

# 9 *Appraisal of flood risk management for agriculture*

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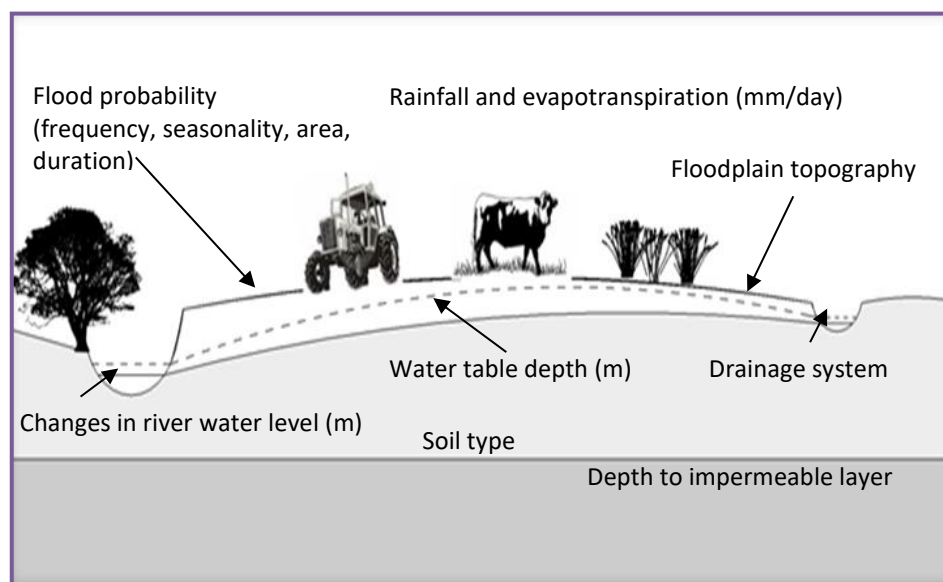
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**Figure 9.1** Flooding and drainage factors influencing agricultural productivity on floodplains in England and Wales



**Table 9.1** General tolerance of flooding by agricultural land use in England and Wales

Agricultural land use Type	Common minimum acceptable flood frequency: annual probability	
	Whole Year	April-October
Horticulture and field scale vegetables	5%	1%
Intensive arable including sugar beet and potatoes	7%-10%	4%
Extensive arable: cereals, beans, oil seeds	10%-15%	7%-10%
Intensive grass: improved grass, usually dairying	50%	20%
Extensive grass, usually cattle and sheep	≥100%	33%

**Table 9.2** Drainage conditions for agriculture and water levels in fields and ditches In England and Wales

Agricultural drainage condition	Agricultural productivity class	Depth to water table from surface	Springtime freeboard <sup>1</sup> in water-courses (natural drainage)	Springtime freeboard <sup>1</sup> in water-course (field drains)
Good: 'rarely wet'	Normal, no impediment imposed by drainage	0.5 m or more	1 m sands	1.2m clays to 1.6m sands (0.2m below pipe outfall)
			1.3 m peats	
			2.1 m clays	
Bad: 'occasionally wet'	Low, reduced yields, reduced field access and grazing season	0.3 m to 0.49 m	0.7 m sands	Temporarily submerged pipe outfalls
			1 m peats	
			1.9 m clays	
Very bad: 'commonly or permanently wet'	Very low, severe constraints on land use, much reduced yields, field access and grazing season: mainly wet grassland	Less than 0.3 m	0.4 m sands	Permanently submerged pipe outfalls
			0.6 m peats	
			1 m clays	

