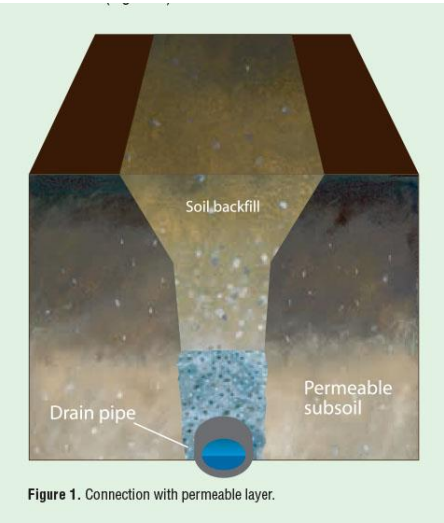
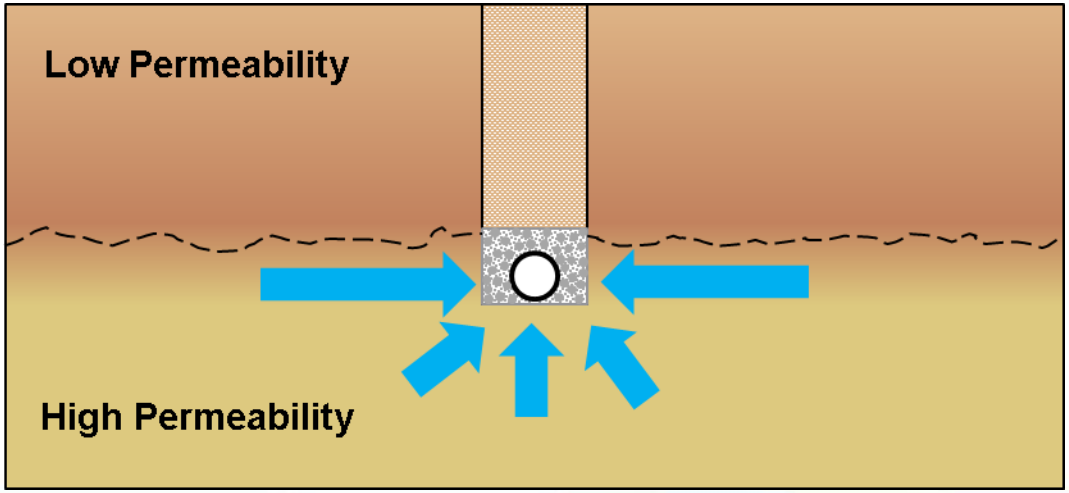


Figure 1. Connection with permeable layer.



Shallow Drainage System

- **A shallow drainage system is a network of field drains in tandem with surface disruption techniques which promote water infiltration and drainage**

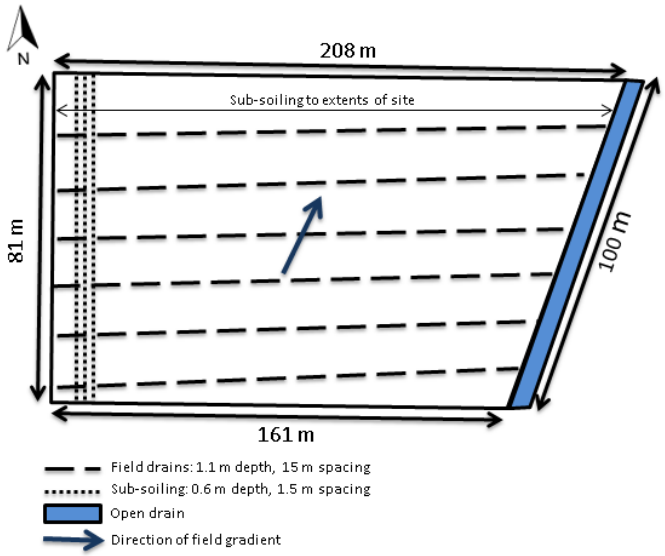
- Used where soil permeability is low at all depths and aims to introduce new pathways for water movement in the soil

