
RURAL ECONOMY AND LAND USE
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LANCASTER UNIVERSITY
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CSWM
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Grazing = defecation = pollution = not that simple?
RELU project team

Livestock – mobile faeces generators

Relative risk of FIO loss from land to water, from grazing livestock, is of equal significance to manure spreading (Vinten *et al*., 2004)

Yet we appear to have a lack of data to reflect & capture spatial (and temporal) distributions of livestock at the farm scale

The importance of field sources depends on the timing and the extent of faecal deposition

Livestock distribution can be valuable information but it is so DYNAMIC …..

f (farmer decision making process) which is *f* (physical landscape characteristics, farming habit, sward height, convenience, …….)

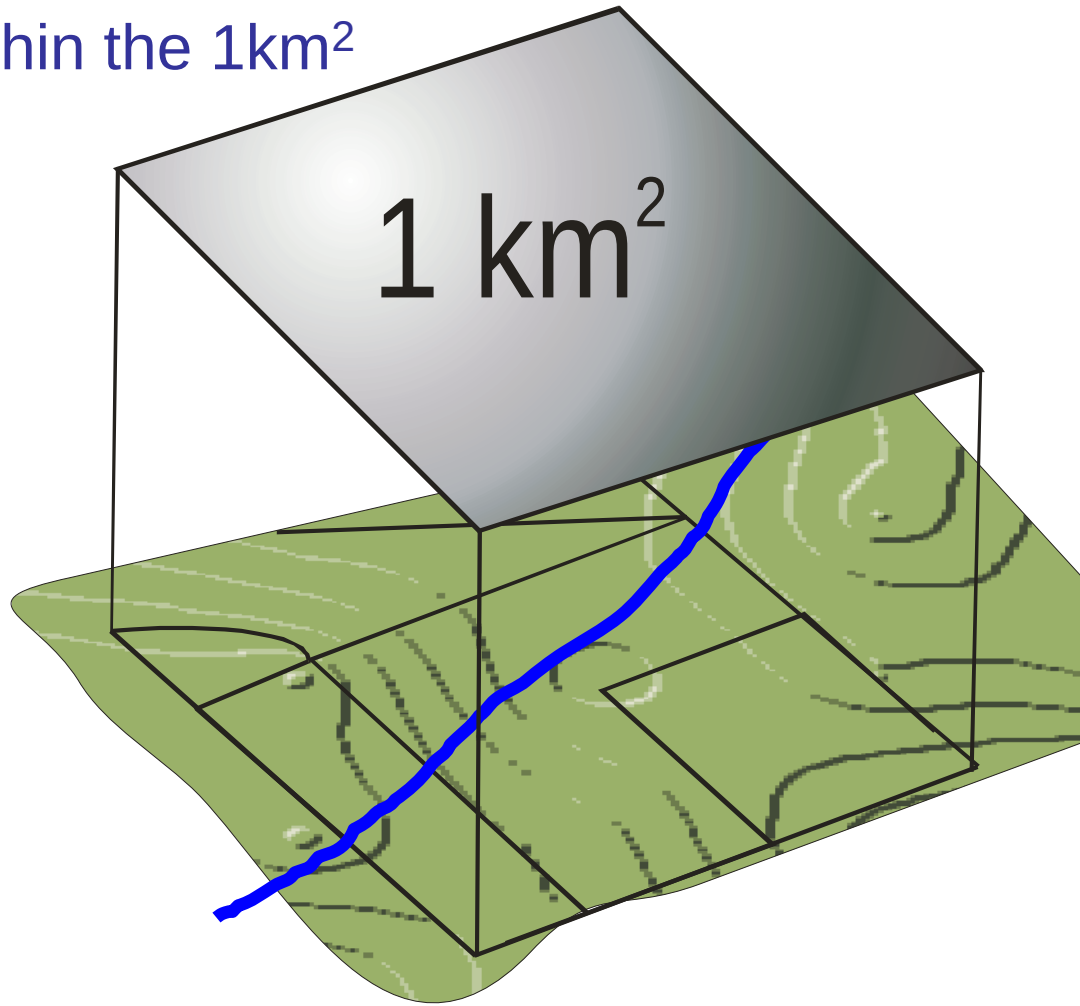
What's in a cell?

1km^2: 84 dairy, 20 beef, 110 sheep

But no idea of distribution within the 1km^2

Are livestock distributed across high or low risk land?

If we had livestock distribution data across farms this could be coupled with the inherent landscape features to inform on the potential 'riskiness' of livestock defecations.



Importance of livestock data at the farm scale

The farm scale is a ‘Decision scale’

We need to translate uncertainties into a decision making domain

Confidentiality restricts the availability of ‘per farm’ animal data

Within large catchments we cannot survey all farms to determine livestock numbers and distributions

We have no certainty regarding the inter-field transfer of livestock units about the farm

Detailed mapping via farmer exercise

To gain a spatial understanding of livestock distribution we incorporated a mapping exercise into our farmer survey

Turnout

What grazes where?

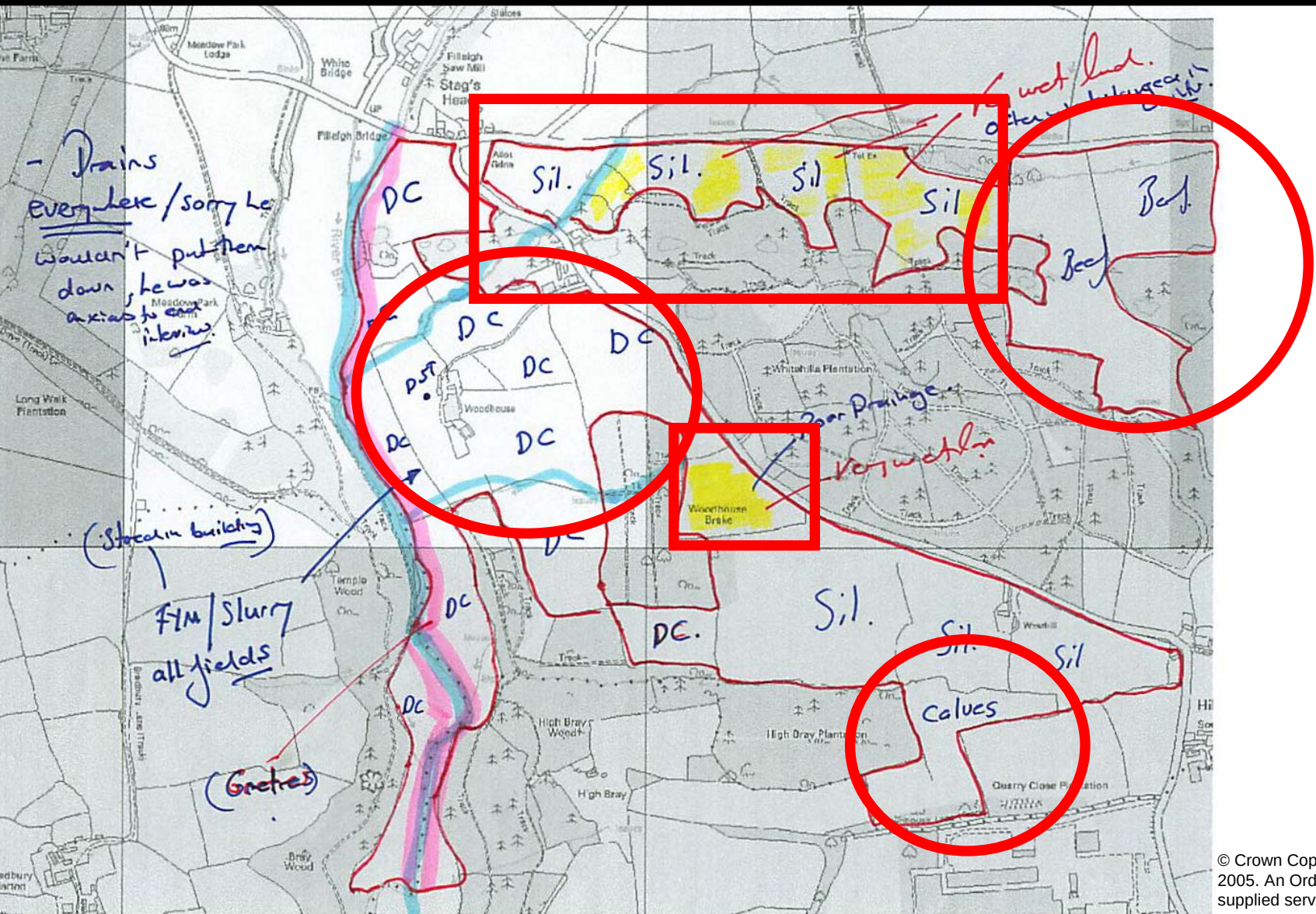
Separation of animals?

