9 Appraisal of Flood Risk Management for Agriculture

Author: Joe Morris

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OVERVIEW

Flood and Coastal Erosion Risk Management (FCERM) for agricultural land and businesses is an important element of government support to the agricultural sector in Britain. Many floodplain and coastal areas benefit from publicly funded flood defence[1] and land drainage schemes that reduce flood loss and damage on agricultural land and provide opportunities for productive farming (Morris, 1992).

FCERM for agricultural land can facilitate agricultural production where otherwise it would be impeded, for the whole or part of the year, by surface inundation and saturated soils. Agricultural land may be lower than high tide or fluvial flood levels and investment in FCERM infrastructure and services can protect these areas from frequent flooding, in some cases assisted by pumping schemes. Sea defences can prevent inundation by sea water that would result in complete crop loss and also reduced yields in subsequent years. Coastal protection may prevent agricultural land from being lost to the sea.

Increased flooding associated with changes in climate, land use and urban development, and concerns about the efficacy of traditional engineering responses, have encouraged greater use of Natural Flood Management (NFM) that seeks to 'protect, restore and emulate the natural functions of the catchment, floodplains, rivers and the coast' (Burgess-Gamble et al., 2018; Morris et al., 2014; SEPA, 2015). Simultaneously, there has been a drive to integrate FCERM in rural areas with other objectives such as nature conservation, soil protection, water quality improvement and recreation (CaBa, 2017), often supported by an 'ecosystems' approach to the management of land and water resources (Posthumus et al., 2010; Rouquette et al., 2011).

In this context, agricultural land and businesses are a ***recipient*** of FCERM benefits where FCERM measures reduce the risk of flooding on farmland. They are a ***provider*** of FCERM benefits where 'on-site' mitigation actions are taken to control runoff and retain and/or facilitate the controlled movement of potential flood waters in the farmed landscape to reduce flooding elsewhere, especially in the urban space (Morris et al., 2023).

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[1]The terms flood 'defence' and 'protection' are often used in the agricultural case, reflecting the past focus on reducing flooding on agricultural land to enhance its productivity. The term 'flood risk management', however, is now more appropriate for the appraisal of the range of flood management options on agricultural land and businesses, including the intentional use of farmland for the retention and/or temporary storage of flood waters. In the assessment of natural hazards, the terms 'loss' and 'damage' are commonly used. Loss denotes negative impacts on output and incomes (and value-added). Damage denotes negative impacts on asset values. In the agriculture case, typically over 80% of flood costs are losses associated with reduced crops and livestock production and 20% are damages to assets.

Considering agriculture as a beneficiary of FCERM, the role of appraisal is to determine whether it is worthwhile to provide a given standard of FCERM service for agriculture (Figure 9.1). This may involve comparing some existing or proposed standard with the 'Do-Nothing' option, recognising that tolerance of flooding and associated flood costs vary considerably amongst land uses (Table 9.1). Appraisal may require a comparison of the financial (to farmers) and economic (to the national economy) performance of agricultural land use under a range of different FCERM regimes, and how these compare with the costs of delivering those options. Conversely, where agriculture is a provider of FCERM services, appraisal seeks to assess the impact on agricultural land and businesses of NFM measures on farmland as this affects exposure to flooding with consequences for land use, agricultural productivity, and agricultural businesses (Morris et al., 2023).

Where farming is not possible in the absence of protection from flooding, Defra (2008) advise estimating economic loss (and therefore the potential benefits of flood protection) in terms of the loss of the market value of agricultural land, adjusted to remove the possible effect of agricultural subsidies on land prices. A detailed assessment of agricultural losses may be justified where large areas of prime agricultural land are concerned that have strategic importance for national food security and for local and regional economies.

The approaches needed for appraisal may vary according to context and purpose.

