Soils report 4 – John O'Sullivan, Castleisland

Introduction

This dairy farm is located 2 km to the south of Castleisland in the townland of Ballygree, Co Kerry (Plate1). The farm is 71 hectares in total with over 100 cows being milked. Annual precipitation is on average 1298 mm at the met. station 2.5 km away. Slopes are generally between 1 and 2 degrees. The Brogheen River, a tributary of the River Maine, runs along the western and southern fringes of the home farm. It also runs along the southern boundary of the paddocks in the out farm.

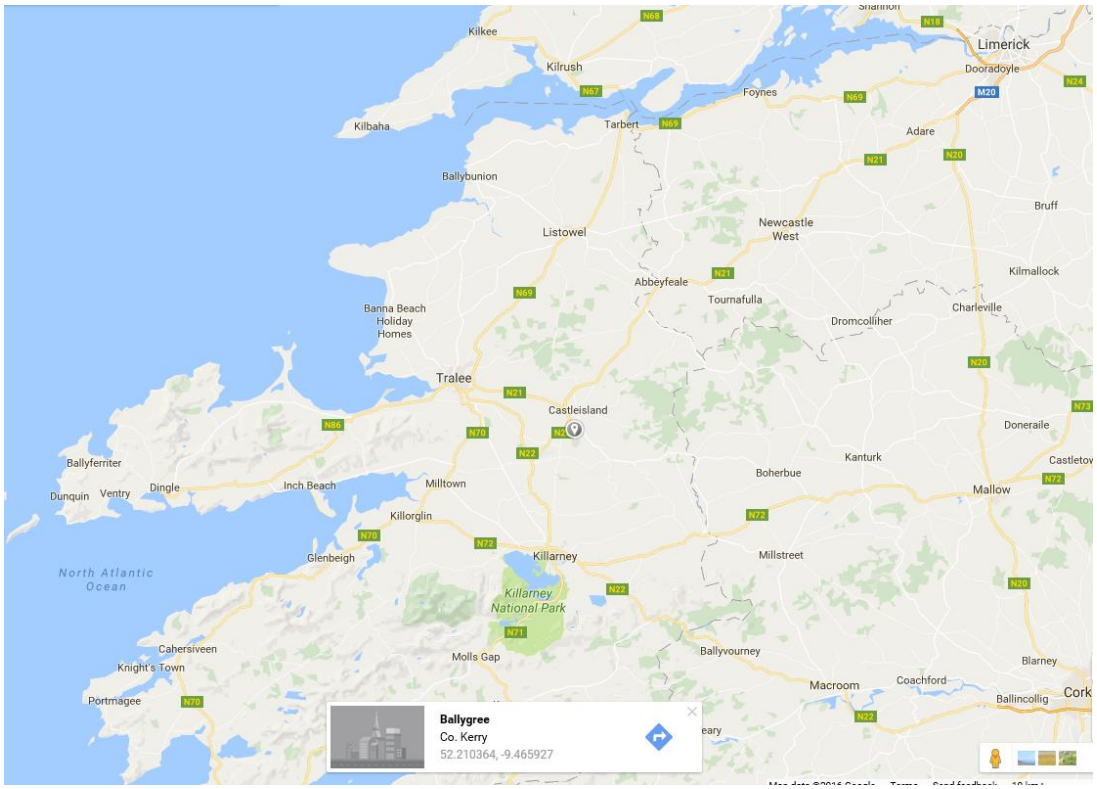

Plate 1. Location of O'Sulivans farm to the south of Castleisland, Co. Kerry.

The area has high rainfall, which is restricted from draining away quickly enough leading to stagnation. The slopes are rarely more than 2 degrees on the farm. The problem is exacerbated by poor porosity due to high stone content and poor permeability in the soil due to high silt and clay contents. The soil is compacted and within 1 metre in many parts of the farm cemented.

The geology of the region is Castleisland - Waulsortian Limestone – Massive unbedded, lime – mudstone. It was formed from sand and mud deposited in a narrow ocean basin. The limestone lowlands from Castleisland to Farranfore and Castlemaine are also mantled with Saale Age glacial drift comprised of carboniferous shale and sandstone (Kerry County Agricultural Committee, 1972). The more recent Weichsel glaciation did not extend as far as eastern Kerry (Finch, T. F and Ryan P. 1966). The resulting topography in this region is gently rolling soliflucted slopes with occasional steep knobs of limestone. The drift has undergone extensive weathering and illuviation is apparent.

Historical soil information

The county of Kerry did not have a soil survey report published by An Forais Talútais. There was no reconnaissance soil survey reported for the county or parts of it either. There was a survey of the Annascaul area of the Dingle peninsula; however the geology is different here, with Devonian sandstone dominating with a band of Ordovician shale, sandstone, basalt & rhyolite within this. The resulting soils would not be comparable. The County Kerry Agricultural resource survey (Compiled by Kerry County Committee of Agriculture—1972) was restricted to comments on the soils being either dry or wet lowland mineral soils, mountain and hill soils or peat.

The Irish Soil Information System (Creamer et al 2014), is the primary resource for investigation of the soils of the area. Focussing on the Ballygree area to the south of Castleisland Co. Kerry, there are two associations covering the area of the farm. The soil association Crosstown (Plate 2) covers the area of the home farm. The lead soil series is the Stagnic Luvisol, Crosstown. There are a further 6 Luvisols within this association, all being on drift, indicating that the illuvial process is dominating the soils of this area. There are two Typical Surface-water Gleys which generally have illuviation. Finally 1 Stagnic Brown Earth and 1 Groundwater Gley complete the association.