Rotation?

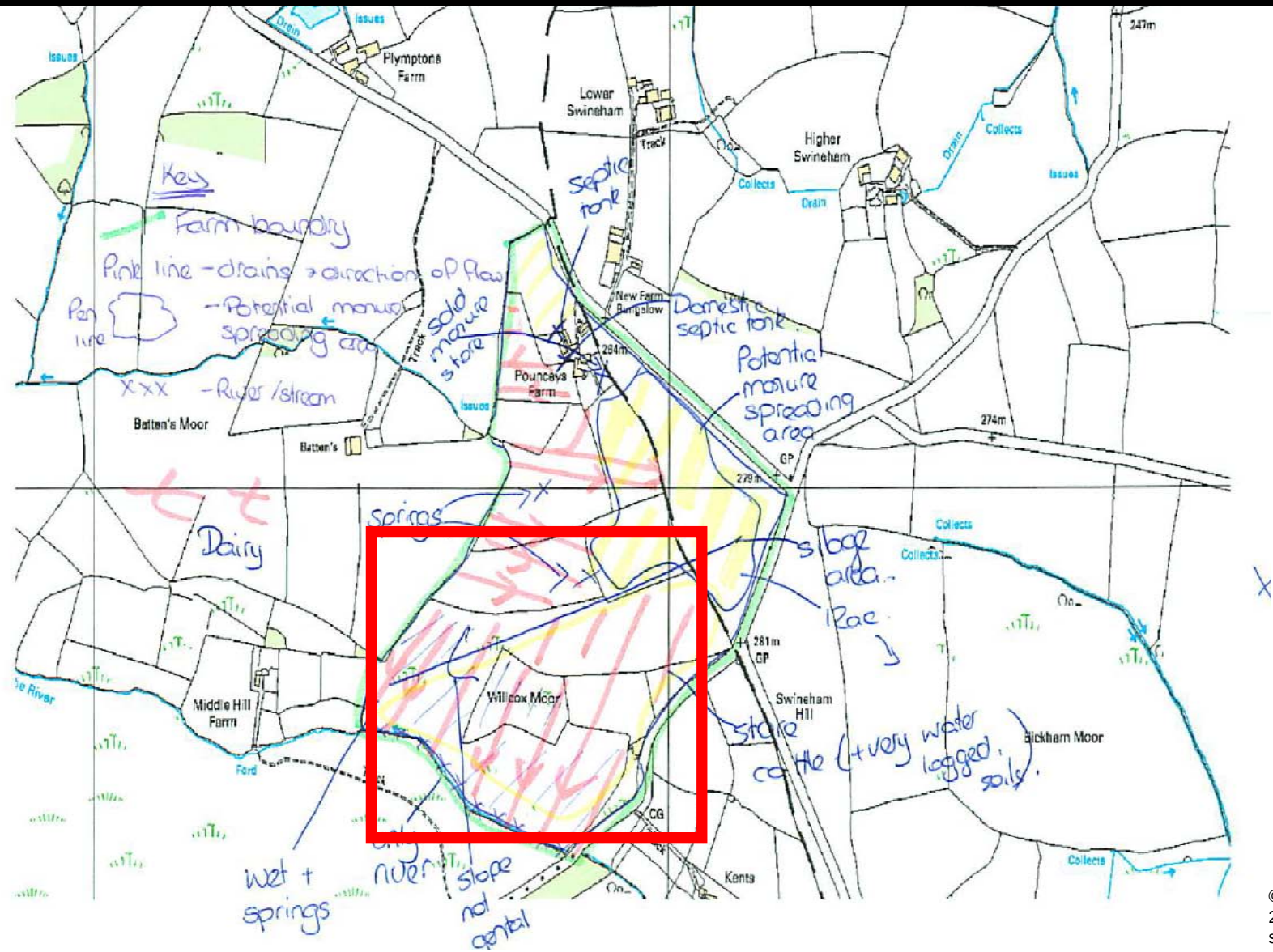
Never grazed?

