8FCS 4034

25/90

REMOVAL OF TOPSOIL/TURF FROM LAND AT BEECH FARM, PRIDDY AGRICULTURAL ASSESSMENT

SUMMARY

An investigation was carried out at Beech Farm, Priddy, to determine the agricultural implications of the removal of surface material from a field. The soil is a deep, well-drained, fine silty over clayey soil, which typically has a topsoil of approximately 20 cm thick. It was estimated that between 6 cm and 7 cm of topsoil had been removed from the site. The agricultural land classification of both the worked area and adjacent unworked land is sub-grade 3a. The most limiting factor is the climate of the site. The removal of surface material has not altered the ALC grade of the land. The moisture retention properties of the soil have not been significantly affected by the removal of surface material. The worked land is not susceptible windblow as a result of the working. As a one-off operation on this particular soil type under these particular climatic conditions, the operation was not damaging from an agricultural point of view.

REMOVAL OF TOPSOIL/TURF FROM LAND AT BEECH FARM, PRIDDY - AGRICULTURAL ASSESSMENT

INTRODUCTION

On 6 September 1990 members of the Resource Planning Group, South West Region, carried out investigations at Beech Farm, Priddy, Somerset. The investigations were in response to a request by Somerset County Council for ADAS to carry out an agricultural assessment of land at Beech Farm where surface material had been removed from approximately 3.5 hectares of land.

ADAS were asked to investigate the following factors:-

1. The likely depth and characteristics of topsoil in the field before working.

2. The depth and quantity of topsoil removed and the percentage constituting grass including roots.

3. The effect of removing the material in terms of moisture retention, loss of minerals, effect on cropping and windblow.

4. The ability to restore the land to it's state prior to working, and the necessary measures.

The soil was examined by hand auger at 6 sites within the worked area and at 2 sites in an adjacent unworked area. A soil pit was dug and described in the worked area to confirm the soil classification and agricultural land classification grading. A small pit was dug to below the topsoil depth in the unworked area. Auger hole descriptions are given as appendix 1 and the pit description as appendix 2.

Soil Classification

The soil is of the same type at all sites examined, and belongs to the Nordrach series (1). This is a deep, well drained, fine silty over clayey soil. The typical profile description for the series is given as appendix 3.

Agricultural Land Classification

The agricultural land classification was determined using the Revised guidelines and criteria for grading the quality of agricultural land (2). The agricultural land classification is sub-grade 3a at all sites examined. The most limiting factor is the climatic limitations of the site. The parameters used in the assessment of the climatic limitation are the average annual rainfall, as a measure of overall wetness; and accumulated temperature, as a measure of the relative warmth.

Climatic variables were obtained by interpolation from a 5 km grid database (3). The variables for Beech Farm are as follows:-

Altitude	:	260 m
Accumulated Temperature (ATO)	:	1262^{o}
Average Annual Rainfall (AAR)	:	1082 mm
Moisture Deficit, Wheat (MDW)	:	58 mm
Moisture Deficit, Potatoes (MDP)	:	37 mm
Field Capacity Days (FCD)	:	223 days

The combination of a high average annual rainfall and a low accumulated temperature for the locality lead to a best possible ALC grade of 3a. This overall wetness limitation, due to the local climate of the area, is the major ALC limitation at Beech Farm.

Exposure is also a site limitation. Although not a quantified assessment, it is estimated that sub grade 3a is also the best allowable ALC grade due to site exposure.

The only other ALC limitation is the soil workability. This is related to the climatic conditions in terms of the number of days that the soil is at or above field capacity. The high field capacity days value for the locality, related to the topsoil texture of medium silty clay loam, leads to a grade of 2 for soil workability. This grade is not allowable, however, due to the overall climatic grade of 3a.

The removal of the surface material has not altered the Agricultural Land Classification grade of the site.

Topsoil Characteristics

"Topsoil" is defined here as the dark coloured layer of silty clay loam that is higher in organic matter than the underlying subsoil. The topsoil of the Nordrach series is typically silty clay loam, approximately 20 cm thick, with a moderately developed fine subangular blocky structure. The organic carbon content is typically 4.1% and the bulk density 1.15 g/cc.

Topsoils from the worked and unworked areas on Beech Farm were analysed for particle size analysis and organic matter content. The laboratory analytical results are given below.

	Organic Matter %	Sand %	Silt %	Clay %
Worked area	5.2	68	5	27
Unworked area	5.5	67	6	27

Both sets of data are from single sites, so comparisons are tentative but may be made on an "order of magnitude" basis. However, the analyses show no significant differences between the topsoils from the worked and unworked areas.