On the out farm to the east the soil association Clashmore covers the majority of the area (Plate 3). This is a Typical Brown Earth, there are 3 more Brown Earths, 3 Luvisols and one Typical Surface-water Gley completing the association. The southernmost edge of the paddocks in the out farm is covered by a polygon of peat. In this case it would be likely to be fen peat with its proximity to the river.

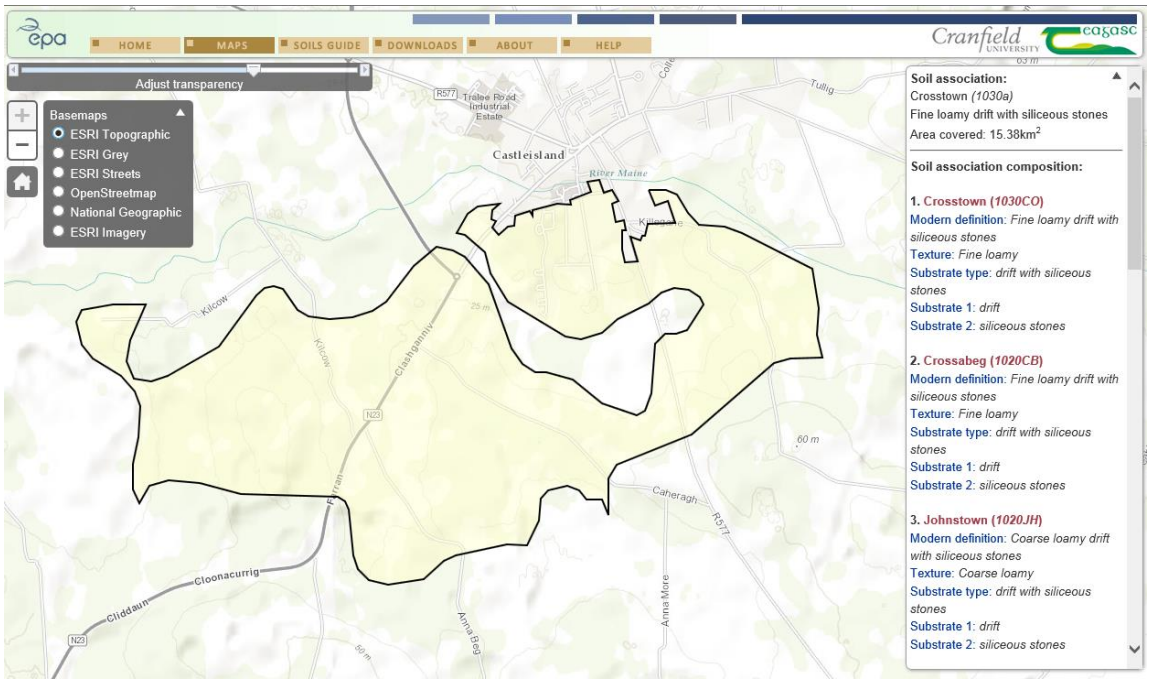

Plate 2. Irish SIS map of the Castleisland farm. The soil association Crosstown dominates the area of the home farm.

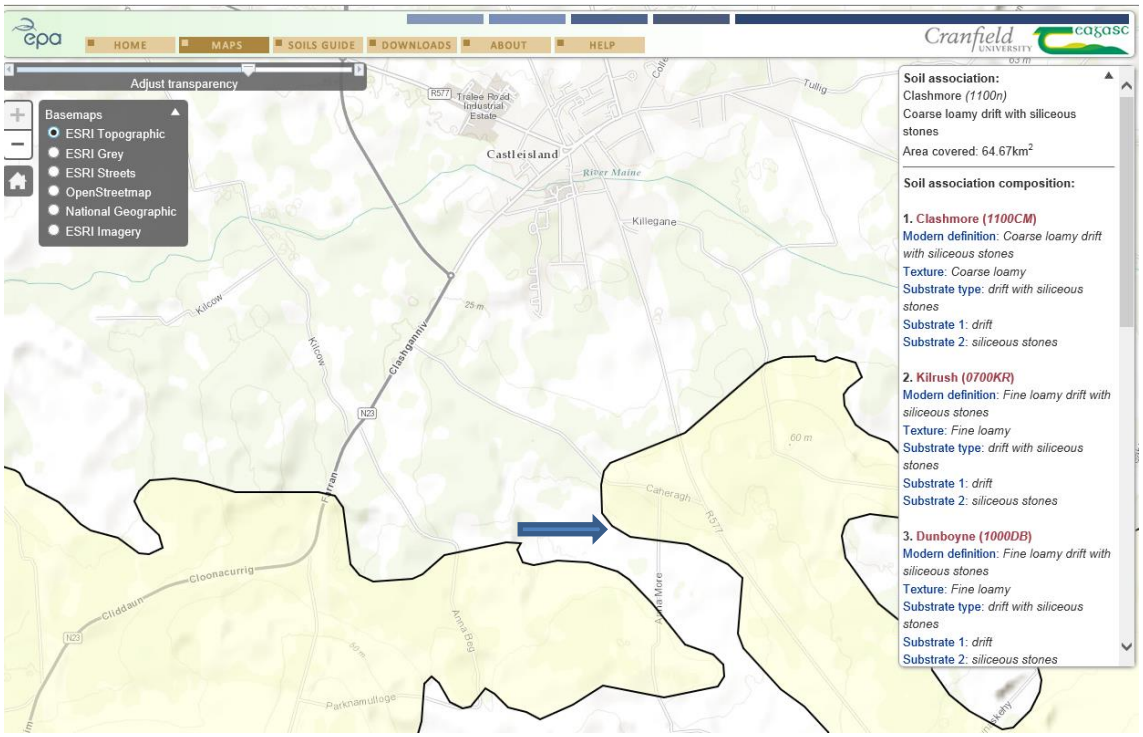

Plate 3. Irish SIS map of the area of Castleisland farm. The soil association of Clashmore, dominates the out farm to the east of the home farm. The blue arrow indicates the band of peat on the southern boundary of the out farm.