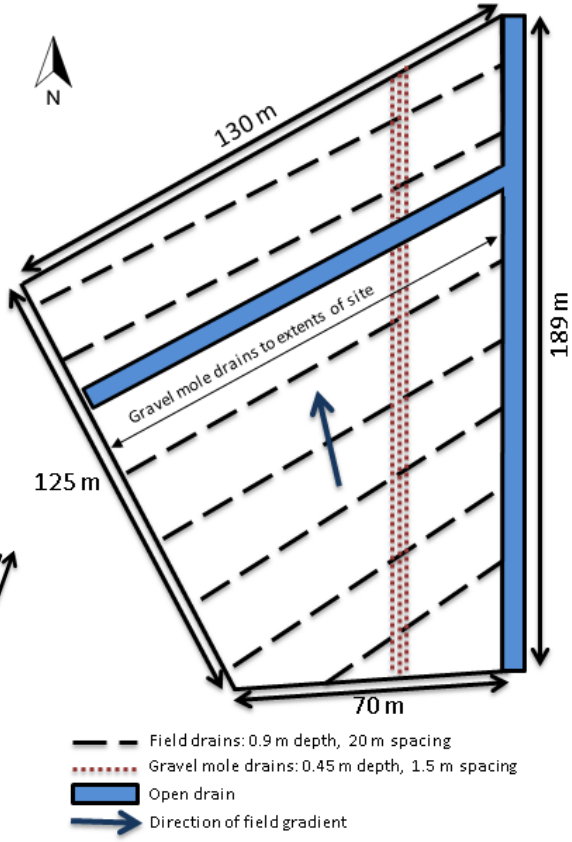
- Methods include: Mole drainage, gravel mole drainage, sub-soiling (pan busting) and land forming

Drainage System Materials

- The drainage pipe facilitates a unobstructed flow path from the field drain.
- Perforated corrugated pipe is the cheapest and most convenient
- Drainage stone has three functions
  - Hydraulic: to facilitate water flow to the pipe
  - Filter: to prevent the entry of fine particles to the pipe
  - Bedding: to provide support for the pipe and prevent collapse
- Synthetic filters are common in other parts of the world, where creating an outlet and discharging water are enough to create gradients and remove water.
- Some Irish soils would be suited to these systems