Estimate of Material Removed

The median thickness of topsoil before working is estimated to be 22 cm. The median thickness of topsoil after working is estimated to be 15 cm. Measurements at 15 sites along the "lip" formed at the edge of the worked area showed a median depth of cut of 6 cm.

It is therefore estimated that between 6 cm and 7 cm of material was removed. Over an area of approximately 3.5 ha, this amounts to a volume of material removed of approximately 2,300 cubic metres.

Soil content of Material Removed

A sample of the type of material removed was taken from the lip at the edge of the working. This was analysed for fresh weight, dry weight, and loss on ignition. The results were as follows:-

Fresh weight of sample - 1090.0 g
Dry weight of sample - 935.5 g
Loss on ignition - 11.1%

These figures approximate to an organic material content of 20% by weight in a fresh condition.

Moisture Retention

In the Agricultural Land Classification system the quantity of water held in a soil profile which can be taken up by a crop is estimated for two reference crops, wheat and potatoes. This is called the crop-adjusted available water capacity (AP). This was calculated for the worked area of Beech Farm, and high values of moisture retention were found.

Another site variable is the moisture deficit (MD). This is the balance between the rainfall and the loss of moisture by evaporation and transpiration. Subtracting the MD from the AP gives the moisture balance, which is a measure of the droughtiness of a site.

At Beech Farm there are low values for moisture deficit (MD) due to the high rainfall and low temperatures. There are therefore high values for moisture balance, meaning that droughtiness is not a problem, even on the worked area.

The situation may be different, however, on similar soils in other locations, where drier and warmer conditions prevail. Under those circumstances, the removal of surface material could lead to a droughtiness limitation in the remaining profile. Also, a shallow soil under similar climatic conditions to Beech Farm could be at risk from droughtiness following surface material removal.

There has been no significant effect on the moisture retention properties of the soil from the removal of surface material.

Loss of Minerals

Topsoil samples from the worked and unworked areas were analysed for extractable phosphorus, potassium and magnesium. The results were as follows:-

	P Ext mg/l	K Ext mg/l	Mg Ext mg/l
Worked area	19	131	71
Unworked area	17	226	59

There has been a loss of potassium due to the removal of surface material. The total amount of potassium removed over the 3.5 ha area in 6 cm of material can be replaced by an application of 300 kg of potassium as fertiliser.

Effect on crop growth

The land has been returned to a grass ley, and no detrimental effect is expected on the new grass crop.

Ability to Resist Windblow

The worked land has an average of 15 cm of topsoil remaining. The soil is well structured with a low fine sand content. Following the removal of the surface layer the remaining topsoil would not have been susceptible to windblow because of its structural and textural characteristics. It would have been in a similar condition as if it had been ploughed following an arable crop.

Restoration

The operation removed almost one third of the topsoil layer. As a one-off operation on a soil such as the Nordrach series, which is a deep soil with a thick topsoil, this is not a damaging operation from an agricultural aspect. Should it be repeated, though, the topsoil will be reduced to an unacceptable thickness, and the agricultural quality of the land will be seriously reduced.

The state of the land following this operation (or indeed any form of turf removal) is similar to an old arable field. Some research has shown that at least 50 years under grass may be necessary to restore old arable land to the physical state of old pasture (4). However, for the land to return completely to its state prior to working, sufficient time must pass for 6 cm of the underlying subsoil to change into topsoil. Although the rate of formation of topsoil from subsoil is very variable, the time for 6 cm of topsoil to re-form will probably be well over 100 years (5). These figures are very tentative, but indicate the very long time span that is required for complete restoration following any form of turf or topsoil removal. Grassland provides the best soil forming environment, so that a long term grassland use is recommended.

The operations carried out at Beech Farm have not significantly affected the agricultural quality of the land. From an agricultural aspect the operation was similar in its effect on land quality to a traditional turfing exercise. The land has been restored to grassland, and this is considered to be the appropriate follow-up land use.