Auger campaign

Method

The distribution of the farm paddocks are in Plate 4. An auger bore was carried out on average every hectare to investigate the soil physical features. In practice more or less augers were used based on landscape complexity. Their resulting distribution was an even coverage in this area (Plate 5). The Dutch auger was driven into the soil to a depth of 1 metre if possible. The coordinates, landscape features and soil features were described and recorded on a field tablet. Horizon type, depth, texture, colour, mottling, structure, roots and stones were recorded along with many more physical attributes detailed in the Irish SIS soil profile handbook (Simo et al 2014).

In total there were 52 augers covering the area of O' Sullivans farm. The main area of the farm (Paddock 1 to 30) is dominated by a large flat plateau in the central, north and eastern areas (plate 6 and 7), with some shallow slopes at western and southern edges towards the river (Plate 8). The Plateau area was dominated by Luvisols, with some Typical Surface-water Gleys and Typical Groundwater Gleys in places. Only in the north west and south east corners were alluvial soils found on the home farm despite the river forming the perimeter of the farm on the western and southern sides.

The stagnating conditions prevalent in the soils have been overcome by good management practice and still allow for good sward growth in most paddocks (plates 6, 7 and 8). However the surface water and groundwater restricting conditions are evident with the abundance of rushes in some paddocks (Plate 9, A & B). In some of the remote paddocks the management effort is not worth the

expense, in these smaller paddocks the rush domination is being superseded by Iris and bramble (Plate 10, A & B).

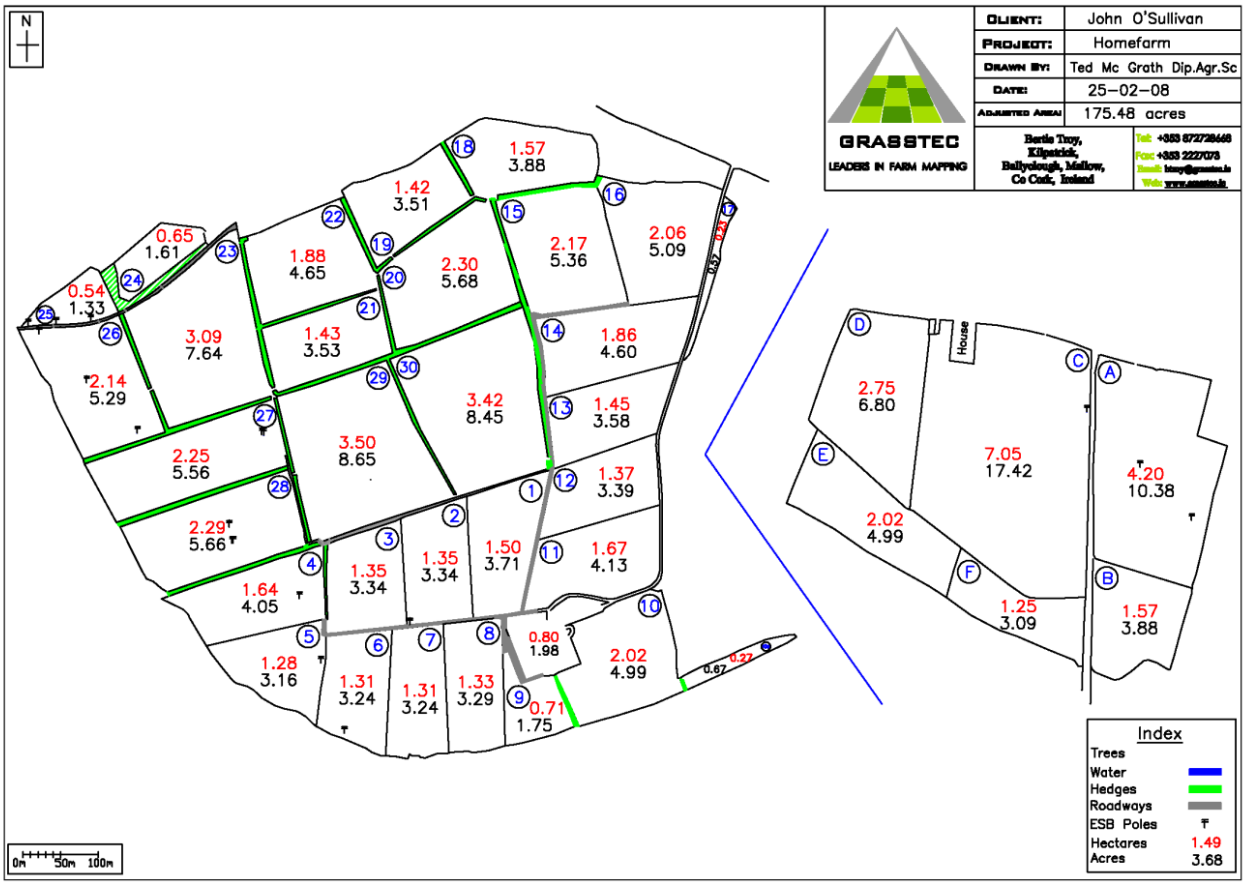

Plate 4. Paddock arrangement on O'Sullivans farm, Castleisland, Co. Kerry. The Brogheen River runs along the western and southern border of the home farm (Paddocks 26, 27, 28, 4, 5, 6, 7, 8, 9, 10 and 10a). It also runs along the southern border of paddock E, F and B on the out farm.