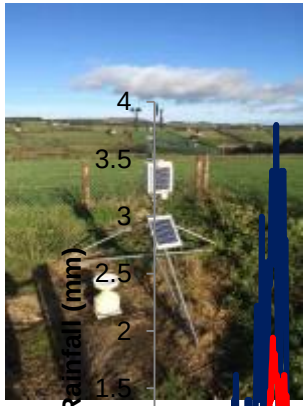
Drainage Systems Installed

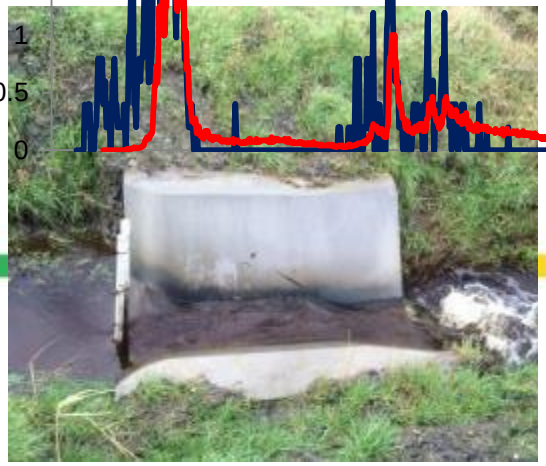


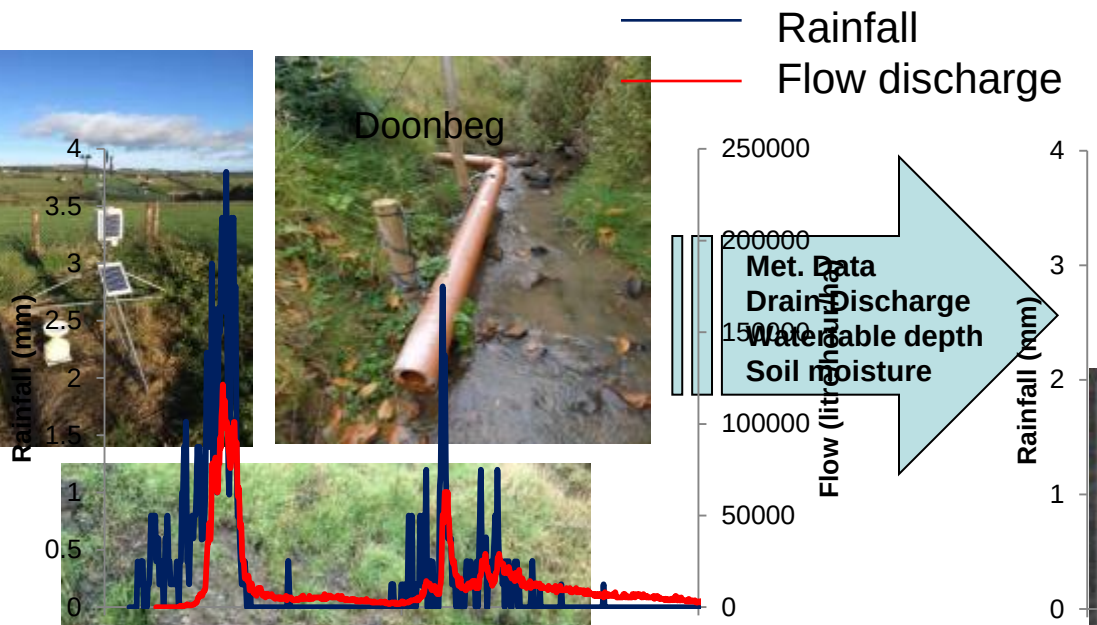


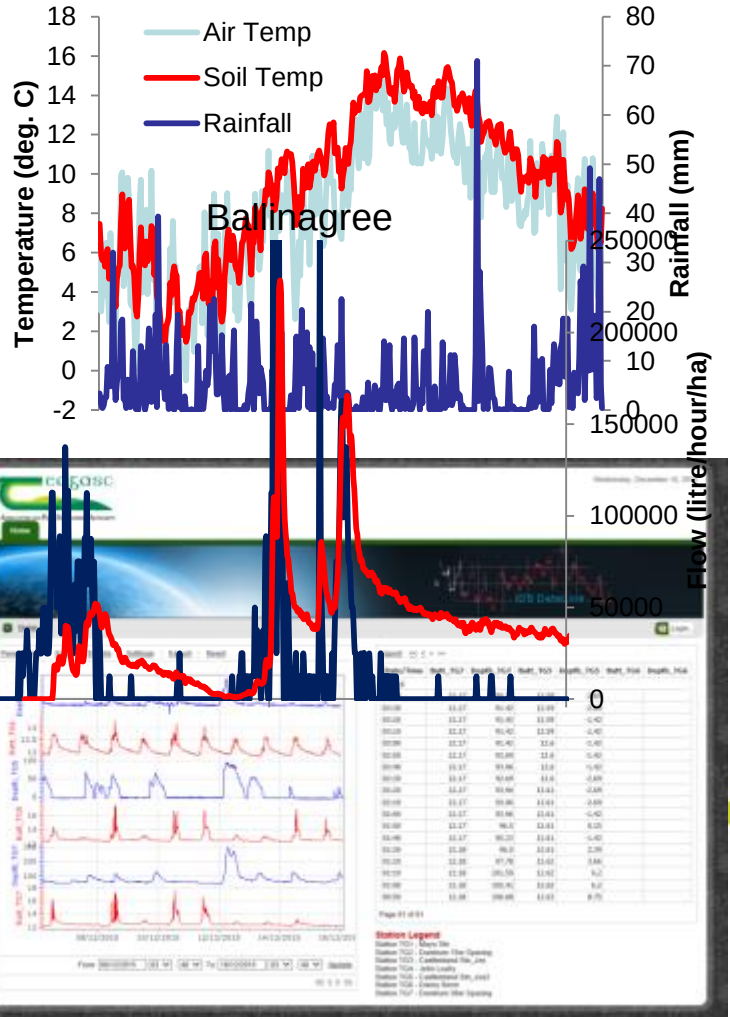
Monitoring drainage system performance

- Land drainage systems installed on all farms
- Real time performance data is continuously collected
- Efficiency of systems quantified









2017 Rainfall-Totals summary

	Rainfall (mm)	Evap. (mm)	Excess (Rain-Evap)		Long Term Average (mm)	Difference from LTA (mm)
Kishkeam	1425.6	418.4	1007.2		1621.5	-195.9
Ballinagree	1425.6	396.7	1028.9		1756.7	-331.1
Athea	1350.6	493.7	856.9		1320.2	30.4
Castleisland	1284.8	467.6	817.2		1297.6	-12.8
Rossmore	1225.4	462.6	762.8		981.8	243.6
Doonbeg	1196.2	515.2	681.0		1185.1	11.1
Crossmolina	1169.6	458.3	711.3		1161.5	8.1
Lisselton	1055.5	477.2	578.3		1095.3	-39.8
Stradone	1049.0	434.6	614.4		1093.3	-44.3
Swans Cross	1028.6	443.8	584.8		1078.5	-49.9
Mean	*1221.1*	*456.8*	*764.3*		*1259.2*	*-38.1*

Site details

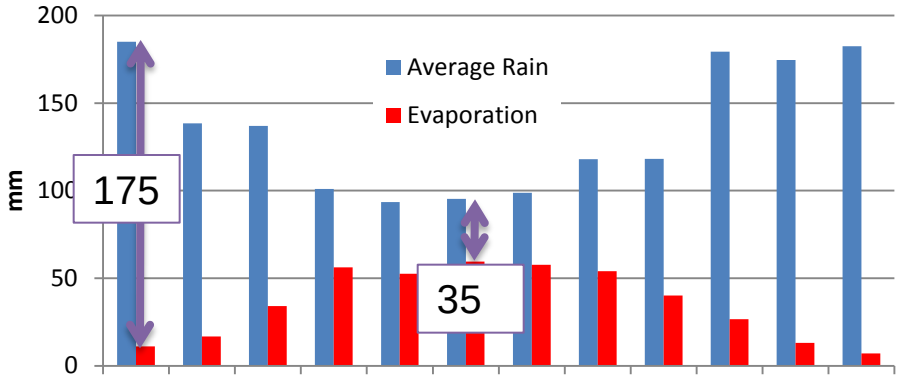
Site	Northing	Westing	Elevation (m) ASL
Kishkeam	52°12’	09°08’	233
Ballinagree	51°59’	08°56’	231
Athea	52°27’	09°19’	139
Castleisland	52°13’	09°28’	36
Rossmore	52°36’	08°01’	105
Doonbeg	52°44’	09°30’	9
Crossmolina	54°06’	09°17’	15
Lisselton	52°28’	09°33’	8
Stradone	53°57’	07°11’	180
Swans Cross	54°09’	07°02’	115