- At a broad catchment and coastal area scale, appraisals will at least require information on the types and areas of land use and the extent to which these might be affected by a change in flood frequency and coastal erosion risk;
- At a detailed scheme appraisal level, there will be a need to collect primary data and undertake detailed analysis of farming systems and businesses, in proportion to the significance of agriculture within the investment programme as a whole. Such detailed scheme-level analysis can be complex. Further guidance is available in MCM online (Penning-Rowsell et al., 2013)

Concerns about global food security and the possible impacts of climate change have renewed interest in improving the productivity of British agriculture. 1.4 million ha of agricultural land in England and Wales (12% of the total) is at risk of flooding from rivers (61% of the flood risk area), the sea (23%), or both (16%) (Roca, 2011). Almost 60% of Grade 1 Agricultural Land in England is dependent on flood risk management and land drainage, including coastal defences and pumping infrastructure. However, for major flood events in the UK, agricultural losses tend to be a relatively small proportion of total loss and damage costs. Flooding occurred on between 40,000 ha and 45,000 ha of farmland in the 2007 summer floods in England and also in the winter 2013/14 floods England and Wales. In both cases 'on-farm' agricultural flood costs only accounted for about 3% of the estimated total economic costs of the event (Chatterton et al., 2010; Chatterton et al., 2016, Hess et al., 2023). Agricultural flood costs may however be regionally or locally concentrated: agricultural costs accounted for about 8% of total estimated economic costs attributed to flooding in Somerset during the long duration winter 2013/14 event (Parsons Brinkerhoff, 2015).

The assessment of agricultural flood costs, whereby the attributes of flooding are combined with the characteristics of agriculture land use as a receptor, is based on the methods explained in Chapter 9 of the MCM (Penning-Rowsell et al., 2013). The methods draw on evidence from the studies of flood events in England and Wales, notably during summer 2007 (Posthumus et al., 2009), spring and early summer 2012 (Morris and Brewin, 2014), winter 2013/14 (Chatterton et al., 2016), and from a rapid evidence review of the impacts of flooding on agriculture in England and Wales (Hess et al., 2023).

This 2024 update of the MCH involves the extended use of historic data on agricultural land use and farming systems published by Defra to derive estimates of the economic value of agricultural production. MCH 2024 also further develops the estimates of flood costs by broad categories of land use and farming system, Agricultural land Classification Grade, flood duration, water quality (salinity) and seasonality, all consistent with the methods outlined in Chapter 9 of the MCM. Notably, flood loss and damage costs to agriculture for FCERM investment appraisal are estimated using regional Farm Business Surveys data (Defra, 2024a) on land use, productivity and financial performance by type of farm for the 5-year period 2018/19 - 2022/23 inclusive, updated to 2024 prices using GDP deflators (ONS, 2024).

Medium to long run agricultural prices and 'profitability', critical for FCERM appraisal, are difficult to predict. Agricultural commodity prices in the UK are strongly influenced by world market prices, moderated by UK£ exchange rates. Disruption to international markets associated with the COVID pandemic and more recently the Ukrainian conflict have increased the volatility of agricultural markets and prices, especially for bulk commodities such as cereals and oil seeds, and for inputs such as fertiliser and energy (Defra, 2024b). Variable global and regional climatic conditions have further added to commodity price variation, especially in seasonal fresh produce. There is concern that future global and national food insecurity could refocus the role of agriculture within the UK national economy. The medium-term outlook for agriculture at the global scale is characterised by a high level of uncertainty in agricultural markets with a range of plausible outcomes (FAO-OECD, 2023; EC, 2023). A cautious approach is required when estimating the value of agricultural output that is supported by long term FCERM investments, especially where large areas of prime agricultural land are involved.

LESSONS FROM EXPERIENCE

- There is a close connection between the management of flood risk for agriculture and the management of agricultural land drainage as this affects the productivity of farmland. Managing flooding on farmland cannot be seen in isolation of managing waterlogging and groundwater flooding.
- The main factors affecting the costs of a flood event on agricultural land are the type of land use, and the seasonality and duration of flooding. Flood costs are much higher on arable land than on grassland, especially where the production of high value potatoes, vegetable and salad crops is affected. Flooding in summer results in much higher losses (£/ha) than flooding in winter, especially on arable crops and grassland conserved for winter feed. Generally, the longer the period of flooding, the greater are the losses. Most arable crops and grassland can sustain short duration winter flooding of less than one-week, but yields may be affected. Longer duration floods have much greater impact, as do coastal floods involving saline water.
- Over 80% of agricultural flood costs are commonly associated with loss of production or additional production costs. The remainder is associated with damage to property and equipment. Generally, production losses are not insured.
- At the individual farm scale, the bigger the proportion of the total farm area affected by flooding, the bigger is the likely magnitude of the costs (£/farm) and impact on the farm business as a whole.
- Data and methods for the appraisal of FCERM capital investments for agriculture can be adapted to evaluate the benefits of the ongoing maintenance and operation of FCERM services and standards (Morris et al, 2023).
- Methods to assess the economic impacts of flooding on agricultural land can also be used to help appraise Natural Flood Management (NFM) options that involve Working With Natural Processes (WWNP) such as the retention of flood water in the general landscape, floodplain conveyance and storage, and the creation of wetlands.