Can couple with informed landscape knowledge of farmer

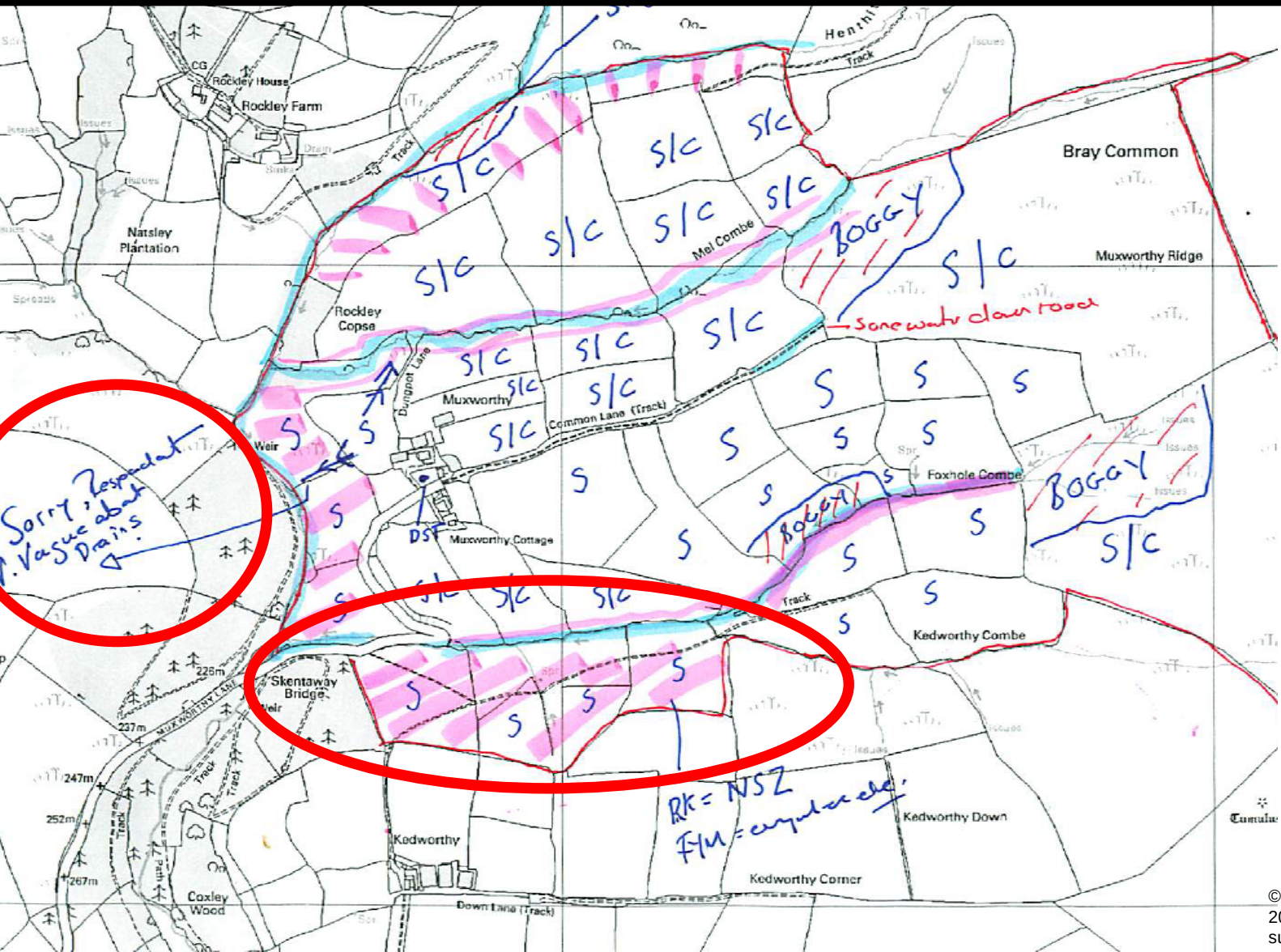
Example 1: LIVESTOCK TYPE SOIL DRAINAGE



Example 2: SUBSURFACE DRAINAGE



Example 3: NO SPREAD ZONES
UNCERTAINTY IN DRAINAGE PLANS



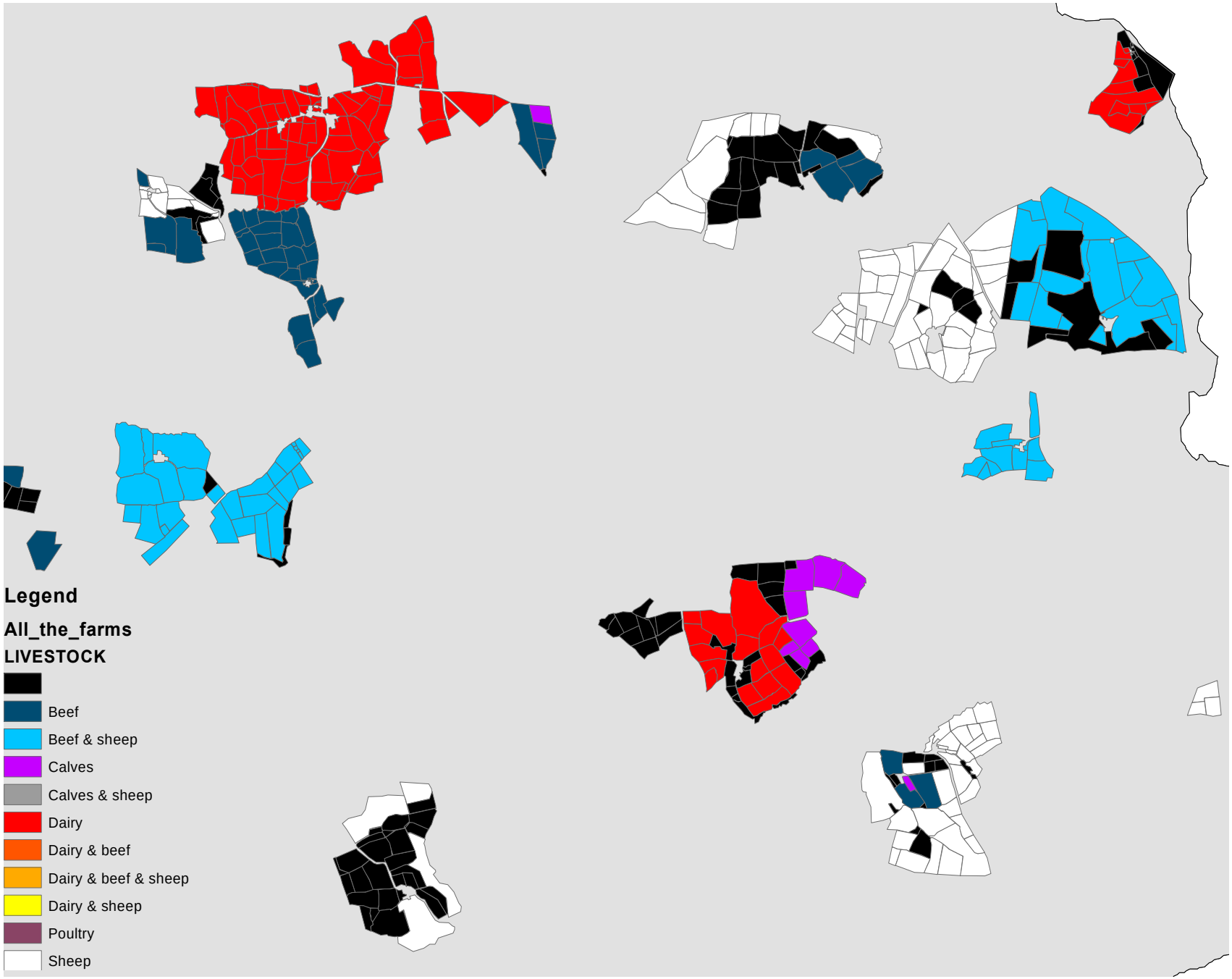
A detailed dataset?

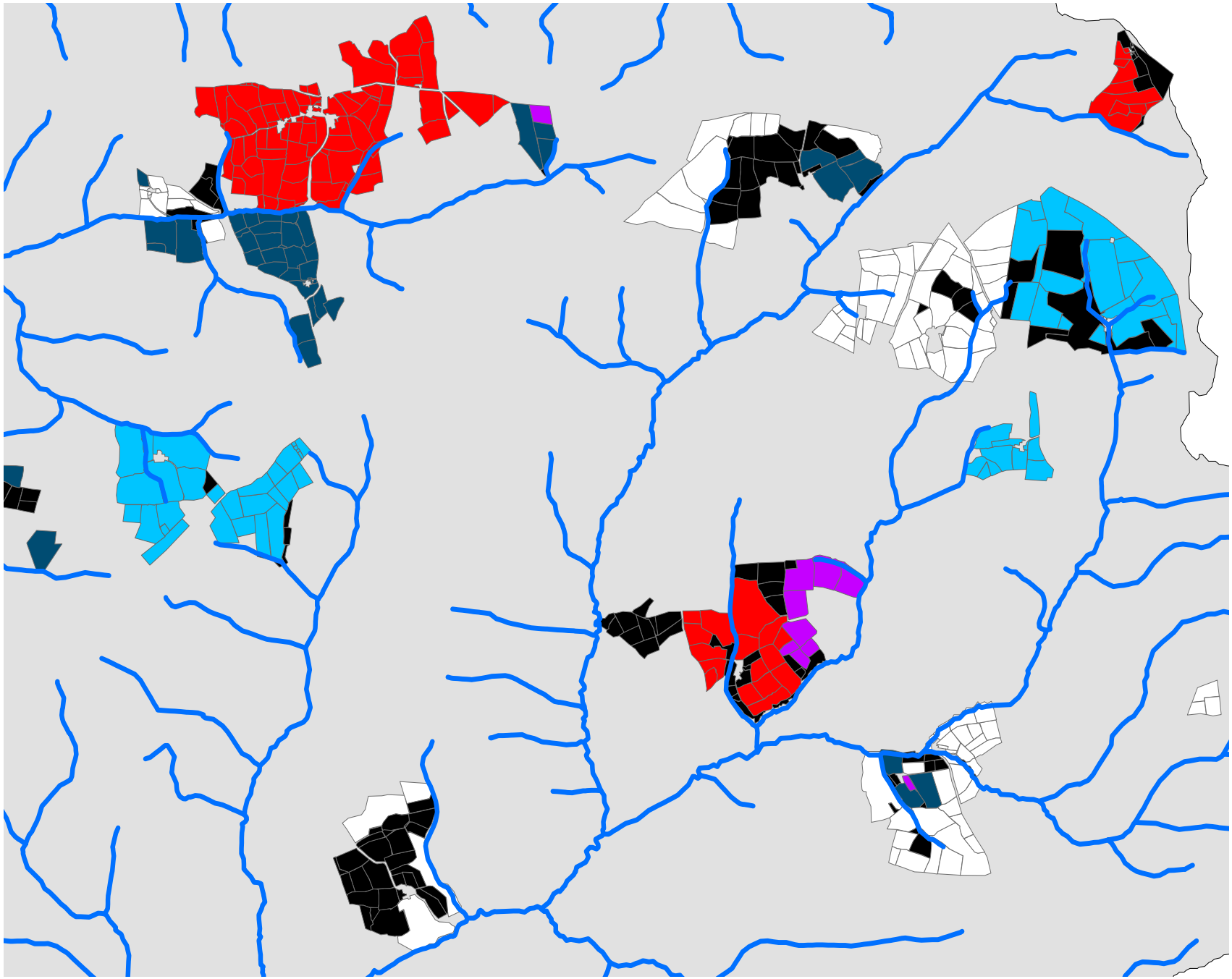
A survey of 77 farms in the Taw catchment has generated a dataset for 2077 fields