Note: ASL = above sea level

https://www.teagasc.ie/crops/grassland/heavy-soils/weather-data/

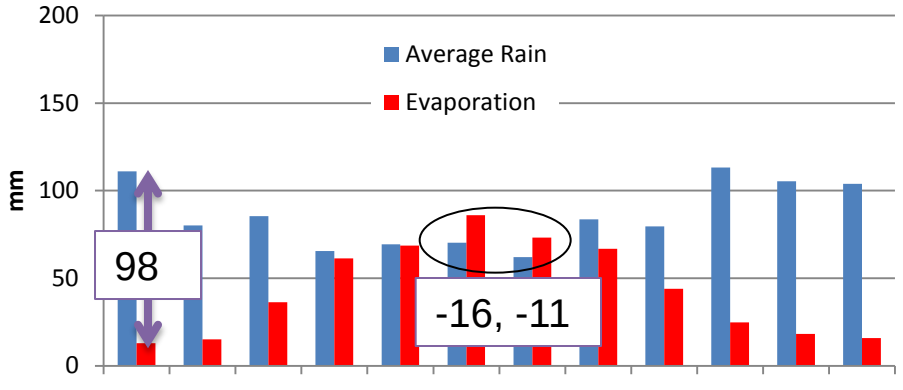
Excess Water (Effective drainage)

Kishkeam, Co. Cork: Avg. Rain = 1622 mm



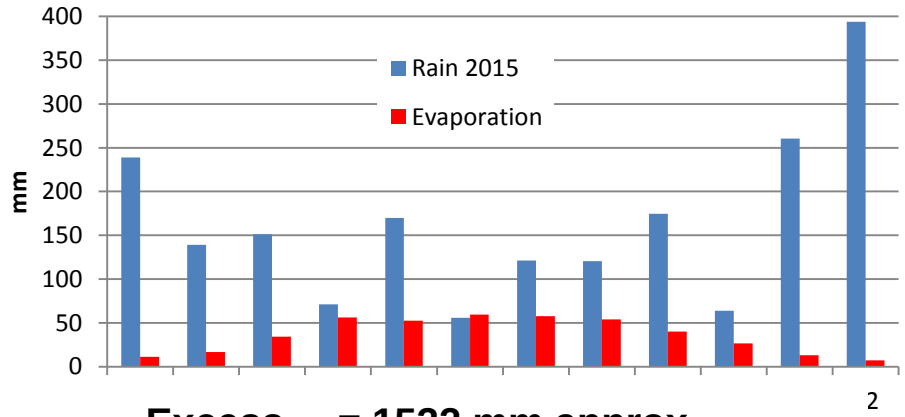
Excess = 1195 mm approx.

Moorepark, Co. Cork: Avg. Rain = 1029 mm



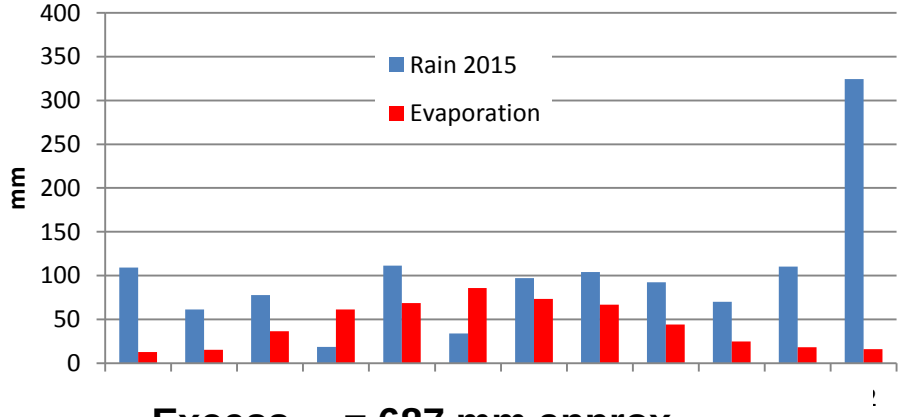
Excess = 510 mm approx.