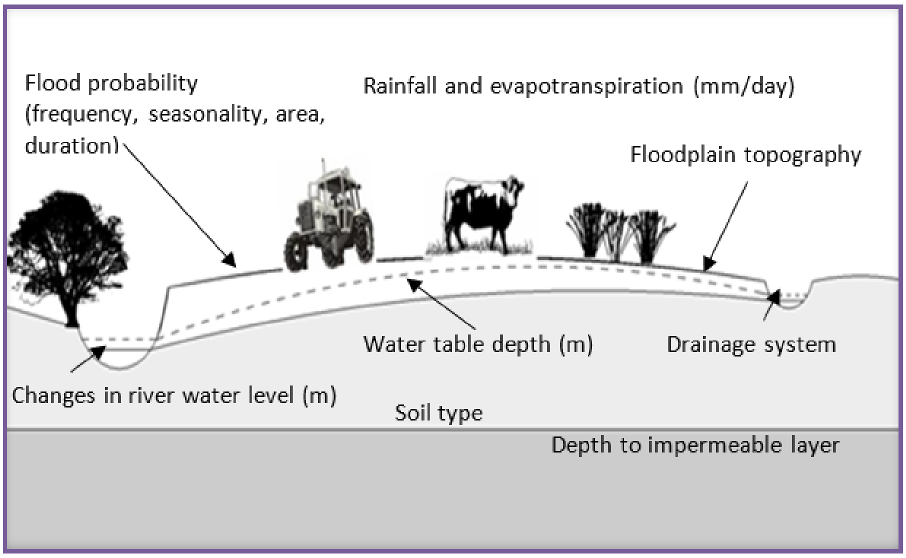

Figure 9.1 Flooding and drainage factors influencing agricultural productivity on floodplains

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 to 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%

METHOD FOR ASSESSING AGRICULTURAL BENEFITS

The principle behind the appraisal is to identify and quantify the impact of flooding regimes on agricultural land and businesses. Three main steps are required to derive a monetary value of agricultural benefits under different FCERM/NFM conditions. These are considered below. The greatest detail will be required to assess possible changes in exposure to flooding on relatively intensively cropped high grade agricultural land, including intensive grassland for dairying. Less detail may be justified for initial broad scale or 'overview' assessments at the catchment scale, although this may prompt further enquiry.

Step One: Defining agricultural productivity

This step involves three actions. The *first* action identifies the total area that is liable to flooding, and hence the 'benefit area' of FCERM interventions. The *second* action determines land use classified into major crop and grassland types (Table 9.1) in order to estimate the likely impact of flooding on the physical and financial performance of arable crops, grassland and associated livestock production.

The *third* action assesses the likely soil 'drainage' and associated waterlogging conditions as determined by field water table levels during critical periods of the farming calendar. Land drainage conditions are a key determinant of agricultural land use and productivity, and hence the cost of flooding on farmland when flooding occurs (Table 9.2). Under 'Good' agricultural drainage conditions, land uses and yields typical of a well-drained site for the soils concerned can be expected. 'Bad' agricultural drainage conditions, associated with 'sub-surface' flooding and waterlogging of soils, reduces yields and limits land use options relative to the 'Good' condition. 'Very bad' drainage conditions impose severe constraints on land use. It is important that the agricultural drainage conditions associated with different FCERM options are identified and factored into the assessment[2]. Flood event costs (£/ha) are likely to be greater on well-drained soils compared to poorly drained soils because land use is likely to be more intense and 'normal' yields higher.

[2] There is increased recent interest in the causes and effects of groundwater flooding in the urban sector whereas the groundwater levels and management of groundwater flooding have long been of concern for agricultural land use and productivity. FCERM investments for agriculture in the 20th Century generally combined measures to simultaneously reduce flooding and improve land drainage.