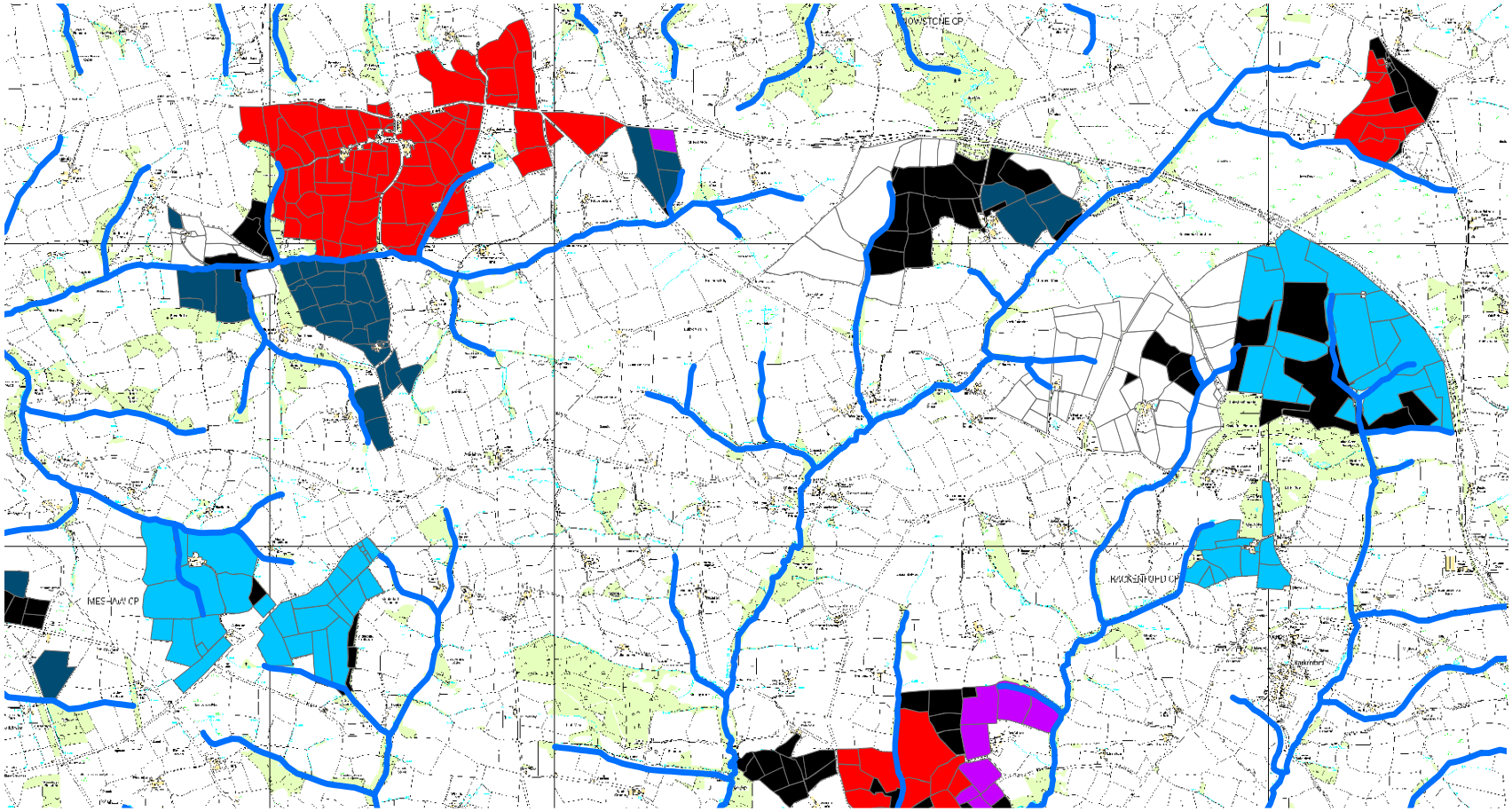
Livestock distribution data coupled with farmer knowledge of landscape connectivity

High level of detail but incomplete coverage of catchment area

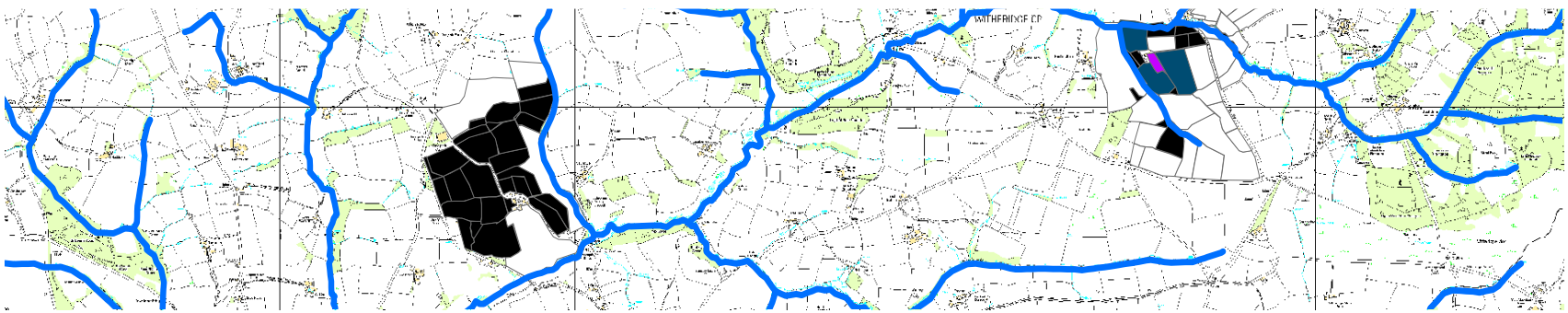
Can we use this dataset to generate reliable farm-type rules?