Kishkeam, Co. Cork: 2015 Rain = 1960 mm



Excess = 1532 mm approx.

Moorepark, Co. Cork: 2015 Rain = 1209 mm

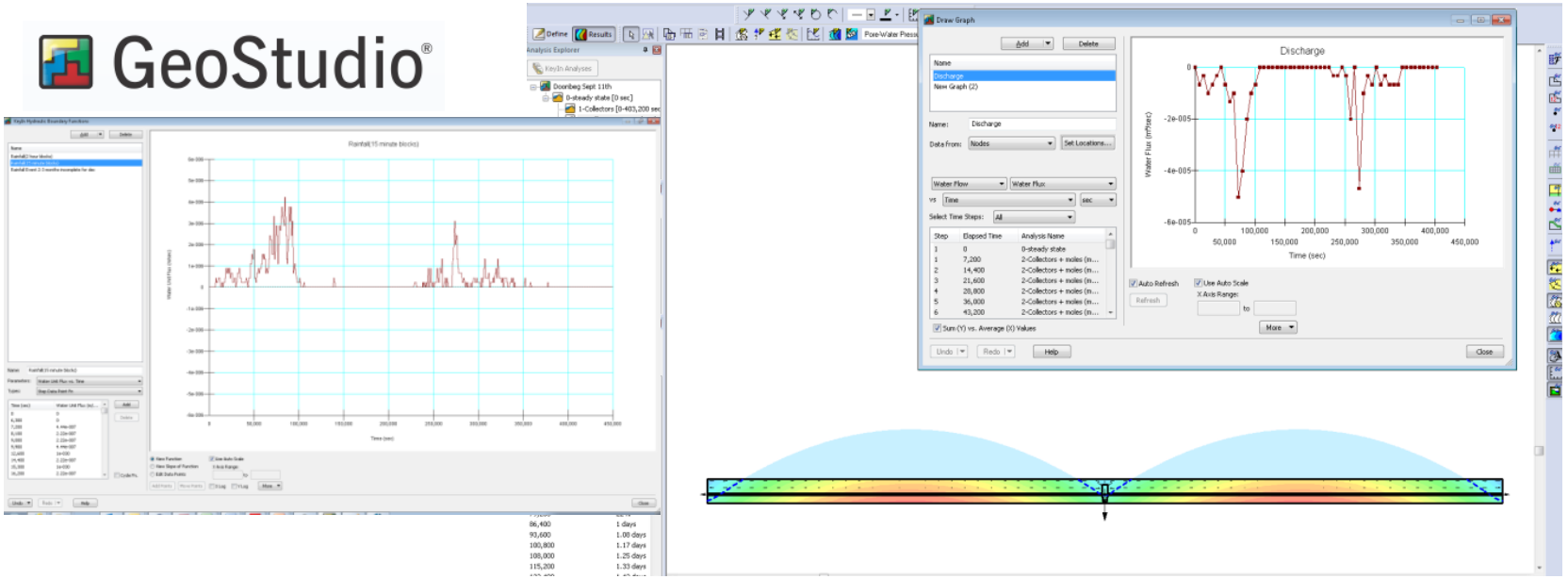


Excess = 687 mm approx.

1 mm = 10,000 Litres per Hectare!!!

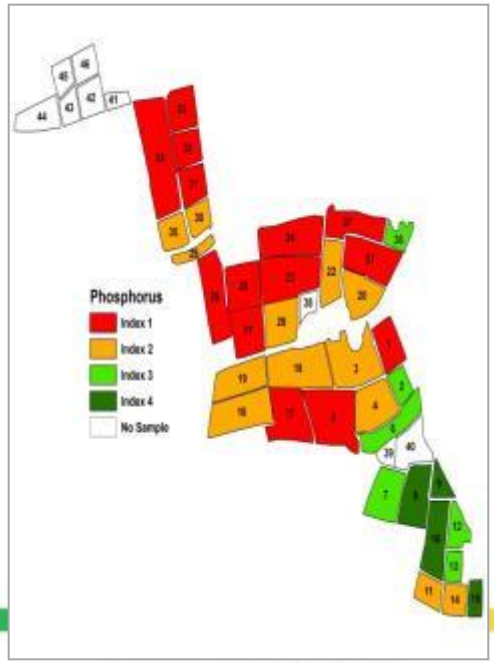
Model simulations

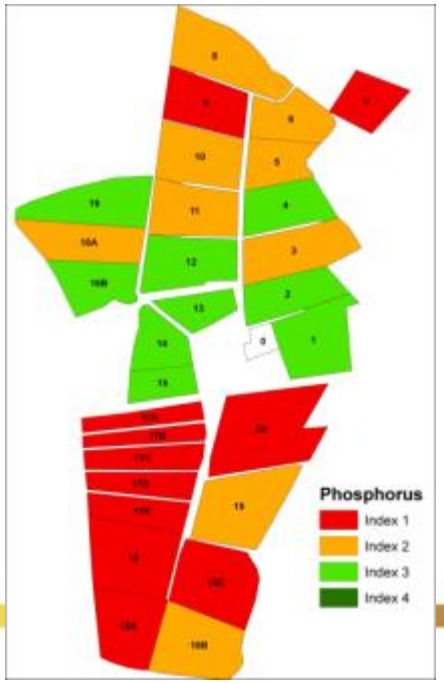
- Model simulations of drain performance are dependent on high resolution performance data and detailed measurement of soil
- Simulation models allow for variations in drainage design to be tested at low cost
- Scope for assessing drainage systems across a range of soil types and climates