Table 9.2 Drainage conditions for agriculture and water levels in fields and ditches

Agricultural drainage condition	Agricultural productivity class	Depth to water table from surface	Springtime freeboard* in water-courses (natural drainage)	Springtime freeboard* in water-course (field drains)
Good: 'rarely wet'	Normal, no impediment imposed by drainage	0.5 m or more	1 m sands 1.3 m peats 2.1 m clays	1.2 m clays to 1.6 m sands (0.2 m below pipe outfall)
Bad: 'occasion-ally wet'	Low, reduced yields, reduced field access and grazing season	0.3 m to 0.49 m	0.7 m sands 1 m peats 1.9 m clays	Temporarily submerged pipe outfalls
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 0.6 m peats 1 m clays	Permanently submerged pipe outfalls

Notes to table: Freeboard refers to the mean difference between water level and adjacent field level

With respect to estimating the productivity and financial performance of agricultural land use:

- For **arable land**, estimates of crop yields can be obtained from bespoke farm surveys or from published data on regional yields adjusted for local drainage conditions (Table 9.3). Farmers are usually able to report the degree to which yields on poorly drained parts of their farm are lower than elsewhere;
- Assessing the productivity of **grassland** is more complicated, requiring information on the type and age or weight of grazing livestock, livestock feeding regime, length of grazing season, liveweight gain or milk yield, and type and tonnage of conserved grass (Table 9.3);
- Using data from secondary sources and from farm surveys in the benefit area, the productivity of grassland can be estimated from the type and number of livestock that can be carried per hectare (ha) under different drainage conditions – see Chapter 9, MCM (Penning-Rowsell et al., 2013).

Step Two: Defining the attributes and impacts of flooding

The attributes of flooding that affect the type and magnitude of agricultural flood impacts can be distinguished as follows:

- Frequency of occurrence (including the chance of multiple floods per year);
- Seasonality (especially the distinction between winter and summer floods);
- Duration (from a few days to one or more weeks);
- Depth (relative to the height of standing crops and livestock, and property);
- Water quality (including contamination, sedimentation and salinity);
- Velocity (as this affects erosion risk, flow related impacts, and debris).

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The costs of flooding depend on the characteristics of the agricultural land use and businesses in flood receptor areas and their sensitivity to flood attributes (Hess et al., 2023). The key question is 'what changes in agricultural benefits and costs result from a change in exposure to flooding?'. The key components of agricultural flood costs are as follows:

- Flood costs for arable crops include the loss of the value of output, the costs of additional inputs less any savings in uncommitted costs if crops are not harvested, and remedial work such as land restoration and re-sowing of crops;
- For grassland, costs include the loss of grass-feed valued at substitute feed prices, the cost of additional inputs such as fertiliser less any 'savings' in hay/silage making costs if output is reduced, plus restoration costs if reseeding is required;
- Livestock costs include the loss of grazing days and the cost of relocating and/or housing animals, increased veterinary expenses, increased morbidity/mortality and loss of sales;
- 'Other' costs include damage to buildings and contents, field infrastructure (fencing, drain, tracks), machinery, the cost of clean-up and restoration, and disruption to utilities and services.

Flooding can also result in changes in soil properties with consequences for agricultural productivity, associated for example with compaction, erosion, and loss of soil biota. Remedial action may be required to reduce the impacts on soil degradation on yields in subsequent years.

The seasonal timing of flooding critically affects flood costs (£/ha) on farmland depending on the type of land use. Summer floods usually result in much higher losses (£/ha) than winter floods (see Table 9.4).

In the case of coastal saline flooding, yield losses on most crops are approximately 20% higher than freshwater losses if flooding occurs only for a few days, except for potatoes and horticultural crops that would be completely lost. Longer duration saline flooding can result in significantly higher losses, with effects in subsequent years (Gould et al., 2020). Planting a salt tolerant crop such as barley in the year following flooding may be required, with resultant loss in profitability compared with normal cropping. Remedial application of gypsum to neutralise saline soils may be required. Coastal flooding tends to result in much higher livestock fatalities than fluvial flooding.

Where flooding is of sufficient magnitude and severity, indirect effects may extend beyond the farm gate into the agricultural supply and value chains (Hess et al., 2023). Businesses supplying goods and services to farms may be affected, as well as downstream industries dependent on farm outputs for processing and marketing. For example, the tidal surge in the winter of 2013/14 in eastern England affected poultry farms supplying a major food company, imposing indirect costs of over £650,000 in 2024 prices (Chatterton et al., 2016). These indirect, off-site impacts can be substantial for major events, especially at the local and regional scale.