The out farm is a plain, becoming an alluvial plain at the southern edge (Paddocks A to F). There are Alluvial Gleys in this area as well as Typical Surface-water Gleys (Paddocks B, D, F and E). There is surface water in places and rushes apparent (Plate 11 A & B). Part of the area was planted with conifers in the past due to the poor nature of the soils, these have been stunted in their performance. The central paddocks of C and A are covered by Typical and Stagnic Luvisols. The better condition of these soils allow for greater productivity and trafficability (Plate 12)

Coarse fragments

In 23 of the augers the coarse fragments (gravels, stones and boulders) prevented any sampling below 60 cm depth. In some cases this was shallower to 35 cm depth. In many cases more than 3 attempts were made to get deeper with no success. In the sampled horizons coarse fragments were described as many (15 to 40 %) and in some cases abundant (40 to 80 %). The resulting soil types covered all great groups found on the farm: 10 Stagnic or Gleyic Luvisols; 5 Typical Luvisols, 4 Typical Surface-water Gleys; 2 Groundwater Gleys and 2 Alluvial soils. Therefore the coarse fragment effect appeared to be the same across the farm- reduced porosity leading to higher permeability.

Plate 5. Distribution of the soil auger points on the Castleisland Heavy soil farm, Co. Kerry.

As there is less soil volume in the profiles due to the coarse fragments and larger pore spaces, water can travel quickly from the surface down though the profile. However the water holding capacity of the soil is restricted meaning small amounts of water fill the available pore spaces quickly, leading to stagnation. The situation was also exacerbated by compaction of the upper horizons due to cementation of the deeper horizons as was recorded in the soil profile pits below.

Humic/Histic

Paddocks 15 A, 15 B, 30 A and C2 had high organic matter in the upper horizon. This suggests there are periods with stagnation long enough to prevent the breakdown of organic matter. These soils did not have high levels of coarse fragments, meaning there was more soil volume in the profile and greater water holding capacity. The soil texture classes of silty clay loam and clay loams also have high porosity but low permeability – the water will take much longer to drain from these soils.

Illuviation

The translocation of clay particles from the surface to lower horizons is the dominant feature of the Luvisol Great Group. Out of 52 augers 32 soils were described as Luvisols indicated by a Bt horizon for increases in clay from upper horizons. Many of the augers had soil texture classes of silt clay

Plate 6. Flat terrain of the central plain of the home farm of O' Sullivans. Paddock 4 looking northwards.

Plate 7. Flat terrain of the central plain of the home farm looking south and east. Paddock 15 O' Sullivans Heavy Soil Farm.

Plate 8. 2 degree incline looking north in paddock 28 b, O' Sullivans Heavy Soil farm.

Plate 9. A, rushes in the background of paddock 23 b. B, rushes in the background of paddock 20 on the Castleisland Heavy Soil Farm.

loam, clay loam and silty clay in the A and B horizons. All three classes have over 27 % clay which again indicates high porosity with low permeability. These soils are susceptible to waterlogging in the medium to long term after prolonged periods of rain as drainage is very slow to permeate down the profile. With the increase in clay in the Bt horizon the drainage will be slower and in effect creates a perched watertable.

There are also 11 Surface-water Gleys which also have an increase in clay in the B horizon. This time the watertable prevents oxygen entering the pores for longer periods leading to mottling and gleying of the soil matrix. This horizon is designated Btg and many of the Bt horizons of the Luvisols would become Btg with time if drainage measures are not put in place.

In severe cases of illuviation, clay skins appear on the surface of soil aggregates in lower horizons, these were recorded in the augers of paddocks 10, 18b, 20, 28 and 30b.

Groundwater

Only one auger encountered the groundwater table in paddock F1 at 70 cm depth. This was an Alluvial Gley close to the Brogheen River in the out farm. It is clear that for prolonged periods in the year the other Alluvial Gleys in paddocks F2a, F2b and D the water table does rise to cause severe gleying as was noted in the mottling of these augers. Groundwater Gleys were also recorded in paddocks 13, 14 and 15b. Again there is evidence of common to many mottles in the lower horizons in these cases.

In speaking with the farmer small sections of paddocks would hold water, have rushes or diminished grass growth. These areas could be sink holes which have blocked up and new sink holes having appeared nearby. Groundwater Gleys by their nature can be very sporadic and small in area coverage therefore their total coverage could be underestimated by the auger campaign.

Plate 10. A, paddock 24 dominated by rushes and brambles. B, paddock 25 overgrown by iris.

Plate 11. View of out farm, A, looking west in paddock F silty clay & B, looking south in paddock A2.

Conclusions

In keeping with the Irish SIS description of the area, Luvisols dominate the farm with 32 augers recorded. The Typical Surface-water Gleys accounted for 11 augers which are similar to the Luvisols with an increase in clay in the B horizon. There were 6 Alluvial soils and 3 Groundwater Gleys making up the remainder of the augers (Table 1). A drainage class was assigned based on the description of Schulte et al (2015) in relation to the soil moisture deficit hybrid model.

There were however no Brown Earths or Clashmore soil series as indicated by the Clashmore soil association in the Irish SIS map. This series is also found over coarse loamy drift. The drift in most of the augers was fine loamy drift to silty/clayey drift in places. It would appear on the ground that the Crosstown association of the home farm, should extend into the area of the Clashmore association of the out farm (northern two thirds of the area). The area of peat in the Irish SIS, on the south part of the out farm is not evident and an Alluvial association (Boyne) would be more appropriate for this part of the farm.

The north western third of the home farm was rented and therefore would not be considered for longer term management measures to improve the drainage capacity of the soils. If longer term agreements were in place, it is likely that the management measures successful in terms of productivity were applied throughout the farm, the soil drainage would improve in this area also.