**Notes to table:**

1. Freeboard refers to the mean difference between water level and adjacent field level

**Table 9.3** Common farming performance and field drainage conditions in England and Wales

£ 2024 Values	Field Drainage Conditions		
	Good	Bad	Very Bad
<b>Arable</b>			
Yield as % of 'good' category			
Winter wheat and barley	100	80	50
Spring wheat and barley	100	90	80
Oil seed rape	100	90	80
Potatoes, Peas, Sugar Beet	100	60	40 <sup>1</sup>
Wheat financial gross margin <sup>2</sup> £/ha/year	£1,200-£1,500	£800-£1,000	£330-£430
<b>Grassland</b>			
Typical nitrogen use kg N/ha/year	150 - 200	50 – 75	0 - 25
Grass conservation	2 cut silage	1 cut silage or graze	1 cut hay or graze
Typical stocking rates <sup>3</sup> ; Livestock units/ha/year	1.7 - 2.0	1.2 - 1.4	0.7 - 1.0
Typical livestock type	Dairy, intensive beef and sheep	Beef cows, 24-month beef, sheep	Fattening of 'store' cattle, and sheep
Financial gross margins <sup>2</sup> £/ha/year (after forage costs)	£2,200-£3,000 (dairy) £600-£950 (intensive beef/sheep)	£430-£630	£250-£430
Days reduction in grazing season compared to 'good' category <sup>4</sup>	none	Spring: 14 to 21 Autumn: 14 to 21	Spring: 28 to 42 Autumn: 28, no stock out in winter

**Notes to table:**

1. Not grown if persistently 'very bad'.
2. Gross Margins estimates based on Defra Farm Business Survey data 2018/19 to 2022/23, weighted by GDP deflators to 2024 prices, see Table 9.5
3. Livestock units (Lu): dairy cow, 1 Lu; beef cow, 0.8 Lu; 24-month beef, 0.7 Lu; sheep plus lambs, 0.14- 0.17 Lu.
4. A grazing day is worth about £3.2/Lu in spring/summer, £1.6/Lu in autumn, and £0.8/Lu in winter in terms of savings in housing costs and feed conservation costs.

**Table 9.4** The Impacts of flooding on farmland by type of agricultural land use and the seasonality of flooding in England and Wales

	Spring	Summer	Autumn	Winter
	March – May	June- August	September – November	December – February
<b>Horticulture (soft fruits, salad crops)</b>	Complete loss of soft fruits and winter /spring salads	Complete loss of annual production, possible loss of perennial stock	Loss of late season harvest, possible loss of perennial stock: replanting/reseeding	Damage to standing crops, annuals /perennials
<b>Intensive Agriculture (including field vegetables &amp; roots)</b>	Delay in planting or loss of established crops	Likely complete loss of standing root crops eg potatoes/onions/carrots	Loss of unharvested autumn crops, notably potatoes. Delayed planting or loss of winter crops, substituted by spring sown crops	Possible loss of winter harvest crops (sprouts, and sugar beet). Yield loss on autumn sown crops
<b>Extensive arable (cereals and oil seeds)</b>	Loss or delay of spring sown cereals, yield loss on winter sown cereals, delayed spring treatments	Complete or partial loss of unharvested crops	Loss of unharvested autumn crops. Delayed planting or loss of winter crops, substituted by spring sown crops	Yield loss on autumn sown crops, reseeding with spring sown crops if severe damage
<b>Grassland: intensive (mainly dairy)</b>	Loss of grass yields, delayed stock turnout, delay fertiliser applications. Grass reseeding if long duration flooding	Loss of grass yields, partial or complete loss of hay/silage crop, loss of grazing, stock morbidity/mortality. Grass reseeding if long duration flooding	Loss of autumn grazing, stock relocation /housing. Possible reseeding if long duration.	Loss of winter 'accommodation' pasture.
<b>Extensive (mainly beef and sheep)</b>	Loss of grass yields, delayed stock turnout, delayed fertiliser applications.	Loss of grass yields, partial or complete loss of hay/silage crop, loss of grazing, stock morbidity/mortality.	Loss of autumn grazing, stock relocation /housing.	Limited impact on flood tolerant grass swards

**Table 9.5** Estimated Financial and Economic Gross Margins and Net Margins (£/ha/year, 2024 prices) for wheat and selected farm types in England