Step Three: Expressing any difference in monetary values

GROSS AND NET MARGINS

The monetary value of changes in the exposure of farmland to flooding can be determined using the accounting conventions of Gross Margins, and Net Margins, expressed either as per hectare (ha) or for a farm as a whole.

The level of detail required depends on the purpose and context of the appraisal. Where the 'Do-Nothing' option involves the potential loss of agricultural land, guidance (Defra, 2008) recommends that agricultural land market prices can be used (as explained below). In many other cases, however, it will be necessary to estimate the financial (to farmers) and economic (to the national economy) performance of agriculture under different FCERM options.

Gross Margins (£/ha/year) of crop or grassland-based livestock activity are used to measure the value of output less variable costs such as seeds, fertiliser and supplementary animal feed if appropriate (Table 9.5). Variable costs are directly related to each unit of activity and can be avoided if that activity is not pursued. Gross Margins show the monetary gain (or loss) associated with one more (or one less) unit of an activity, assuming other so-called 'fixed' resources available to the business, such as regular labour, machinery, buildings and land (and their associated costs) remain unchanged. Net Margins provide an estimate of average annual profit after average Fixed Costs (£/ha/year) are subtracted from Gross Margins.

ECONOMIC VALUATION

Defra (2008) guidance for economic appraisal requires two main types of adjustment to financial estimates: namely, the removal of subsidies (and taxes) and allowance for 'displacement' effects.

Adjustment to remove direct subsidies from crop and livestock Gross Margins is no longer required because previous direct production subsidies have been replaced by direct income support under the 'Basic Payments Scheme' (BPS). Eligible farmers are paid annual amounts (£/ha/year) based on historical entitlement to subsidies. Since the departure of the UK from the European Union and the Common Agricultural Policy, government support for agriculture has shifted from direct income subsidies (BPS) towards the Environmental Land Management scheme (ELMs) and, within this, to Sustainable Farming Incentives and programmes for Nature and Landscape Recovery (Defra, 2023a). Approaches vary between the UK's devolved Governments. In England, for example, the initial post-Brexit policy for Agricultural Transition (Defra, 2024c) proposed complete withdrawal of BPS by 2027/28, to be replaced by payments under ELMs. There is some uncertainty whether this will happen. BPS payments (£/ha) in England in 2024 have declined to about 50% of their 2021 levels, while take up of ELMs options has reportedly been slower than intended (UK Parliament, 2024). Other UK National Government have retained larger elements of BPS and have their own arrangements for agri-environment and nature recovery (Welsh Government, 2024a).

While the income subsidies to farmers are excluded for the purpose of the economic assessment of FCERM agricultural benefits, the types and scale of income subsidies and agri-environment payments have a critical effect on the incentives to farmers and the viability of farm businesses. It is noted for example, that in the absence of BPS and agri-environment payments, many farms would be rendered financially non-viable, especially in the Grazing Livestock sector.

Agri-environment payments to farmers under ELMs options (and associated Countryside Stewardship (Natural England, 2024a)) that integrate with FCERM benefits such as floodplain storage, wetland creation and coastal realignment, should be factored into the assessment of FCERM options. In such cases, agricultural benefit assessment should be extended to include wider environmental aspects, possibly using natural capital and ecosystems frameworks (Morris et al., 2023).

Regarding displacement, Defra (2008) advises that persistent flooding of high value horticultural crops, field vegetables and potatoes, and commodities subject to quota such as sugar beet and dairy milk (subsequently withdrawn in 2015), would lead to the relocation of their production elsewhere, displacing winter sown wheat as the dominant arable crop in the UK by area. For this reason, areas of high value crops and dairying are valued as an equivalent area of winter wheat in the economic analysis of permanent changes in FCERM. This assumption may not apply where the potential changes are large scale, of strategic importance, or where an area has a special comparative advantage that is not easily transferable. Over the past decade, however, the financial comparative advantage of high value but high-cost vegetable production has declined relative to that of wheat, but this trend may not continue in the longer term.

Further adjustments are often required to derive economic values for agricultural benefits. The cost of unpaid family labour should be included, valued at an equivalent wage rate. The costs associated with land purchase and rents should be excluded. Payments for land are an 'economic rent' and not an extra resource cost: land is there whether it is used or not. Here, the purpose is to assess the economic value of a particular land use (£/ha) in terms of the benefits generated, excluding the financial cost of acquiring the land itself. Furthermore, taxes and charges such as Sales or Value Added Tax and National Insurance are also excluded from economic analysis.