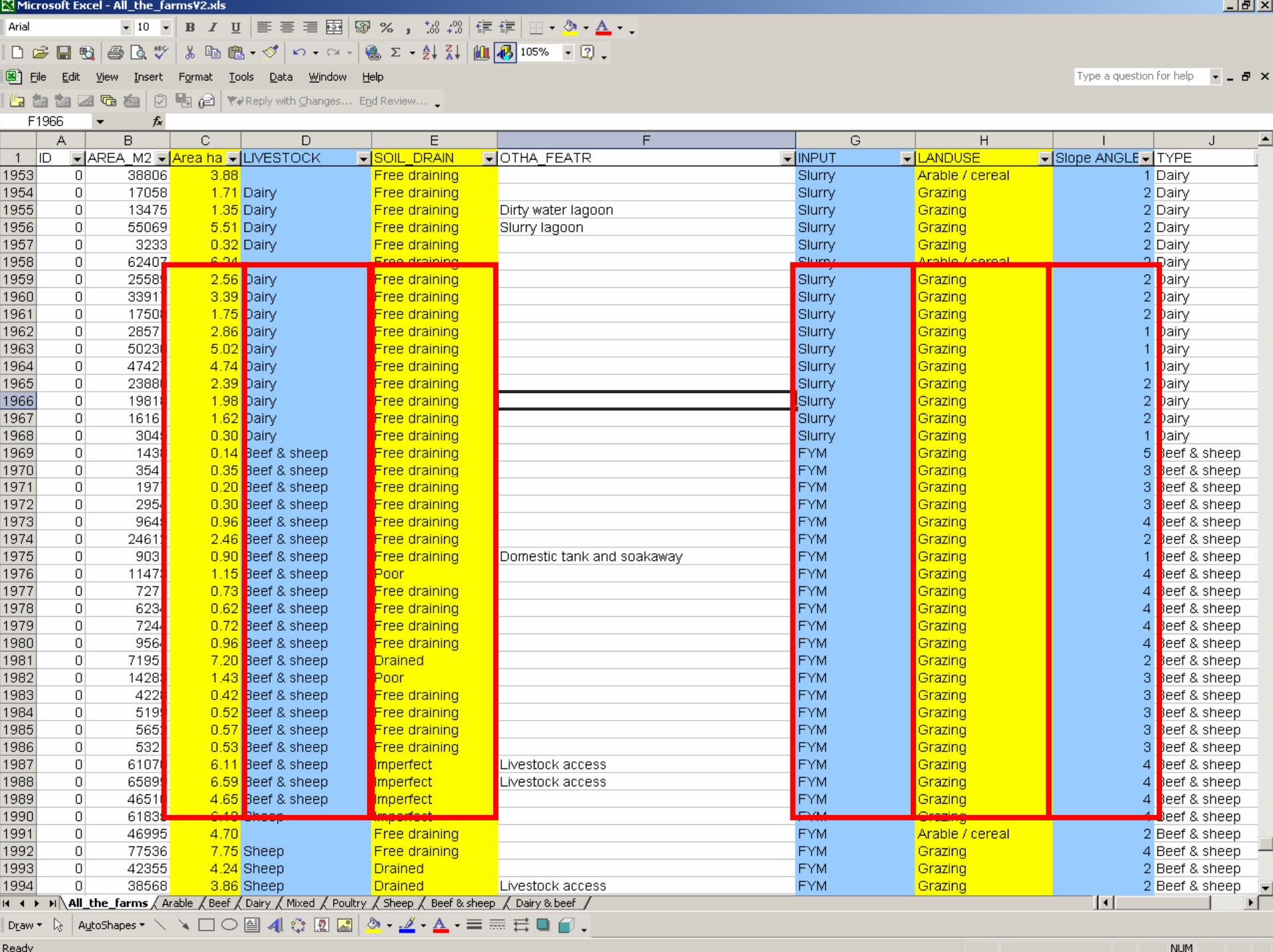

Legend
All_the_farms
LIVESTOCK
Beef
Beef & sheep
Calves
Calves & sheep
Dairy
Dairy & beef
Dairy & beef & sheep
Dairy & sheep
Poultry
Sheep