REFERENCES

1. Soil Survey of England and Wales (1984). "Soils and Their Use in South West England". Lawes Agricultural Trust.

2. Ministry of Agriculture, Fisheries and Food (1988). "Agricultural Land Classification of England and Wales". MAFF.

3. The Met Office (1989) "Climatological Data for Agricultural Land Classification". Met Office.

4. Low, A J (1954). "The Study of Soil Structure in the Field and the Laboratory". J. Soil Sci. 5 pp 57-74.

5. Birkeland, P W (1974). "Pedology, Weathering and Geomorphological Research". Oxford University Press.

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APPENDIX 1

Soil Profile Descriptions

SOIL PROFILE DESCRIPTIONS: EXPLANATORY NOTE

(i) TEXTURE:-

Soil texture classes are denoted by the following abbreviations (all Upper case*):

S	Sand
LS	Loamy Sand
SL	Sandy Loam
SZL	Sand Silt Loam
ZL	Silt Loam
MZCL	Medium Silty Clay Loam
MCL	Medium Clay Loam
SCL	Sandy Clay Loam
HZCL	Heavy Silty Clay Loam
HCL	Heavy Clay Loam
SC	Sandy Clay
ZC	Silty Clay
C	Clay

For the sand, loamy sand, sandy loam and sandy silt loam classes the predominant size of sand fraction may be indicated by the use of prefixes, thus:

F	fine (more than $\frac{2}{3}$ of sand less than 0.2 mm)
C	coarse (more than $\frac{1}{3}$ of sand greater than 0.6 mm)
M	medium (less than $\frac{2}{3}$ fine sand and less than $\frac{1}{3}$ coarse sand)

The sub-divisions of clay loam and silty clay loam classes according to clay content are indicated as follows:-

M	medium (less than 27% clay):
H	heavy (27-35% clay)

Other possible texture classes include:

P	Peat
SP	Sandy Peat
LP	Loamy Peat
PL	Peaty Loam
PS	Peaty Sand
MZ	Marine Light Silts

* There are two exceptions to the Upper Case rule:-

- The prefix "**Calc**" is used to identify naturally calcareous soils containing more than 1% Calcium Carbonate
- For organic mineral soils, the texture of the mineral fraction is prefixed by "**Org**".

(ii) STRUCTURE:-

Nature and size of structural units are denoted by the following abbreviations:

SAB	Subangular Blocky
AB	Angular Blocky
P	Prismatic

(single grain, granular and platy are not abbreviated)

F	Fine
M	Medium
C	Coarse
VC	Very Coarse

eg Weak MSAB = Weakly developed medium subangular blocky

(iii) OTHER

f	=	few	= less than 2% of the matrix or surface described
c	=	commom	= 2-20% of the matrix or surface described
m	=	many	= 20-40% of the matrix or surface described
vm	=	very many	= +40% of the matrix or surface described

f	=	faint	= indistinct mottles, evident only on close examination
d	=	disinct	= although not striking, the mottles are readily seen
p	=	prominent	= the mottles are conspicuous, and the mottling is one of the outstanding features of the horizon
gm	=	grey mottling	
om	=	ochreous mottling	

eg cdom = common distinct ochreous mottles

rrc	=	rusty root channels
ppf	=	pale ped faces
mn	=	manganese

st	=	stones 6 cm
sst	=	stones 2-6 cm
vsst	=	stones 2 cm

WC	=	Wetness Class (use Roman numerals, eg WC IV)
SPL	=	Slowly Permeable Layer
WT	=	Water Table
I	=	Impenetrable if used in Depth Column
IMP	=	Impenetrable if used in soil profile notes

(IMP 2 x 40 cm = 2 additional borings, both impenetrable at 40 cm)

ASP	=	Auger Sample Point

APPENDIX 2

Soil Pit Descriptions

NORDRACH SERIES

Profile No: SK 15/5092

Definition: Typical paleo-argillic brown earths. Fine silty over clayey over lithoskeletal limestone.

Elevation: 292 m O.D. Slope and aspect: 1° SSW, straight.

Land use: Ley grassland.

Horizons:

0-18 cm Ap Very dark greyish brown (10 YR 3/2) very slightly stony silty clay loam; small angular and tabular, chert; moist; moderately developed fine subangular blocky; low packing density; moderately firm soil strength; many very fine fibrous roots; non-calcareous; sharp smooth boundary.

18-41 cm Eb Brown to dark brown (7.5 YR 4/4) very slightly stony silty clay loam; small angular and tabular, chert; moist; moderately developed fine subangular blocky with dark brown (7.5 YR 3/4) faces; low packing density; very weak soil strength; common very fine fibrous roots; non-calcareous; abrupt wavy boundary.

41-80 cm Bt Yellowish red (5 YR 4/6) stoneless silty clay; moist; moderately developed fine subangular blocky; medium packing density; moderately firm soil strength; common very fine fibrous roots; non-calcareous; abrupt irregular boundary from 71 to 90 cm depth.

At 80 cm R Greyish brown (10 YR 5/2) hard jointed limestone.