DERIVING FINANCIAL AND ECONOMIC VALUES FOR AGRICULTURAL LAND USE

To illustrate the approach, estimates of key financial and economic indicators for winter wheat, the dominant arable crop, and for the main lowland arable and grassland farm types for England are given in Table 9.5. These have been derived from historic data for the 5-year period 2018/19 to 2022/23 from the annual regional Farm Business Survey (FBS) (Defra 2024a). Annual mean estimates have been weighted by GDP deflators (ONS, 2024) to derive estimates of mean values in 2024 prices. Similar statistics are available for farm incomes in Wales (Welsh Government, 2024).

Estimates of Farm Business Income attributable to agricultural activities (excluding subsidies and other sources of income to the farm as a business) (Table 9.5) provide a measure of business profitability similar to an annual return on management effort and shareholder capital. As explained above, for the purpose of economic assessment, financial estimates are adjusted to exclude land rent and to include the imputed cost of unpaid family labour. This adjustment mainly reduces Net Margin (£/ha/year), for example, from £480/ha/year to £430/ha/year in the case of Wheat. Notably, charging an 'economic price' for unpaid family labour results in a large negative average Net Margin for Grazing Livestock farms (excluding subsidies and other income). Table 9.5 also shows the effect of treating high value cropping and dairy areas as equivalent areas of wheat to derive economic values. For example, the estimated Economic Net Margin for the 'average' Dairy Farm is £271/ha/year, considerably lower than the adjusted Financial Net Margin of £436/ha/year.

It is noted that the 'mean' estimates for the 5-year period 2018/19 to 2022/23 hide considerable variation amongst years and amongst low, mean and high performing farms. For detailed analysis, it is important that there is further disaggregation of data and estimates to allow for regional and local differences, and especially to allow for variation in farm performance. The top third of farms by performance, for example, generate mean Gross Margins and/or Net Margins that can exceed the mean estimate by 20% to 40%, especially in the Grazing Livestock sector where the variation between farms is very high.

Estimates of Financial Gross Margins based on historic time-series data can be different from those more readily available from Farm Business Management Handbooks (e.g. Redman, 2023; SAC, 2023). The latter typically provide single-year forward budgets and may not include the aforementioned adjustments. These Handbooks are, however, invaluable and comprehensive sources of supporting information to which reference can be made. Detailed appraisals of FCERM investments where agriculture is a key beneficiary should take a long-term view, extrapolating from locally relevant historic data and allowing for possible future market and policy conditions.

Detailed analysis should consider plausible variations in key factors affecting agricultural revenues and costs over time. Low and high estimates used in sensitivity analysis are likely to be at least plus and minus 50% of the central estimates given in Table 9.5.

SCENARIOS AND THEIR TREATMENT

Defra (2008) appraisal guidance identifies three scenarios which reflect the nature of changes in flood and coastal erosion risk, namely:

- Scenario I: Permanent loss of agricultural land;
- Scenario II: One-off damages arising from infrequent flood events;
- Scenario III: Permanent change in FCERM standards.

These scenarios use different methods for the assessment of flood risk management benefits (Table 9.6).

Regarding Scenario I, Defra (2008) advise that land permanently lost to agriculture should in most cases be valued at market 'vacant possession' prices, excluding buildings. Current and historic agricultural land prices are available from leading land agents and advisors (Strutt and Parker, 2024; Savills, 2024; RICS/RAU, 2023).

In 2023, agricultural land prices averaged £27,900/ha for arable land (range £18,500/ha to £30,900/ha), and £21,500/ha for pastureland (£13,600 to £22,850/ha) (Strutt and Parker, 2024) with prices varying according to land quality and region. According to Savills (2024), land agent assessment of sales by Agricultural Land Classification (ALC) Grades in 2023 showed mean values for prime arable land (Grade 1 and 2) at £26,200/ha, good arable land (Grade 3) at £21,500/ha, good pasture (Grade 3) at £17,800/ha and poor pasture (Grade 4 and 5) at £14,300/ha. Agricultural land prices in 2023 returned to the peak prices last recorded in 2014/15. They are expected to either level off due to policy uncertainty (Strutt and Parker, 2024) or rise by between 1.5% and 3.5% per year (in current prices) over the next 5 years, mainly reflecting interest from non-farming and institutional buyers (Savills, 2024).