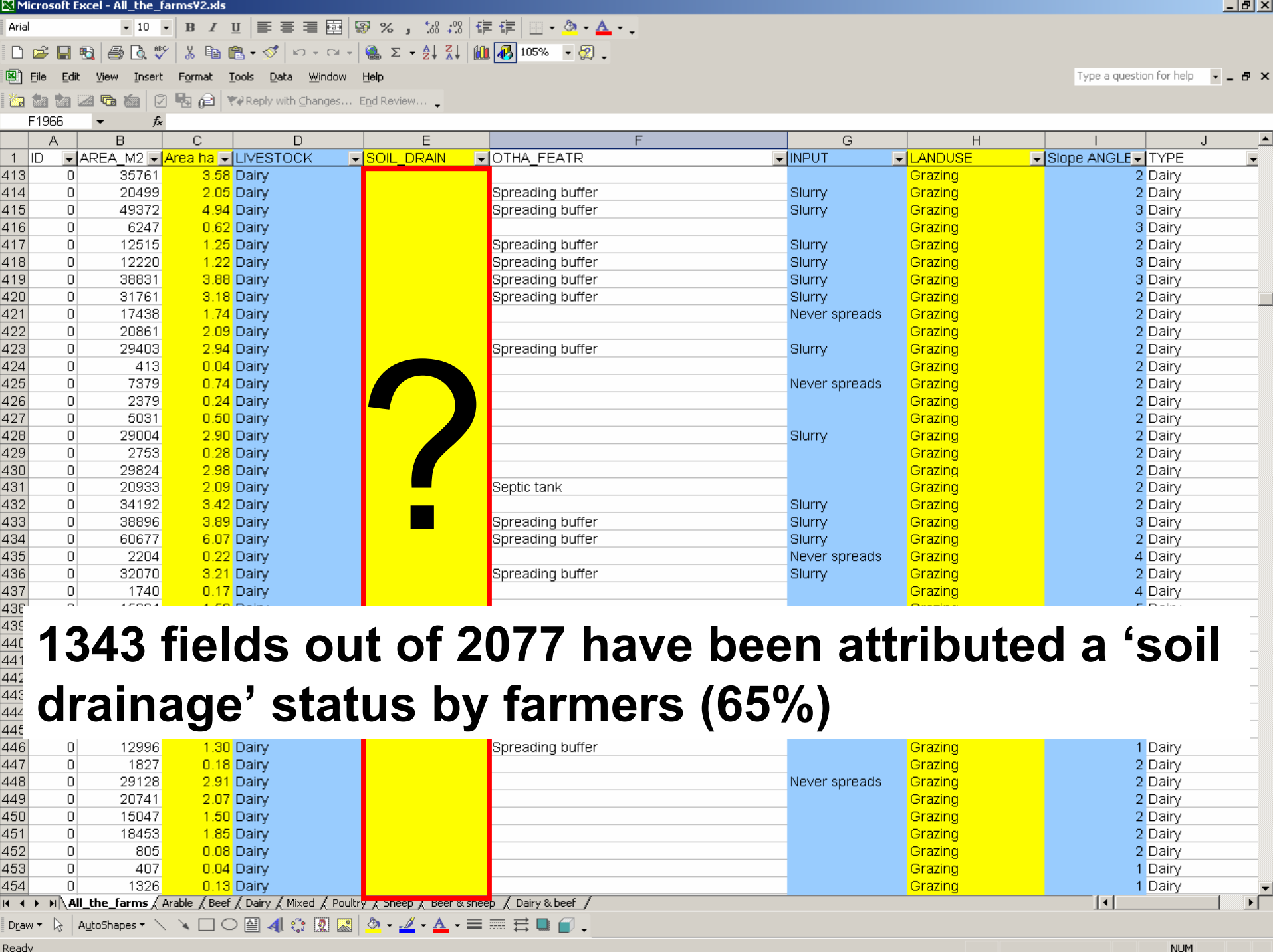


Detailed …… BUT spatially incomplete





	A	B	C	D	E	F	G	H	I	J
1	ID	AREA_M2	Area ha	LIVESTOCK	SOIL_DRAIN	OTHA_FEATR	INPUT	LANDUSE	Slope ANGLE	TYPE
1953	0	38806	3.88		Free draining		Slurry	Arable / cereal	1	Dairy
1954	0	17058	1.71	Dairy	Free draining		Slurry	Grazing	2	Dairy
1955	0	13475	1.35	Dairy	Free draining	Dirty water lagoon	Slurry	Grazing	2	Dairy
1956	0	55069	5.51	Dairy	Free draining	Slurry lagoon	Slurry	Grazing	2	Dairy
1957	0	3233	0.32	Dairy	Free draining		Slurry	Grazing	2	Dairy
1958	0	62407	6.24		Free draining		Slurry	Arable / cereal	2	Dairy
1959	0	2558	2.56	Dairy	Free draining		Slurry	Grazing	2	Dairy
1960	0	3391	3.39	Dairy	Free draining		Slurry	Grazing	2	Dairy
1961	0	1750	1.75	Dairy	Free draining		Slurry	Grazing	2	Dairy
1962	0	2857	2.86	Dairy	Free draining		Slurry	Grazing	1	Dairy
1963	0	5023	5.02	Dairy	Free draining		Slurry	Grazing	1	Dairy
1964	0	4742	4.74	Dairy	Free draining		Slurry	Grazing	1	Dairy
1965	0	2388	2.39	Dairy	Free draining		Slurry	Grazing	2	Dairy
1966	0	1981	1.98	Dairy	Free draining		Slurry	Grazing	2	Dairy
1967	0	1616	1.62	Dairy	Free draining		Slurry	Grazing	2	Dairy
1968	0	304	0.30	Dairy	Free draining		Slurry	Grazing	1	Dairy
1969	0	143	0.14	Beef & sheep	Free draining		FYM	Grazing	5	Beef & sheep
1970	0	354	0.35	Beef & sheep	Free draining		FYM	Grazing	3	Beef & sheep
1971	0	197	0.20	Beef & sheep	Free draining		FYM	Grazing	3	Beef & sheep
1972	0	295	0.30	Beef & sheep	Free draining		FYM	Grazing	3	Beef & sheep
1973	0	964	0.96	Beef & sheep	Free draining		FYM	Grazing	4	Beef & sheep
1974	0	2461	2.46	Beef & sheep	Free draining		FYM	Grazing	2	Beef & sheep
1975	0	903	0.90	Beef & sheep	Free draining	Domestic tank and soakaway	FYM	Grazing	1	Beef & sheep
1976	0	1147	1.15	Beef & sheep	Poor		FYM	Grazing	4	Beef & sheep
1977	0	727	0.73	Beef & sheep	Free draining		FYM	Grazing	4	Beef & sheep
1978	0	623	0.62	Beef & sheep	Free draining		FYM	Grazing	4	Beef & sheep
1979	0	724	0.72	Beef & sheep	Free draining		FYM	Grazing	4	Beef & sheep
1980	0	956	0.96	Beef & sheep	Free draining		FYM	Grazing	4	Beef & sheep
1981	0	7195	7.20	Beef & sheep	Drained		FYM	Grazing	2	Beef & sheep
1982	0	1428	1.43	Beef & sheep	Poor		FYM	Grazing	3	Beef & sheep
1983	0	422	0.42	Beef & sheep	Free draining		FYM	Grazing	3	Beef & sheep
1984	0	519	0.52	Beef & sheep	Free draining		FYM	Grazing	3	Beef & sheep
1985	0	565	0.57	Beef & sheep	Free draining		FYM	Grazing	3	Beef & sheep
1986	0	532	0.53	Beef & sheep	Free draining		FYM	Grazing	3	Beef & sheep
1987	0	6107	6.11	Beef & sheep	Imperfect	Livestock access	FYM	Grazing	4	Beef & sheep
1988	0	6589	6.59	Beef & sheep	Imperfect	Livestock access	FYM	Grazing	4	Beef & sheep
1989	0	4651	4.65	Beef & sheep	Imperfect		FYM	Grazing	4	Beef & sheep
1990	0	6183	6.18	Sheep	Imperfect		FYM	Grazing	1	Beef & sheep
1991	0	46995	4.70		Free draining		FYM	Arable / cereal	2	Beef & sheep
1992	0	77536	7.75	Sheep	Free draining		FYM	Grazing	4	Beef & sheep
1993	0	42355	4.24	Sheep	Drained		FYM	Grazing	2	Beef & sheep
1994	0	38568	3.86	Sheep	Drained	Livestock access	FYM	Grazing	2	Beef & sheep



	A	B	C	D	E	F	G	H	I	J
1	ID	AREA_M2	Area ha	LIVESTOCK	SOIL_DRAIN	OTHA_FEATR	INPUT	LANDUSE	Slope ANGLE	TYPE
413	0	35761	3.58	Dairy				Grazing	2	Dairy
414	0	20499	2.05	Dairy		Spreading buffer	Slurry	Grazing	2	Dairy
415	0	49372	4.94	Dairy		Spreading buffer	Slurry	Grazing	3	Dairy
416	0	6247	0.62	Dairy				Grazing	3	Dairy
417	0	12515	1.25	Dairy		Spreading buffer	Slurry	Grazing	2	Dairy
418	0	12220	1.22	Dairy		Spreading buffer	Slurry	Grazing	3	Dairy
419	0	38831	3.88	Dairy		Spreading buffer	Slurry	Grazing	3	Dairy
420	0	31761	3.18	Dairy		Spreading buffer	Slurry	Grazing	2	Dairy
421	0	17438	1.74	Dairy			Never spreads	Grazing	2	Dairy
422	0	20861	2.09	Dairy				Grazing	2	Dairy
423	0	29403	2.94	Dairy		Spreading buffer	Slurry	Grazing	2	Dairy
424	0	413	0.04	Dairy				Grazing	2	Dairy
425	0	7379	0.74	Dairy			Never spreads	Grazing	2	Dairy
426	0	2379	0.24	Dairy				Grazing	2	Dairy
427	0	5031	0.50	Dairy				Grazing	2	Dairy
428	0	29004	2.90	Dairy			Slurry	Grazing	2	Dairy
429	0	2753	0.28	Dairy				Grazing	2	Dairy
430	0	29824	2.98	Dairy				Grazing	2	Dairy
431	0	20933	2.09	Dairy		Septic tank		Grazing	2	Dairy
432	0	34192	3.42	Dairy			Slurry	Grazing	2	Dairy
433	0	38896	3.89	Dairy		Spreading buffer	Slurry	Grazing	3	Dairy
434	0	60677	6.07	Dairy		Spreading buffer	Slurry	Grazing	2	Dairy
435	0	2204	0.22	Dairy			Never spreads	Grazing	4	Dairy
436	0	32070	3.21	Dairy		Spreading buffer	Slurry	Grazing	2	Dairy
437	0	1740	0.17	Dairy				Grazing	4	Dairy
446	0	12996	1.30	Dairy		Spreading buffer		Grazing	1	Dairy
447	0	1827	0.18	Dairy				Grazing	2	Dairy
448	0	29128	2.91	Dairy			Never spreads	Grazing	2	Dairy
449	0	20741	2.07	Dairy				Grazing	2	Dairy
450	0	15047	1.50	Dairy				Grazing	2	Dairy
451	0	18453	1.85	Dairy				Grazing	2	Dairy
452	0	805	0.08	Dairy				Grazing	2	Dairy
453	0	407	0.04	Dairy				Grazing	1	Dairy
454	0	1326	0.13	Dairy				Grazing	1	Dairy

Distribution through time?

Mapped exercises do not necessarily provide temporal information

How important are field to field livestock movements?