	£ 2024 values		Winter Wheat <sup>3</sup>	Cereals (Extensive Arable)	General Cropping (Intensive Arable)	Dairy (Intensive Grass)	Lowland Grazing (Extensive Grass)
<b>Financial assessment</b> <sup>1,2</sup>							
<b>a</b>	Gross Output	£/ha/year	1,954	1,452	1,908	4,793	988
<b>b</b>	Variable Costs	£/ha/year	627	590	825	2,509	515
<b>c</b>	Gross Margin (a-b)	£/ha/year	1,327	862	1,083	2,284	473
Fixed Costs (including rent, excluding unpaid labour)							
<b>d</b>	Semi-fixed Costs	£/ha/year	306	250	334	599	205
<b>e</b>	Total Fixed Costs	£/ha/year	847	708	934	1704	588
Financial Net Margin <sup>4</sup>							
<b>f</b>	After semi fixed costs (c-d)	£/ha/year	1,021	612	749	1,685	268
<b>g</b>	After full fixed costs (c-e)	£/ha/year	480	154	149	580	-115
Adjustment to Financial Net Margin <sup>5</sup>							
<b>h</b>	Plus Farm rents	£/ha/year	127	106	154	250	84
<b>i</b>	Less unpaid family labour	£/ha/year	168	140	106	394	365
<b>j</b>	Subtotal (h-i)	£/ha/year	-42	-35	48	-144	-281
Adjusted Financial Net Margin (excluding income subsidies)							
<b>k</b>	after semi fixed costs (f+j)	£/ha/year	979	577	797	1541	-13
<b>l</b>	After full fixed costs (g+j)	£/ha/year	438	119	197	436	-395
<b>Economic Assessment</b> <sup>6</sup>							
	Adjustment for high value crops and dairy		None	None	High value crop area treated as wheat	Dairy area treated as wheat	None
	Gross Margin (c weighted by wheat area)	£/ha/year	1,327	862	1,132	1,156	473
Net Margin							
	After semi fixed costs (k weighted by wheat area)	£/ha/year	979	577	833	780	-13
	After total fixed costs (l weighted by wheat area)	£/ha/year	438	119	245	271	-395
	Range high <sup>7</sup>	£/ha/year	657	179	368	407	-198
	Range low	£/ha/year	219	60	123	136	-593

**Notes to table:**

1. Estimated mean annual values in 2024 prices derived from Regional Farm Business Survey (FBS) mean annual values, for England (all farms by type) 2018/19 to 2022/23. weighted by GDP deflators (ONS, 2024)
2. Farm type classifications are based on the proportion of Total Output by value attributable to given enterprises, where more than 67% of total output by value is attributable to particular crop or livestock enterprises, namely Cereals (cereals and combinable crops such as field peas and beans, and oils seeds), General Cropping (arable crops including field scale vegetables), Dairy (milk production) and Grazing Livestock (beef and sheep).

3. Wheat: average yields 8.6 t/ha (2018/19 - 2022/23), average price 2024 (weighted) £217/t. The 10-year (2014/15-2023/24) GDP weighted price for wheat is £212/t in 2024 prices. Average total fixed costs (£/ha/year) for Winter Wheat are about 20% higher than the overall average for Cereals farms based on FBS crop production data.

4. Net margins here are the same as the Farm Business Income estimates derived by the Farm Business Survey and used in reporting Farm Incomes (Defra, 2024a). Net margins here show the financial returns generated by 'agricultural' activities, excluding income from subsidies and other sources, including land rents paid and paid wages and salaries but excluding charges for family labour. Basic Payment Scheme direct income subsidies averaged £117/ha/year in 2024 for eligible land. Agri-environment payments currently average about £40/ha/year on Lowland Grazing Livestock Farms.

5. For economic analysis, land purchase and/or rental costs are excluded, and unpaid familiar labour is included at equivalent cost. No deduction has been made here for National Insurance costs on labour, averaging about 10% of labour costs.