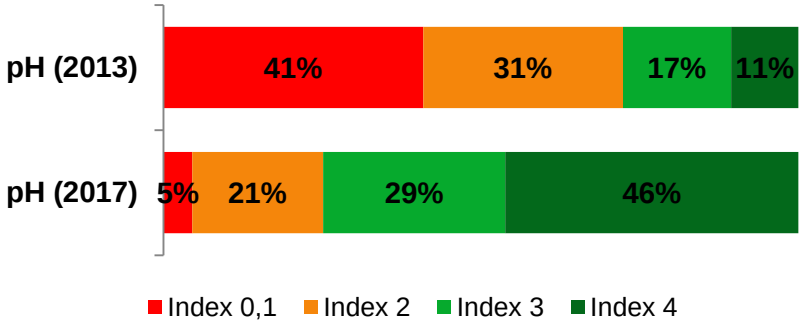
Soil fertility status

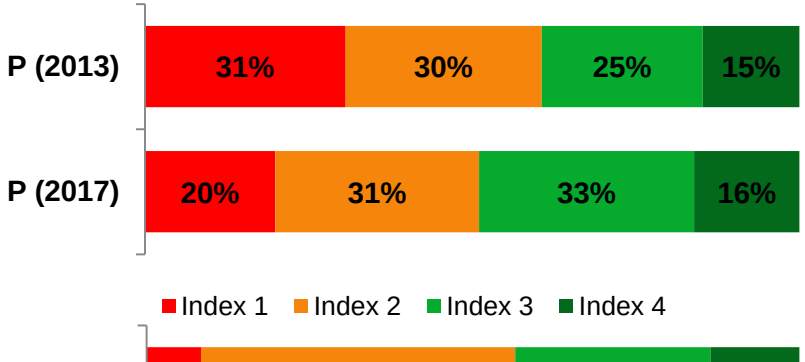
- Majority of farms are severely limited by poor soil fertility status
- A soil sampling campaign has been established: **Every paddock , Every year** and all inputs are recorded on farms
- Aim to develop strategies for improving fertility on heavy soils in light of technical, financial and legislative restraints