Plate 12. Paddock C2, looking east on the out farm. With recently cut silage in the foreground on O' Sullivans Heavy Soil Farm.

Table 1. Field observations of soil type during the auger campaign on Castleisland Heavy Soil Farm. Paddocks are listed with Subgroup and Soil series based on the Irish SIS (Creamer et al 2014). The drainage class is described in Schulte et al (2015).

Paddock	SUBGROUP	SERIESNAME	Drainage Class
8	0700 Typical Surface-water Gley	Drumkeeran	Poorly
7b	0700 Typical Surface-water Gley	Coolykereen	Imperfectly
7a	0700 Typical Surface-water Gley	Coolykereen	Imperfectly
6	0700 Typical Surface-water Gley	Drumkeeran	Poorly
5a	0700 Typical Surface-water Gley	Lismeelcunnin	Poorly
5b	1000 Typical Luvisol	Cloongeel	Imperfectly
4	1030 Stagnic Luvisols	Gortavoher	Poorly
29a	0700 Typical Surface-water Gley	Drumkeeran	Poorly
29b	0700 Typical Surface-water Gley	Coolykereen	Poorly
30a	1030 Stagnic Luvisols	Crosstown	Imperfectly
30b	1020 Gleyic Luvisols	Crossabeg	Imperfectly
28a	1030 Stagnic Luvisols	Crosstown	Imperfectly
28b	1030 Stagnic Luvisols	Gortavoher	Imperfectly
27	1030 Stagnic Luvisols	Rathowen	Imperfectly
23a	1000 Typical Luvisols	Dunboyne	Moderately
23b	1030 Stagnic Luvisols	Gortavoher	Imperfectly
23c	1030 Stagnic Luvisols	Gortavoher	Imperfectly
24	1030 Stagnic Luvisols	Gortavoher	Imperfectly
24b	1000 Typical Luvisols	Dunboyne	Moderately
22a	1030 Stagnic Luvisols	Gortavoher	Imperfectly
22b	1030 Stagnic Luvisols	Gortavoher	Imperfectly
19	1030 Stagnic Luvisols	Gortavoher	Imperfectly
18	1030 Stagnic Luvisols	Gortavoher	Imperfectly
20	0700 Typical Surface-water Gley	Drumkeeran	Poorly
21	0700 Typical Surface-water Gley	Coolykereen	Poorly
18b	1000 Typical Luvisol	Cloongeel	Imperfectly
15a	1030 Stagnic Luvisols	Gortavoher	Imperfectly
15b	0660 Humic Groundwater Gleys	Noonan	Imperfectly
16	1000 Typical Luvisols	Dunboyne	Moderately
14	0600 Typical Groundwater Gleys	Kilpierce	Imperfectly
13	0600 Typical Groundwater Gleys	Kilpierce	Imperfectly
12	1030 Stagnic Luvisols	Gortavoher	Imperfectly
11	1000 Typical Luvisols	Dunboyne	Moderately
10	1000 Typical Luvisols	Dunboyne	Moderately
17	0500 Typical Alluvial Gley	Boyne	Moderately
25	1000 Typical Luvisols	Dunboyne	Moderately
26	0500 Typical Alluvial Gley	Boyne	Moderately
1	1000 Typical Luvisol	Cloongeel	Moderately
2	1000 Typical Luvisol	Drumkeen	Moderately

Table 1 continued.

Paddock	SUBGROUP	SERIESNAME	Drainage Class
3	1000 Typical Luvisols	Dunboyne	Moderately
F1	0500 Typical Alluvial Gley	Boyne	Poorly
F2a	0500 Typical Alluvial Gley	Vicarstown	Poorly
F2b	0500 Typical Alluvial Gley	Boyne	Poorly
C1	1000 Typical Luvisols	Dunboyne	Moderately
C2	1000 Typical Luvisols	Dunboyne	Moderately
C3	1000 Typical Luvisols	Dunboyne	Moderately
C4	1030 Stagnic Luvisols	Gortavoher	Imperfectly
A1	1000 Typical Luvisols	Dunboyne	Moderately
A2	1030 Stagnic Luvisols	Gortavoher	Poorly
B	0700 Typical Surface-water Gley	Coolykereen	Poorly
D1	0700 Typical Surface-water Gley	Drumkeeran	Poorly
D2	0570 Typical Drained Alluvial Soils	Suir	Imperfectly

Representative soil profile pits

Using the auger survey as a guide, four pits were selected to represent the dominant soils on the farm and to investigate the principal drainage restrictions identified. Paddock 6 was to represent the Stagnating Luvisols on the shallow slopes of the home farm. Paddock 30 was chosen to represent the more Humic Surface-water Gleys in the flat areas. Paddock C was to represent the Luvisols of the out farm with a minor drainage problem. Paddock F was to represent the Alluvial soils with a severe drainage problem, the Alluvial Gleys, also on the out farm.

Plate 13. Paddock 6. Stagnic Luvisol 1030, series Gortavoher

Table 2. Soil profile description of paddock 6, Castleisland Heavy Soil Farm.

Horizon depth (cm)	Horizon designation	Description
36	Ap	Rich brown colour, abundant root mottles , silty clay loam, common gravels, weathered stones
100	BCtg	Light reddish brown, many matrix mottles, slity clay loam, many gravels, clay coats, compacted
190	Cr	Light reddish brown, common matrix mottles, loam, dominant stones. Weakly cemented. Sandy clay loam in places. Limestones bottom of pit.