Horizon:	Ap	Eb	Bt	Bt
Depth (cm)	0-18	18-41	41-80	80-85
Sand 600 um-2 mm %	1	1	1	1
200-600 um %	2	2	2	2
60-200 um %	5	4	4	4
Silt 2-60 um %	67	70	53	56
Clay <2 um %	25	23	40	37
<0.2 um %	7	6	13	15
$CaCO_3$ equivalent %	<1	0	0	<1
Organic carbon %	4.1	1.7	1.2	0.7
pH in water (1:2.5)	6.5	7.2	7.2	7.5
Ph in 0.01M $CaCl_2$ (1:2.5)	6.1	6.6	6.6	7.0
Pyrophosphate ext.				
Fe %	0.4	0.3	0.1	0
Al %	0.2	0.2	0.1	0.1
C %	0.7	0.4	0.1	0.1
Residual dithionite ext.				
Fe %	1.6	1.5	3.2	3.2
Bulk density g cm^{-3}	1.15	1.15	1.20	
Available water capacity				
% vol. <15 bar	22	18	12	
Air capacity % vol.	9	17	15	
Retained water capacity				
% vol.	47	40	39	

Reference (1)

APPENDIX 4

DESCRIPTION OF THE AGRICULTURAL LAND CLASSIFICATION SYSTEM GRADES AND SUBGRADES

DESCRIPTION OF THE GRADES AND SUBGRADES

The ALC grades and subgrades are described below in terms of the types of limitation which can occur, typical cropping range and the expected level and consistency of yield. In practice, the grades are defined by reference to physical characteristics and the grading guidance and cut-offs for limitation factors in Section 3 enable land to be ranked in accordance with these general descriptions. The most productive and flexible land falls into Grades 1 and 2 and Subgrade 3a and collectively comprises about one-third of the agricultural land in England and Wales. About half the land is of moderate quality in Subgrade 3b or poor quality in Grade 4. Although less significant on a national scale such land can be locally valuable to agriculture and the rural economy where poorer farmland predominates. The remainder is very poor quality land in Grade 5, which mostly occurs in the uplands.

Descriptions are also given of other land categories which may be used on ALC maps.

Grade 1 – excellent quality agricultural land

Land with no or very minor limitations to agricultural use. A very wide range of agricultural and horticultural crops can be grown and commonly includes top fruit, soft fruit, salad crops and winter harvested vegetables. Yields are high and less variable than on land of lower quality.

Grade 2 – very good quality agricultural land

Land with minor limitations which affect crop yield, cultivations or harvesting. A wide range of agricultural and horticultural crops can usually be grown but on some land in the grade there may be reduced flexibility due to difficulties with the production of the more demanding crops such as winter harvested vegetables and arable root crops. The level of yield is generally high but may be lower or more variable than Grade 1.

Grade 3 – good to moderate quality agricultural land

Land with moderate limitations which affect the choice of crops, timing and type of cultivation, harvesting or the level of yield. Where more demanding crops are grown yields are generally lower or more variable than on land in Grades 1 and 2.

Subgrade 3a – good quality agricultural land

Land capable of consistently producing moderate to high yields of a narrow range of arable crops, especially cereals, or moderate yields of a wide range of crops including cereals, grass, oilseed rape, potatoes, sugar beet and the less demanding horticultural crops.

Subgrade 3b – moderate quality agricultural land

Land capable of producing moderate yields of a narrow range of crops, principally cereals and grass or lower yields of a wider range of crops or high yields of grass which can be grazed or harvested over most of the year.

Grade 4 – poor quality agricultural land

Land with severe limitations which significantly restrict the range of crops and/or level of yields. It is mainly suited to grass with occasional arable crops (eg cereals and forage crops) the yields of which are variable. In moist climates, yields of grass may be moderate to high but there may be difficulties in utilisation. The grade also includes very droughty arable land.

Grade 5 – very poor quality agricultural land

Land with very severe limitations which restrict use to permanent pasture or rough grazing, except for occasional pioneer forage crops.

Descriptions of other land categories used on ALC maps

Urban

Built-up or 'hard' uses with relatively little potential for a return to agriculture including: housing, industry, commerce, education, transport, religious buildings, cemeteries. Also, hard-surfaced sports facilities, permanent caravan sites and vacant land; all types of derelict land, including mineral workings which are only likely to be reclaimed using derelict land grants.

Non-agricultural

'Soft' uses where most of the land could be returned relatively easily to agriculture, including: golf courses, private parkland, public open spaces, sports fields, allotments and soft-surfaced areas on airports/airfields. Also active mineral workings and refuse tips where restoration conditions to 'soft' after-uses may apply.