6 For economic analysis, the areas given to high value cropping and dairy production are treated as equivalent areas of a wheat crop. About 20% of cropping on General Cropping farms comprises high value root and field vegetable crops. About 80% of the area on Dairy farms directly supports milk production with the balance is for livestock rearing and fattening. These proportions can be treated as wheat equivalents. Detailed assessment of enterprise types and performance is recommended to allow for local variation.

7. The high to low range in estimated Net Margin is approximately +/-50% of the central estimate reflecting top and bottom quartile means and variations of between a 12% and 15% change in either Gross Output or Total Costs (£/ha/year).



**Table 9.6** Defra guidance for the appraisal of alternative agricultural FCERM scenarios <sup>1</sup>

	Scenario I	Scenario II	Scenario III
	Land lost to agriculture	Temporary, one-off loss of agricultural output	Permanent change in the value of agricultural output
All agricultural land use	Loss equivalent to market value of land less £600/ha (2008 prices) <sup>2</sup> to reflect 'single payment' subsidies where received (no adjustment on land for fruit and vegetables)		
<b>Crops:</b> Cereals; oilseeds; beans/peas. <b>Grassland:</b> Beef and sheep		Loss of Gross Margins £/ha/year (adjusted for possible savings in costs), plus clean-up costs	Change in Net Margins £/ha/year associated with change in flood and land drainage conditions
<b>Other:</b> Dairy; sugar beet; potatoes; high value fruit/vegetables		As above, treated as though area occupied by wheat	As above, treated as though area occupied by wheat

**Notes to table:**

1. Following Defra (2008) Guidance (See also Tables 9.4 and 9.5 above)
2. £875/ha in 2024 prices

**Table 9.7** Estimated economic cost of freshwater and saline flooding (£/ha in 2024 prices) for a single event of a given duration in weeks by land use and associated farm types in England

	Drainage condition	Freshwater flooding and duration <sup>3</sup>		Saline flooding and duration <sup>2</sup>	
Land Use Type <sup>1, 2</sup>		1 to 2 weeks	2 to 4 weeks	1 to 2 weeks	2 to 4 weeks
1. Extensive Grass. Lowland Grazing livestock	Good	75	272	361	883
	Bad	64	232	334	822
	Very Bad	39	162	99	229
2. Intensive Grass. Mainly Dairy	Good	114	406	438	1,091
	Bad	78	353	383	1,008
3. Grass/Cereal Rotation. Dairy/Cereal mixed	Good	355	824	687	1,380
	Bad	229	552	503	1,069
4. All Cereal	Good	596	1241	937	1,669
	Bad	379	751	623	1,130
5. Extensive Arable, crops harvested by combine harvester	Good	601	1265	937	1,652
	Bad	388	781	665	1,169
6. Intensive Arable with root crops (sugar beet and potatoes)	Good	930	1,573	1,233	2,568
7. Intensive Arable with specialist root crop and field scale vegetable production	Good	2,311	3,218	3,572	6,362

**Notes to table:**

1. Indicative associated Agricultural Land Classification Grade (ALC) by land use are as follows. Land use 1: ALC 4. Land use 2 and 3: ALC 3a and b. Land use 4 and 5: ALC 3a. Land use 6: ALC 2. Land use 7: ALC 1.
2. Average arable crop yields for land use and ALC associations are assumed relative to ALC 3, at + 15% for ALC 1, +10% for ALC 2 and -15% for ALC 4, but local conditions vary substantially and should be checked.
3. Assumes monthly distribution of flood probability for all England, with weighted monthly flood costs that vary according to land use and estimated monthly loss and damage to crops and livestock according to production cycles

**Table 9.8** Estimated economic cost of flooding (£/ha in 2024 prices) in England for a single event of a given duration in weeks by Agricultural Land Classification (ALC) Grade and associated agricultural land use.