Paddock 6 contains the Stagnic Luvisol, series Gortavoher. Its definition is fine silty drift with siliceous stones (Plate 13). The stagnation has occurred due to an increase in stones from hz 1 to hz 2 from common to many gravels, this has coincided with a 60 % increase in bulk density (Table 2). The soil texture class remains at silty clay loam. The water can move more quickly through this horizon, but there is less permeability so its capacity is greatly reduced leading to a perched water

Plate 14. Paddock 30. Humic Surface-water Gley 0760, series Ballygree.

Table 3. Soil profile description of paddock 30, Castleisland Heavy Soil Farm.

Horizon depth (cm)	Horizon designation	Description
28	AO	Black, peaty loam, many root mottles, few stones
62	Btg	Brownish yellow, abundant mottles, stagnic channels, abundant stones, silty clay loam, compacted, stone layer at bottom of hz.
140	Cgx	Light yellowish brown, common mottles, clay loam, clay coats abundant stones, cemented
180	R	Brown, clay texture just above Limestone boulders/bedrock

table. This is exacerbated by a cemented horizon 3. As the water slowly percolates from horizon 2 to horizon 3 it has very little pore space to move into. There are many matrix mottles in horizon 2 indicating the water table fluctuates in this zone and there are periods of aeration following anoxic periods where iron deposition occurs. The appearance of clay coats in this horizon is indicative of the illuviation process bringing clay particles from horizon 1 into horizon 2.

Plate 15. Zone of severe stagnation just below horizon 1.

The pit of paddock 30 has a soil texture class of silty clay loam (Table 3). Fine silty drift with siliceous stones is the profiles definition overall. The Humic Surface-water gley, Ballygree meets this combination (Plate 14). The abundant mottles of horizon 2 allude to the severe stagnation and perched water table at this depth (Plate 15). The stagnic channels in the upper part of the Btg horizon indicate preferential flow due to the restricted water movement. The stone layer at the bottom of this horizon causes the compaction at this depth. There is also a 50 % jump in bulk density from hz 1 to hz 2.As a result poaching is bad in this field and there is standing water in places. At depth in horizon 3 there are clay skins indicating the translocation and deposition of clay particles on the pressure faces of the soil aggregates here from the previous layer.

Paddock F was to the north of the north of the Brogheen River in the out farm (Plate 16). Horizon 1 and 2 have very few stones and when present were sub rounded in places. There also is a texture of Silty clay which leads to the designation of Alluvial Gley. Due to the dark colour and high organic matter content of the A horizon the profile is designated humic. The definition is therefore Clayey river alluvium with a humic surface horizon. This keys out as the Camoge soil series.

Plate 16. Paddock F. Humic Alluvial Gley. 0560. Camoge

Table 4. Soil profile description of paddock F, Castleisland Heavy Soil Farm.

Horizon depth (cm)	Horizon designation	Description
43	AO	Dark grey, humic ,Silty clay, abundant mottles, few stones, weathered stones.
65	Btg	Light grey, humic intrusion (inverted). silty clay, abundant mottles, few stones, common manganese coats, very plastic, Compacted, dead roots, weathered stones.
110	Cg	Light greenish grey, silty clay loam, many mottles, many stones, Compacted, dead roots
180	2Cg	Light bluish grey, silty clay loam, many mottles, dominant stones, Cemented, dead roots

Further away from the river flood plain, this soil would likely become the Humic Surface-water Gley. 0760. Cluggin. As before the high clay contents of this soil reduces permeability but increases the water holding capacity of the soil. Again there is a cemented sub surface horizon leading to a perched watertable. With high mottling throughout the groundwater table rises regularly also. There

were remnants of artificial drains which were not sufficient as the ground had consequently been dug and inverted to improve trafficability, presumably. In any case the growth is severely restricted in this area with long periods of anoxia. This is reflected also in the amount of dead roots from a drier period in the past (Table 4).

Plate 17. Paddock C, Stagnic Luvisol 1030, series Gortavoher (Humic version).

Table 5. Soil profile description of paddock C, Castleisland Heavy Soil Farm.

Horizon depth (cm)	Horizon designation	Description
30	Ap	Dark greyish brown, humic, silty clay loam, many root mottles, common stones, compacted
80	BC	Brown, silty clay loam, many mottles, many stones, Clay coats, compacted, stagnic channels
180	Cg	Light yellowish brown, clay loam, common mottles, dominant stones manganese coats, cemented
200	2Cg	Yellowish brown, silty clay loam, shale boulders with limestone bedrock beneath

Paddock C is represented by the Stagnic Luvisol series Gortavoher (Plate 17). Fine silty drift with siliceous stones is the definition. It has a humic surface horizon with high organic matter content (Table 5). This organic matter has built up due to anoxic conditions preventing microbial breakdown. There is a 6 % increase in clay content in horizon 2 compared to horizon 1. The clay has illuviated from the surface to the sub surface horizon. There is further evidence of this process with clay coats found on the soil aggregates. There are also many mottles in this 2nd horizon indicating stagnation at certain periods of the year.

There is a 40 % increase in bulk density hz1 to hz2, which is reflected in the compacted nature and many stones. Horizon 3 has become cemented over time and contains dominant stones. Manganses coats are present indicating perching of the watertable and many biochemical reactions occurring under anoxic conditions (Plate 19). This profile can be seen as a transition from Paddock 6 where there was no humic horizon with illuviation dominating to paddock 30 where stagnation is dominating and the Surface-water Gley results from the on-going pedogenetic process.

Plate 19. Manganese coat, continuous, found in horizon 3 of the soil profile from paddock C.