We do know turn out time + length of grazing season

So at best we have spatial seasonal data coupled with stocking density [but even correct stocking densities can be problematic to obtain]

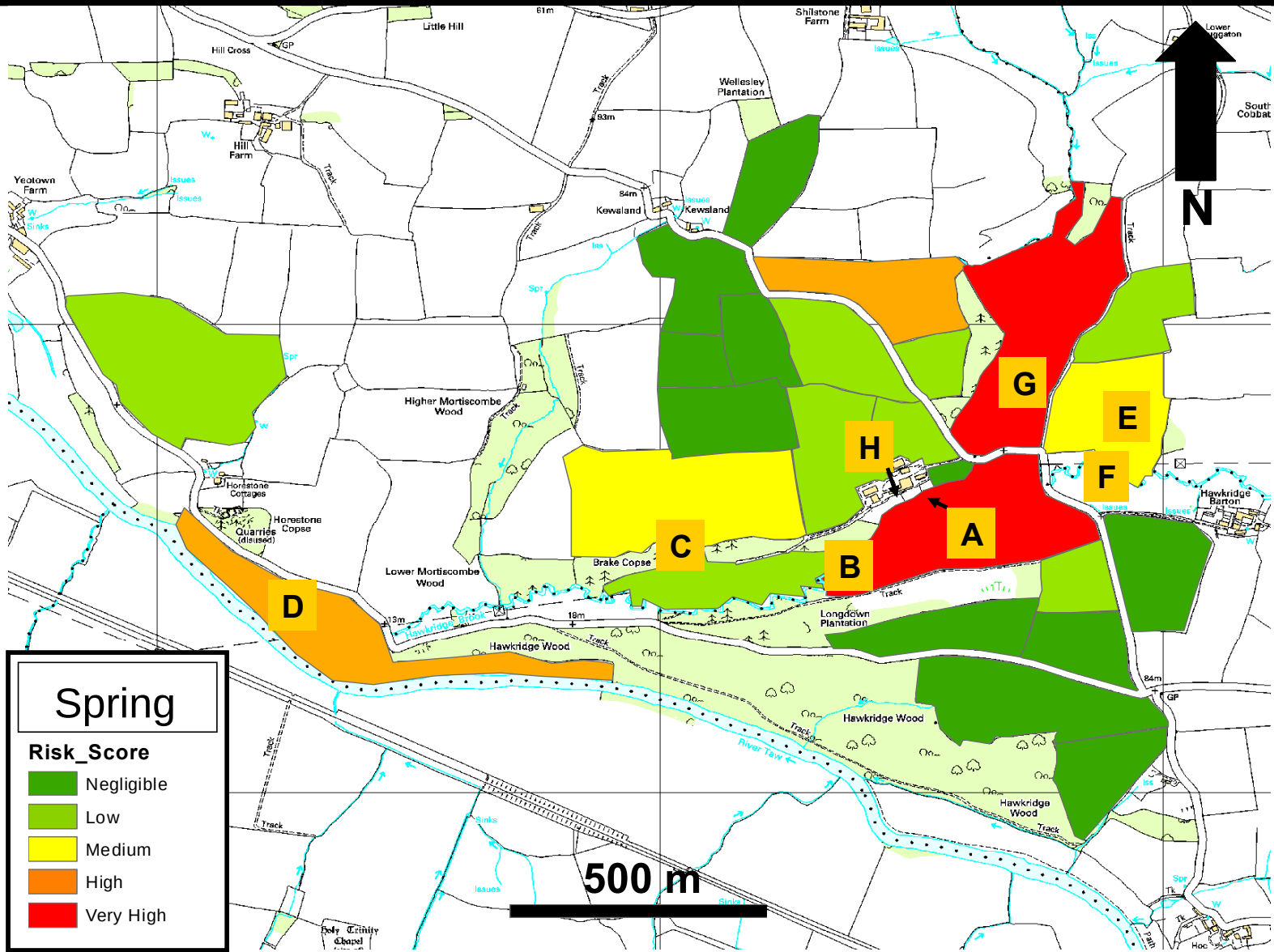
Livestock distribution important for:

(i) Field risk indexing tool

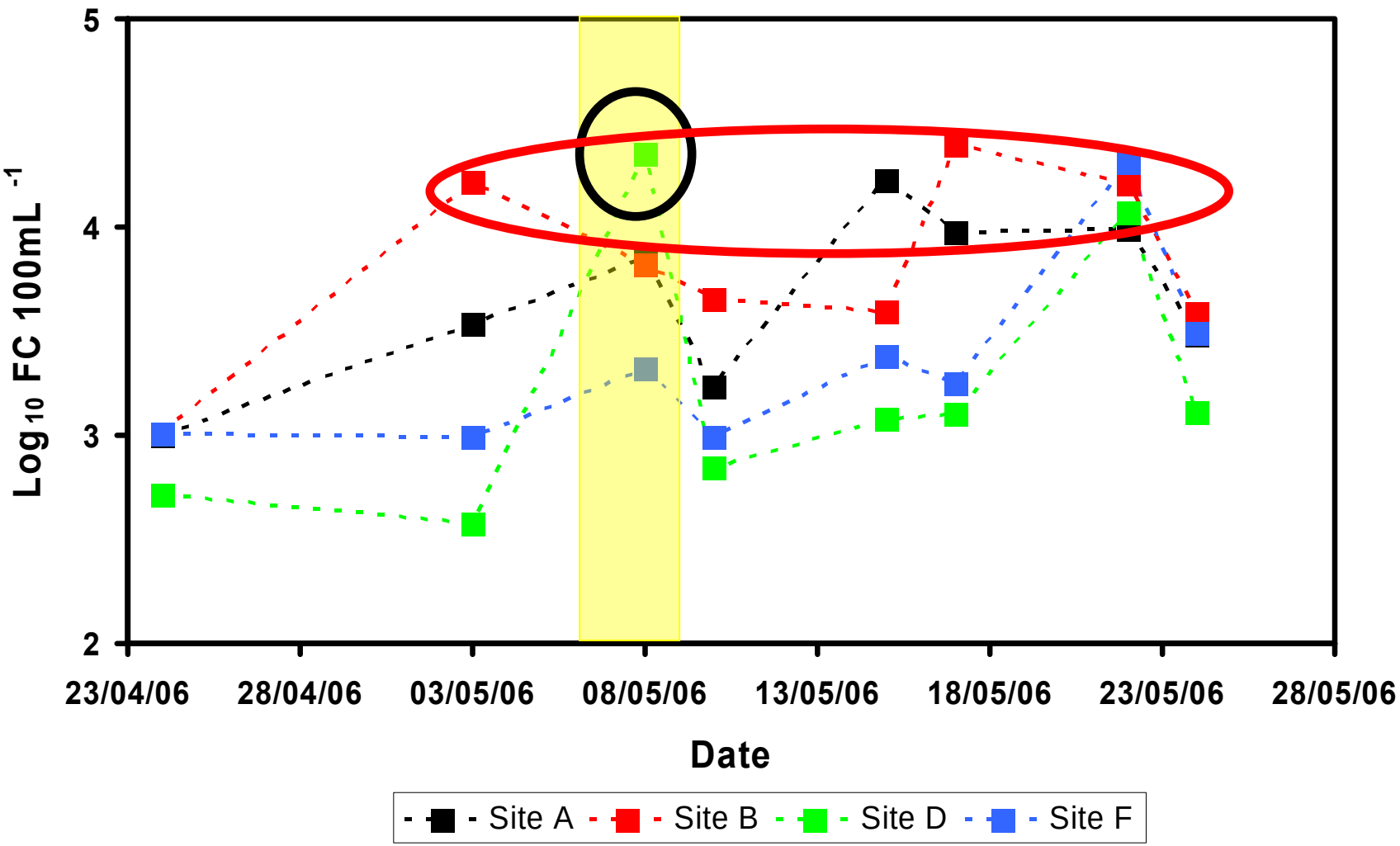
(ii) Complement microbial data as explanatory evidence base for data peaks / trends etc

Weight	Field component: Risk factors					
	Site transport characteristics	None (0)	Low (1)	Medium (2)	High (4)	Very high (8)
0.73	Runoff potential					
0.56	Preferential flow potential	Scored by field assessment & farmer survey				
0.38	Erosion potential					
	Site source characteristics	None (0)	Low (1)	Medium (2)	High (4)	Very high (8)
0.49	Evidence of bacterial legacy in the soil					
0.66	Type of waste applied to field					
0.52	Waste application method					
0.59	Waste application rate	Scored by field assessment & farmer survey				
0.35	Animal type grazing					
0.72	Grazing density					
0.58	Grazing duration					
	Site connectivity characteristics	None (0)	Low (1)	Medium (2)	High (4)	Very high (8)
0.49	Subsurface drainage					
0.68	Overland flow distance					
0.82	Livestock access to streams	Scored by field assessment & farmer survey				
0.48	Tracks and tramlines against contour					
0.39	Gateway location					
0.73	Connected spring					