Woodland

Includes commercial and non-commercial woodland. A distinction may be made as necessary between farm and non-farm woodland.

Agricultural buildings

Includes the normal range of agricultural buildings as well as other relatively permanent structures such as glasshouses. Temporary structures (eg polythene tunnels erected for lambing) may be ignored.

Open water

Includes lakes, ponds and rivers as map scale permits.

Land not surveyed

Agricultural land which has not been surveyed.

Where the land use includes more than one of the above land cover types, eg buildings in large grounds, and where map scale permits, the cover types may be shown separately. Otherwise, the most extensive cover type will usually be shown.

AGRICULTURAL LAND CLASSIFICATION - BEECH FARM, PRIDDY

SOIL PROFILE DESCRIPTION

Date of Survey 6/9/90

NO	TEXTURE	COLOUR	DEPTH (CM)	SOIL PROFILE NOTES	TOPOGRAPHY NOTES
1	MZCL	10YR $^{3}/_{4}$	0-5		
	MZCL	10YR $^{4}/_{4}$	5-40		
	C	5YR $^{4}/_{4}$	40-85	Ped faces 7.5YR $^{4}/_{6}$. Few Mn	
			I	WCI	
2	MZCL	10YR $^{4}/_{3}$	0-25		
	MZCL	7-5YR $^{4}/_{6}$	25-60		
	HZCL	7-5YR $^{4}/_{4}$	60-85	Few Mn	
			I	WCI	
3	MZCL	10YR $^{4}/_{4}$	0-10		Near outcrops in
	HZCL	10YR $^{3}/_{5}$	10-35		field corner.
			I	2nd bore 30 cm, WCI	
4	MZCL	10YR $^{4}/_{4}$	0-15		
	HZCL	7.5YR $^{4}/_{6}$	15-30		
	C	5YR $^{4}/_{6}$	30-80	Common Mn	
			I	WCI	
5	MZCL	10YR $^{4}/_{4}$	0-15		
	MZCL	10YR $^{4}/_{6}$	15-50		
	C	7.5YR $^{4}/_{6}$	50-95		
			I	WCI	
6	MZCL	10YR $^{4}/_{4}$	0-10		
	MZCL	7.5YR $^{4}/_{6}$	10-40		
	C	7.5YR $^{4}/_{4}$	40-75		
			I	WCI	
7	MZCL	10YR $^{4}/_{4}$	0-15		
	MZCL	7.5YR $^{4}/_{4}$	15-40		
	C	7.5YR $^{4}/_{4}$	40-55		
			I	WCI	
8	MZCL	10YR $^{4}/_{3}$	0-25		
	HZCL	10YR $^{4}/_{4}$	25-90+	WCI	

SITE NAME	PROFILE NUMBER	SLOPE AND ASPECT	LAND USE		PARENT MATERIAL
Beech Farm Priddy	1	NW 1-2°	Grassland	Av Rainfall :- 1082 ATO :- 1262 FC Days :- 233 Climatic grade:- 3a	Limestone
	DATE 6/9/90	GRID REFERENCE ST 521552			

Horizon Number	Lowest Av Depth	Matrix and Ped Face Colours	Texture	Stoniness: Size, Shape, Type, and Field Method	Mottling Abundance, Contrast Size and Colour	Structure: Development Size and Shape	Pores and Fissures	Structural Condition	Consistence	Roots Abundance Size and Nature	Calcium Carbonate Content	Mangan Concs etc	Horizon Boundary: Distinctness and Form
1	18 cm	10YR4/4	MZCL	None	None	mod. med. gran	> 0.5	Good	V. Friable	Common	No	None	Clear smooth
2	60 cm	7.5YR4/4	MZCL	None	None	mod. med. SAB	> 0.5	Good	Friable	Few	No	None	Clear smooth
3	80 cm	5YR4/3	ZC	None	None	mod. med. SAB	> 0.5	Good	Friable	Few	No	Common	Abrupt wavey
4	-	-	Fractured Limestone	-	-	-	-	-	-	-	Yes	-	-

Depth to Slowly Permeable Horizon :- None

Wetness Class :- 1

Wetness Grade :- 2

RPG0023/WJC

Available Water Wheat :- 155

Potatoes :- 143

Moisture Deficit Wheat :- 58

Potatoes :- 37

Moisture Balance Wheat :- 97

Potatoes :- 106

Droughtiness Grade :- 1

Final ALC Grade :- 3a

Main Limiting Factor(s) :- Climate

Remarks :- Also 3a due to exposure