Conclusions

The soils on this farm are dominated by the illuvial process. Clay is being moved from upper horizons to lower horizons due to weathering. These clay particles fill the pore spaces in the lower horizons soil matrix. This process is exacerbated by the high presence of coarse fragment reducing the volume of soil in a given profile. Water has very little space to fill before the soil is saturated. There is general vertical restriction due to compacted sub soil layers and cemented layers within 1 metre of the surface. Therefore Luvisols are the dominant great soil group, with over half having problems with stagnation. As the pedogenetic process continues unabated over time, many of these Stagnic Luvisols become Typical Surface-water Gleys. Indeed parts of paddocks designated Stagnic Luvisols, may already by Typical Surface-water Gleys. Drainage measures may restrict this progression. Shallow limestone beneath the siliceous drift exacerbates the overall drainage problem; this bedrock is porous allowing groundwater to come into shallow depths. Groundwater Gleys are found sporadically in paddocks. With undulating bedrock depths, abrupt rises in the groundwater at certain times of year and throughout the year can be seen in parts of paddocks. Solutions to these smaller more intense wet areas will be more sporadic as these “sink holes” to drain groundwater appear and disappear naturally in this area.

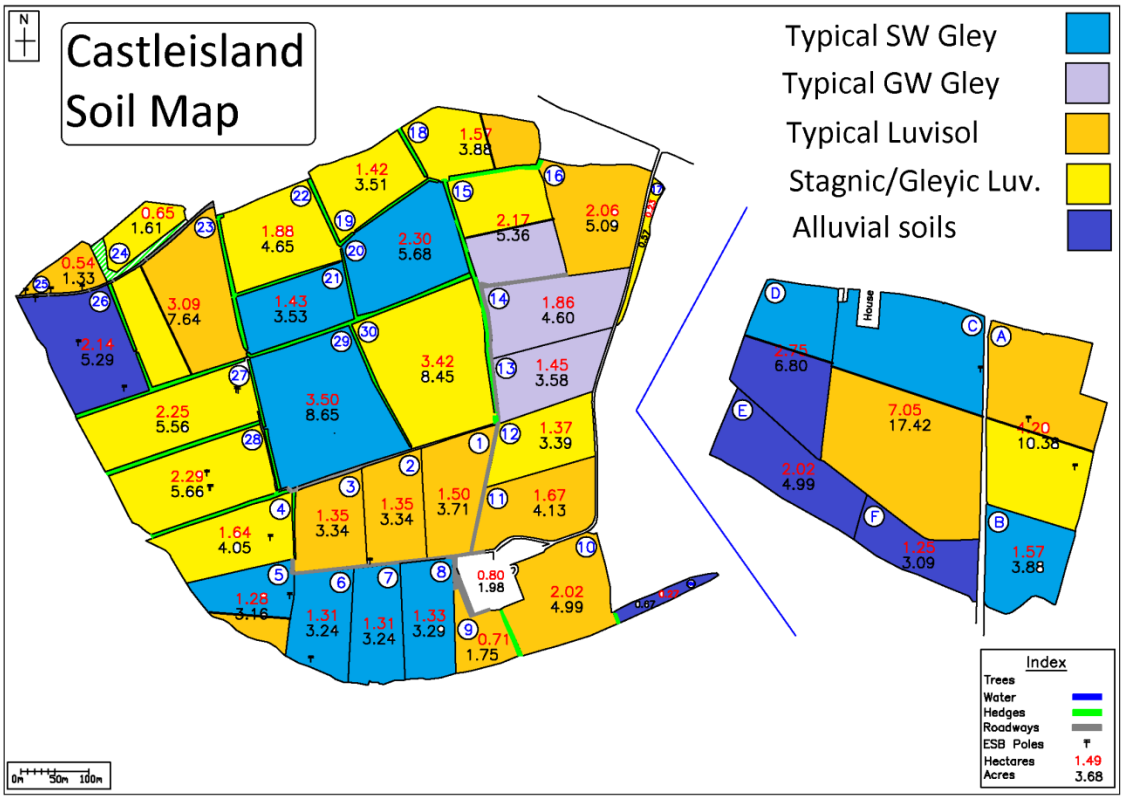

Plate 20. Distribution of soils on the Castleisland HSP farm based on the 2015 auger campaign and pit excavations, coupled with laboratory data from field sampling.

References

Sleeman, A. G. and Pracht, M. (1999). Geology of the Shannon Esturary: A Geological Description of The Shannon Estuary Region including parts of Clare, Limerick and Kerry with accompanying bedrock geology 1:100,000 scale map, Sheet 17. Geological Survey of Ireland.

Pracht, M. (1997). Geology of Kerry-Cork: A geological description to accompany the bedrock geology 1:100,000 scale map series, sheet 21,Kerry-Cork, Geological Survey of Ireland.

Creamer, R.E., Simo, I., Reidy, Carvalho, J., Fealy, R., Hallett, S.,Jones, R., Holden, A., Holden, N., Hannam, J., Massey, P., Mayr,T., McDonald, E., O' Rourke, S., Sills, P., Truckell, I., Zawadzka, J.and Schulte, R.P.O. 2014.Irish Soil Information System.SynthesisReport (2007-S-CD-1-S1). EPA STRIVE Programme, Wexford.http://gis.teagasc.ie/soils/map.php

Finch, T. F and Ryan P. (1966). Soils of County Limerick .Soil Survey Bulletin No. 16 National Soil Survey of Ireland, AnForasTaluntais, Dublin.

Kerry County Committee of Agriculture. 1972. County Kerry Agricultural resource survey, published by County Kerry Committee of Agriculture, Tralee, Ireland.