FIO field risk calculator = [∑(transfer characteristic score x weight)
x ∑ (source characteristic score x weight)]
x ∑ (connectivity characteristic score x weight)


Spring
Risk_Score
Negligible
Low
Medium
High
Very High
A
B
C
D
E
F
G
H
N
500 m
Hill Cross
Little Hill
Hill Farm
Yeotown Farm
Wellesley Plantation
Kewsland
Higher Mortiscombe Wood
Lower Mortiscombe Wood
Horestone Cottages
Horestone Copse
Quarries (disused)
Brake Copse
Hawkridge Wood
Longdown Plantation
Hawkridge Barton
River Taw
Shilatone Farm

Livestock activity responsible for data observed



Model Farms: Dairy farm in Taw catchment
Farm survey data

Dairy Farm	n = 18	SE
AREA_M2	728618	
AREA (ha)	72.86	
DAIRY	165	21
BEEF	15	8
SHEEP	62	32
LAMBS	3	3
POULTRY	0	0
PIGS	0	0
CALVES	55	19

Annual slurry volume generated (m3)	1844
Annual FYM generated (m3)	339
Manure application rate (T/acre)	5.6
Manure application rate (T/Hectare)	13.8

% land used for grazing	77
% land used for arable / cereal	16
% land used for setaside	1
% land used for woodland	2

		and of that, % spread to	0-3°	3-7°	7-10°	10-15°	>15°
% total farm land applied with slurry only	42		30	49	14	6	1
% total farm land applied with FYM only	16		16	61	16	7	0
% total farm land applied with both slurry and FYM	1		32	68	0	0	0
% total farm land never receiving manures	7						

		and of that, % grazing	0-3°	3-7°	7-10°	10-15°	>15°
% total farm land grazed by dairy only	50		22	57	12	7	3
% total farm land grazed by beef only	2		8	64	12	16	0
% total farm land grazed by sheep only	3		0	36	55	5	4
% total farm land grazed by calves only	8		28	53	18	0	0
% total farm land grazed by dairy and sheep	8		28	53	18	0	2

Model Farms: Dairy farm in Taw catchment

Also able to suggest that for the typical 50% grazing area allotted to dairy cattle on a dairy farm:

At least 11% = artificially drained

At least 34% = freely draining

At least 3 % = imperfect drainage

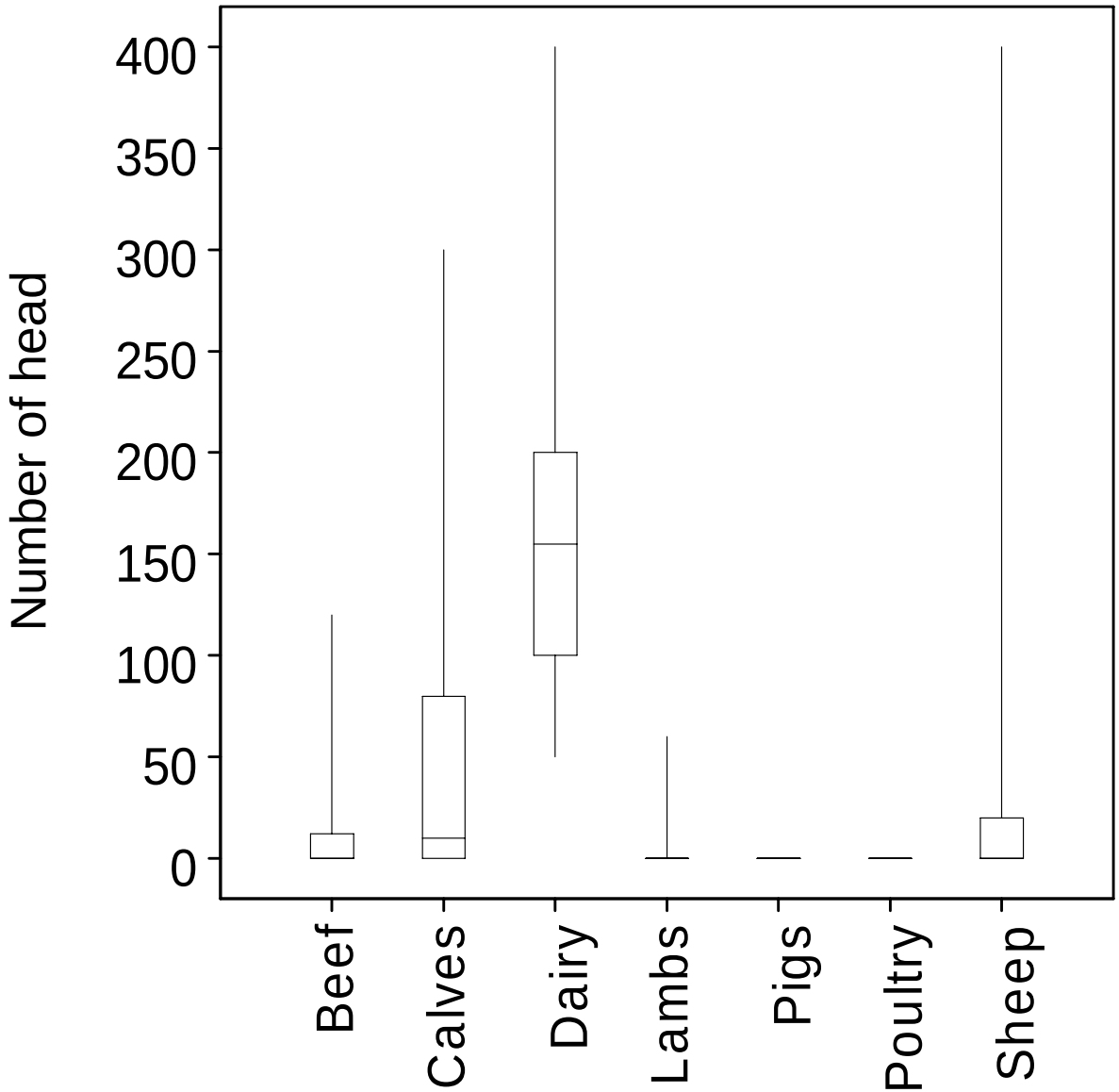
At least 17% = poorly drained

Similarly for other farm types and livestock types.

But even then, dataset is patchy as not all fields allotted a soil drainage status

How does this transfer outside the Taw catchment?

Model Farms: Dairy farms in Taw catchment



Model Farms: Arable farm in Taw catchment
Farm survey data

Arable Farm	n = 3	SE
AREA_M2	1253938	
AREA (ha)	125.39	
DAIRY	0	0
BEEF	47	47
SHEEP	0	0
LAMBS	0	0
POULTRY	0	0
PIGS	0	0
CALVES	50	36

% land used for arable / cereal	87
% land used fro grazing	8
% land used for setaside	3
% land used for woodland	2

% total farm land applied with FYM only	98

% total farm land grazed by beef only	7

SPATIAL DATA

Annual slurry volume generated (m3)	
Annual FYM generated (m3)	200
Manure application rate (T/acre)	7.0
Manure application rate (T/Hectare)	17.29

and of that, % spread to	0-3°	3-7°	7-10°	10-15°	>15°
	28	59	11	3	0

and of that, % grazing	0-3°	3-7°	7-10°	10-15°	>15°
	17	74	0	10	0

Summary

Livestock are key players in pollution research

However, data relating to their spatial distribution across farms is limited and data collection is labour intensive

Q. What's needed? Incomplete (but more certain) datasets *vs* complete (but less certain) datasets?

Development of model farms based on subset of farm survey data

Alternatives to detailed distribution data?