ALC grade <sup>1</sup>		Intensive Arable with root and vegetable crops	Intensive Arable with root crops (sugar beet and potatoes)	Extensive Arable: mainly cereals and oils seeds	Intensive Grass: mainly Dairy	Extensive Grass: mainly beef and sheep	Average Flood costs £/ha/event <sup>2</sup>
1	% of area	15	75	10			
	1 to 2 weeks	£2,310	£970	£665			£1,140
	2 to 4 weeks	£3,220	£1,635	£1,420			£1,750
2	% of area	5	60	35			
	1 to 2 weeks	£2,210	£930	£645			£895
	2 to 4 weeks	£3,080	1,570	£1,360			£1,595
3a	% of area		30	70			
	1 to 2 weeks		£860	£600			£680
	2 to 4 weeks		£1,450	£1,265			£1,320
3b	% of area			50	50		
	1 to 2 weeks			£570	£130		£350
	2 to 4 weeks			£1,190	£460		£825
4	% of area			20	40	40	
	1 to 2 weeks			£540	£115	£75	£180
	2 to 4 weeks			£1,120	£410	£270	£495
52	% of area					100	
	1 to 2 weeks					40	£40
	2 to 4 weeks					160	£160

**Notes to table: (estimates are rounded)**

1. Broad indicative associations of land use and farm type by ALC Grade for England are assumed that should be verified locally. Flood costs (£/ha) reflect difference in normal yields by ALC Grade relative to ALC Grade 3, namely: ALC Grade 1, 115%; Grade 2, 110%; Grade 3, 100%; Grade 4, 85%.

2. Monthly distributions of flood probability for all England are assumed, with weighted monthly flood costs that vary according to land use and crop, grassland and livestock production cycles.

**Table 9.9** A simple example of the economic assessment of flood induced agricultural land use change

		Existing FCERM service	Future FCERM options	
			Option 1: Do Minimum	Option 2: Do Nothing
<b>Flood return period (years) <sup>1</sup></b>		20	8	1
<b>Land Use</b>		General Cropping	Extensive Arable	Extensive Grass
<b>Drainage condition</b>		Good	Good	Bad
<b>Net Margin <sup>2</sup></b>	£/ha/year	245	119	-395
<b>Flood cost <sup>3</sup></b>	£/event	930	596	64
<b>Annual flood cost <sup>4</sup></b>	£/ha/year	46	75	64
<b>Net Margin less flood costs</b>	£/ha/year	199	45	-459
<b>Change in net benefits relative to Existing FCERM service <sup>5, 6</sup></b>	£/ha/year		-154	-658

**Notes to table:**

1. Based on Table 9.1
2. Based on economic Net Margins by land use in Table 9.5
3. Based on Table 9.7, single annual event, duration 1 to 2 weeks
4. A simple average cost for a single flood event is assumed for illustrative purposes rather than a complete estimate of Average Annual Damage (AAD) costs
5. Indicative changes in net annual economic benefits to agriculture at full implementation of FCERM scenario
6. Extensive Grassland Net Margin excludes potential annual agri-environment benefits that should be factored in.

**Table 9.10** Weights applied to central estimates of the cost of a single flood occurring in a year (£/ha) to derive estimates of the seasonal cost of flooding on agricultural land in England and Wales

Flood season <sup>1</sup> and duration	Intensive and Extensive Arable		Intensive and Extensive Grass		Rough Grazing	
	Freshwater	Saline	Freshwater	Saline	Freshwater	Saline
<b>1 to 2 weeks</b>						
Winter	0.47	0.71	0.44	1.20	0.49	0.74
Spring	1.21	1.15	2.50	1.76	1.18	2.00
Summer	2.71	1.91	1.75	1.21	1.28	1.12
Autumn	1.38	1.19	1.07	1.37	0.42	0.80
<b>2 to 4 weeks</b>						
Winter	0.69	0.81	0.52	1.18	0.42	0.63
Spring	1.31	1.20	2.32	1.86	1.20	1.79
Summer	1.69	1.45	2.13	1.41	1.00	1.00
Autumn	1.21	1.12	0.80	1.29	0.42	0.63

**Notes to table:**

1. Winter: December to February inclusive. Spring: March to May. Summer: June to August. Autumn: September to November.