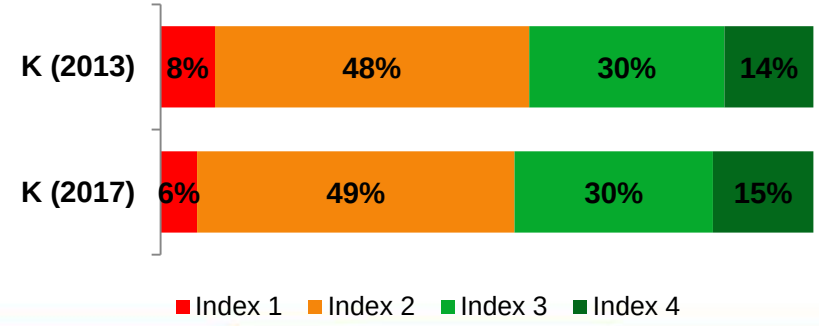


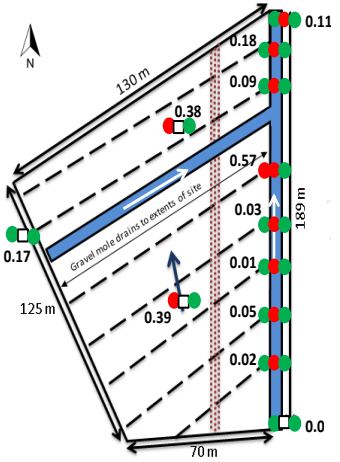


Soil fertility status

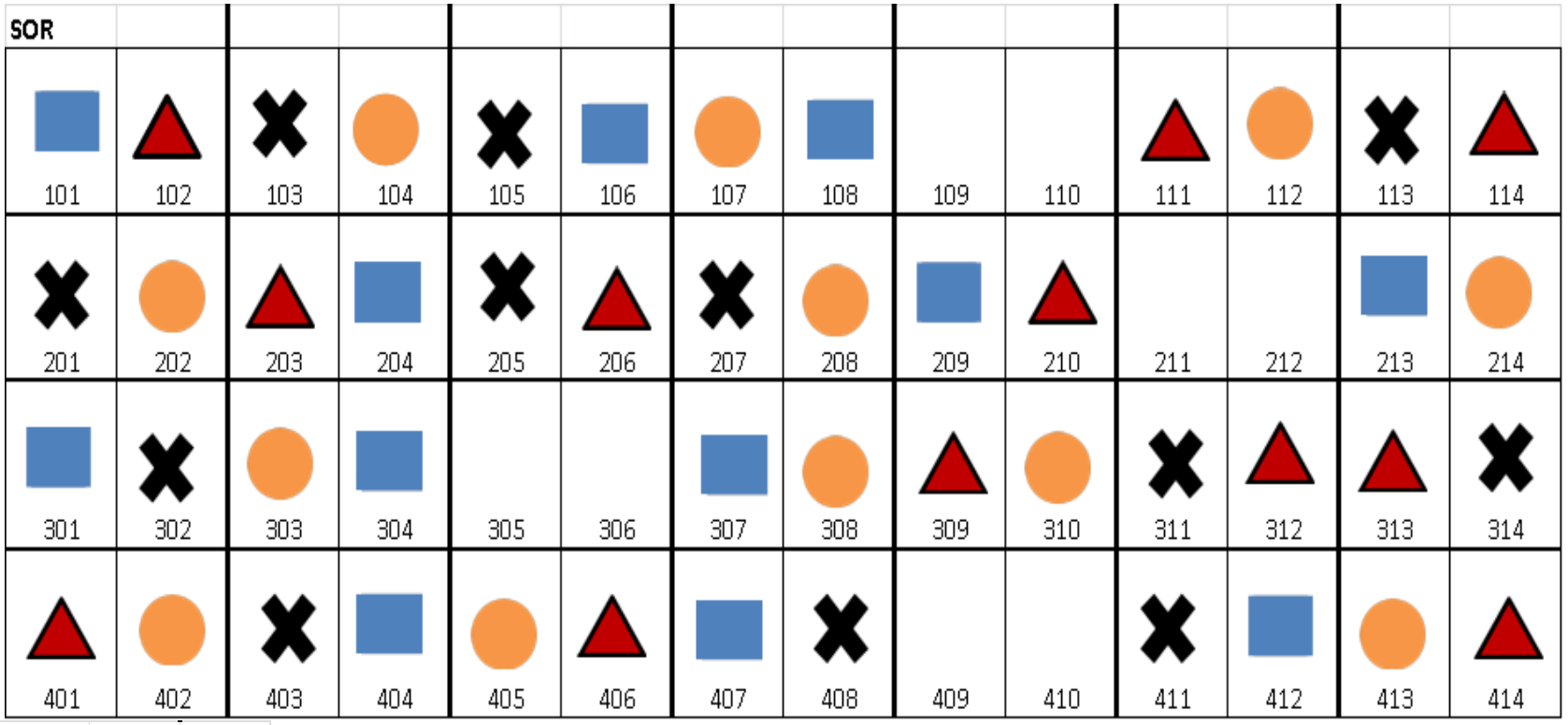








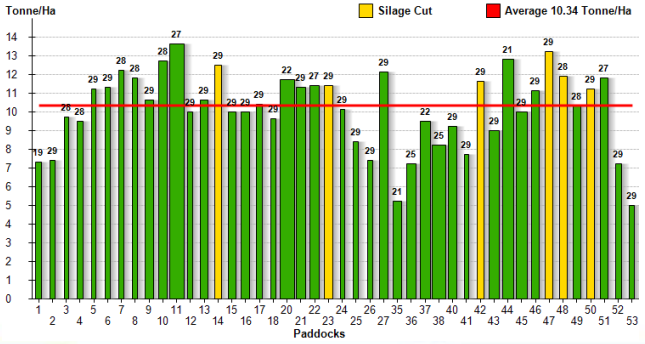
Soil fertility-improvement strategies



Production systems

Farm production and performance on poorly drained soils

- Monitoring whole farm systems
    - **System inputs:** Feed, fertiliser, lime, slurry
    - **Management practices:** Grassland, labour, contracting
    - **System outputs:** Animal performance & productivity
    - **Financial Performance:** Profit monitor, economics



Dissemination & Training

Agricultural land drainage-Theory and design training course (QQI certified)

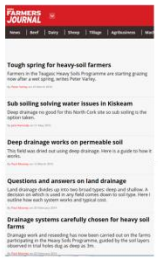
- Equip participants with the ability to design land drainage systems on a range of soils types

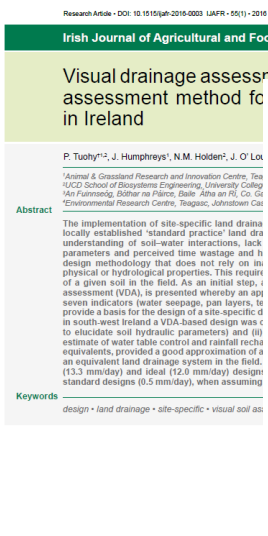
- 8 day course Includes
  - Classroom instruction
  - Practical sessions on the identification of soils and soil characteristics
  - Field trips to a range of sites to identify drainage problems and prescribe appropriate solutions.