Simo I, Creamer RE, Reidy B, Hannam JA, Fealy R, Hamilton B, Jahns G, Massey P, McDonald E, Schulte RPO, Sills P and Spaargaren O, (2014) Irish SIS Final Technical Report 10: Soil Profile Handbook. Associated datasets and digital information objects connected to this resource are available at: Secure Archive For Environmental Research Data (SAFER) managedby Environmental Protection Agency Ireland. http://erc.epa.ie/safer/resource?id=a1b872a2-3b8c-11e4-b233-005056ae0019 (last accessed: 08/09/2016)

Schulte, R.P.O., Simo, I., Creamer, R.E. and Holden N.M. 2015.A note on the Hybrid Soil Moisture Deficit Model v2.0. Irish Journal of Agricultural and Food Research, 54 (2) 126 – 131.

Appendix.

Table 6. Laboratory data for samples taken from soil pits at Castleisland HSP farm.

Label	Paddock	Sample	Clay (%)	Silt (%)	Sand (%)	Dry Density (g/cm^3)	Bulk Density (g/cm^3)	Gravimetric Moisture Content (%)	Total Exchange Capacity (meq/100 g)	pH	Organic Matter (%)	Estimated Nitrogen Release (#'s N/acre)
JOS 1	6	HZ1	35	45	20	1.00	1.56	54.94	14.98	5.5	8.46	117
JOS 2	6	HZ2	30	50	20	1.60	1.98	19.03	7.03	6.3	1.13	43
JOS 3	6	HZ3	25	41	34	Too many stones-no samples			7.04	6.3	1.43	49
JOS 4	30	HZ1	35	45	20	0.82	1.38	67.69	18.61	5.4	17.69	129
JOS 5	30	HZ2	29	54	17	1.44	1.87	28.11	9.77	5.8	1.52	50
JOS 6	30	HZ3	30	45	25	Too many stones-no samples			8.97	6.4	1.19	44
JOS 7	C	HZ1	36	49	15	0.94	1.54	62.08	15.13	5.7	9.35	122
JOS 8	C	HZ2	32	54	14	1.41	1.88	27.59	9.13	6.7	2	60
JOS 9	C	HZ3	32	47	21	Too many stones-no samples			7.38	6.5	1.12	42
JOS 10	F	HZ1	41	40	19	0.72	1.43	96.95	13.10	5.8	16.49	128
JOS 11	F	HZ2	47	40	13	1.29	1.86	44.72	7.73	5.3	2.31	66
JOS 12	F	HZ3	36	45	19	1.48	1.98	29.00	7.21	5.1	1.19	44
JOS 13	F	HZ4	38	42	20	Too many stones-no samples			8.47	5.8	0.98	39

Table 6 continued…

Label	Paddock	Sample	S* (ppm)	P* (mg/kg)	Bray II P (mg/kg)	Ca* (mg/kg)	Mg* (mg/kg)	K* (mg/kg)	Na* (mg/kg)	Ca** (%)	Mg** (%)	K** (%)	Na** (%)
JOS 1	6	HZ1	17	73	123	1597	133	105	38	53.3	7.4	1.8	1.1
JOS 2	6	HZ2	9	3	2	1014	67	55	38	72.12	7.94	2.01	2.35
JOS 3	6	HZ3	12	7	7	978	80	92	34	69.46	9.47	3.35	2.1
JOS 4	30	HZ1	22	110	176	1972	110	107	43	52.98	4.93	1.47	1
JOS 5	30	HZ2	13	3	2	1295	48	41	39	66.27	4.09	1.08	1.74
JOS 6	30	HZ3	16	3	20	1393	57	44	37	77.65	5.3	1.26	1.79
JOS 7	C	HZ1	18	36	54	1866	107	65	47	61.67	5.89	1.1	1.35
JOS 8	C	HZ2	12	3	1	1519	54	37	34	83.19	4.93	1.04	1.62
JOS 9	C	HZ3	10	5	6	1166	41	49	39	79	4.63	1.7	2.3
JOS 10	F	HZ1	19	36	73	1690	86	79	50	64.5	5.47	1.55	1.66
JOS 11	F	HZ2	15	5	6	699	74	52	40	45.21	7.98	1.72	2.25
JOS 12	F	HZ3	13	2	2	478	125	33	34	33.15	14.45	1.17	2.05
JOS 13	F	HZ4	7	2	3	765	244	63	41	45.16	24.01	1.91	2.1

Table 6 continued…

Label	Paddock	Sample	Other Bases** (%)	H** (%)	B* (mg/kg)	Fe* (mg/kg)	Mn* (mg/kg)	Cu* (mg/kg)	Zn* (mg/kg)	Al* (mg/kg)
JOS 1	6	HZ1	6.4	30	0.69	525	19	1.07	1.9	730
JOS 2	6	HZ2	5.1	10.5	< 0.20	88	6	0.89	< 0.4	860
JOS 3	6	HZ3	5.1	10.5	< 0.20	143	19	0.98	0.52	932
JOS 4	30	HZ1	6.6	33	0.53	460	24	2.79	2.57	1097
JOS 5	30	HZ2	5.8	21	< 0.20	220	12	1.4	0.61	950
JOS 6	30	HZ3	5	9	< 0.20	109	85	1.24	1.37	887
JOS 7	C	HZ1	6	24	0.78	485	13	2.35	1.99	711
JOS 8	C	HZ2	4.7	4.5	< 0.20	189	8	1.44	0.79	840
JOS 9	C	HZ3	4.9	7.5	< 0.20	72	7	0.85	0.6	890
JOS 10	F	HZ1	5.8	21	0.51	578	27	0.27	1.83	906
JOS 11	F	HZ2	6.8	36	0.64	560	19	0.6	< 0.4	1132
JOS 12	F	HZ3	7.2	42	0.44	230	84	4.6	1.56	945
JOS 13	F	HZ4	5.8	21	0.51	232	91	2.88	1.38	558