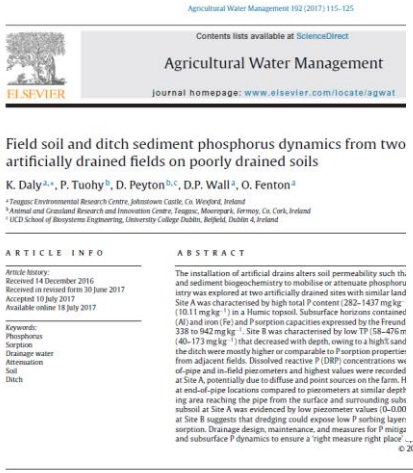
- Run Annually

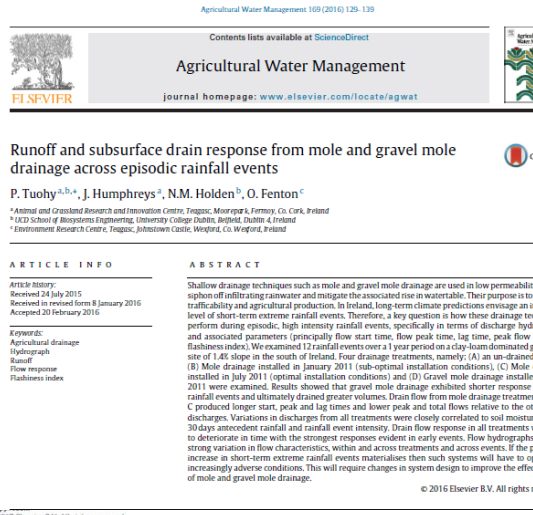
Dissemination & Training

- The programme delivers outputs in scientific and popular press









- And through public on-farm and training events

1. TEAGASC PHD WALSH FELLOWSHIP OPPORTUNITY

"Evaluation of the performance of materials for land drainage systems to increase production potential"

Teagasc
Agriculture and Food Development Authority

NUI Galway
OÉ Gaillimh

- The performance of in-field drainage systems is dictated by the hydraulic capacity of the soil within their catchment, their design and their constituent materials.

- Their functionality is often reduced due to mechanical and biochemical blockages of the drain pipe or the envelope material.

- An appraisal of drain pipe and envelope materials is needed to provide guidance for those investing in land drainage to improve outcomes.

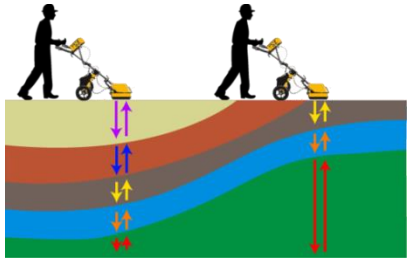
- ***Recruiting!***

Teagasc
Agriculture and Food Development Authority

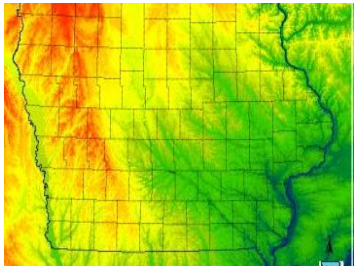
2. TEAGASC PHD WALSH FELLOWSHIP OPPORTUNITY

"Optimising remote-sensing technologies to characterise soils and offer decision support in the design of land drainage works"

teagasc
AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY



- Compare remotely collected data-streams with surface and soil mapping of selected farms



- Calibrate remote sensing techniques using ground truthing and available data and establish which remote techniques offer the most reliable data at appropriate resolutions

- Adapt remote sensing techniques and procedures to ensure reliability of data and enable soil characterisation across a range of poorly drained soil types

- ***Recruiting Soon!***

teagasc
AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY

3. TEAGASC PHD WALSH FELLOWSHIP OPPORTUNITY

"Optimizing dairy farmyard infrastructure for the management and treatment of soiled water"

- Provide guidance on the cost-effective design, operation and maintenance of farm and farmyard infrastructure for the control, collection and treatment of dairy soiled water.

- Assess current status of DSW produced in terms of volumes, management, storage and disposal

- To optimize capacity and design a practically applicable toolkit for operative DSW treatment.

- ***Recruiting Soon!***

References

- Teagasc Land Drainage guidebook
- Heavy Soils Open Day booklets
- https://www.teagasc.ie/crops/grassland/heavy-soils/
- Teagasc Manual on Drainage and soil management