Defra (2008) guidance stipulates a deduction of £875/ha (2024 prices) (£600/ha: 2008) from agricultural land market prices to reflect the subsidy effect of farm income support[3]. Many non-agricultural factors affect agricultural land prices such that care is required when using market prices to reflect the value of land retained in agriculture, especially for prime agricultural areas of strategic national importance.

Regarding Scenario II, estimates of flood costs will reflect the likely impacts on output loss, Gross Margins and other costs for a given land use. Table 9.7 contains indicative estimates in 2024 values of the seasonally weighted economic [4] loss and damage costs (£/ha) of a single flood occurring in a year with a duration of one to two weeks and two to four weeks according to land use, associated farm types and agricultural drainage condition[5]. The costs of a single flood event are, for example, £601/ha

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[3] This guidance may be revised by Defra given the significant changes in agricultural support since 2008.

[4] At the farm scale, the financial costs (excluding subsidies, taxes and land costs, and including unpaid labour) and the economic costs of an infrequent flood event are the same because costs cannot be avoided once a flood occurs.

[5] The estimates in Table 9.8 and subsequent tables combine both loss and damage costs. Damage cost estimates (£/ha/event) are based on farm survey data of 'other' costs (as referred to earlier in the text). Where damage to agricultural business property is known to be high and is not included elsewhere as damage to commercial property, eg as warehousing or processing plant, it should be separately identified and valued.

and £1,265/ha for the two flood durations respectively on Extensive Arable land (assuming normal yields for ALC Grade 3 where this type of land use is common) and good drainage conditions. Table 9.7 also shows the economic costs of flooding by saline water that are typically 50% to 100% higher than freshwater flooding according to land use and duration.

There are broad associations between ALC Land Grade, land use and agricultural yield performance, and between ALC Grade and exposure to flooding, but these can vary considerably at the local scale. Table 9.8 shows indicative estimates of flood event costs (£/ha) according to ALC Grade and associated land use, allowing for variations in 'normal' crop yields amongst ALC Grades (see notes to Table 9.8). For example, estimated seasonally weighted freshwater flood costs on ALC Grade 1 are £1,140/ha and £1,750/ha for the one to two week and two to 4 four-week events respectively. Table 9.8 should be amended to suit local variation in land use and farm types.

Regarding Scenario III, the analysis is more complicated because a change in flood frequency can induce a change in land use and the costs of flooding when it occurs. Table 9.9 provides a simple example, drawing on the contents of earlier tables. A switch from an existing FCERM provision with flooding occurring once in 20 years to a future Do-Nothing option with flooding at least once per year and poor drainage results in a change of land use from General Cropping to Extensive Grazing. The estimated economic loss is £658/ha/year at full scenario development. Possible agri-environmental options under Extensive Grassland could, however, generate additional net benefits in excess of £250/ha/year that would be included in the FCERM appraisal.

The central estimates of flood costs in the preceding tables assume a within-year monthly distribution of flood probability based on Roca et al. (2011) for the all England case, although distributions can vary across the regions. Broadly, the relative seasonal probability of a single flood occurring in a year (p=100%) are Winter (December to February inclusive) 45%, Spring (March to May) 20%, Summer (June to August) 10%, and Autumn (September to November) 25%. Climate change effects could significantly change these seasonal distributions. Table 9.10 shows the weights that can be applied to derive seasonal estimates of flood costs by major land uses relative to the reference all England annual distribution. For example, the costs of a single flood of one to two weeks occurring in Summer only can be derived by weighting the central estimates of flooding in Table 9.7 by a factor of 2.71 for all Intensive and Extensive Arable land uses, by 1.75 for Intensive and Extensive Grazing and by 1.28 for Rough Grazing. For example, the estimated cost of a single freshwater flood of one to two weeks duration occurring in the summer period on Extensive Arable land use under good drainage conditions is £601/ha (Table 9.7) raised by a factor of 2.71 (Table 9.10) to give £1,629/ha. Under similar circumstances, estimated flood costs are £2,137/ha for a summer flood of two to four weeks duration (£1,265/ha x 1.69). Further sensitivity analysis of the seasonal distribution of flooding can be carried out if appropriate.

This may require some adjustment to the 'other' costs included here in the average costs of flooding (typically 15% of total costs (£/ha)).

Table 9.10 Weights applied to central estimates of the cost of a single flood occurring in a year to derive estimates of the seasonal costs of flooding on agricultural land in England and Wales

Flood season[1] and duration	Intensive and Extensive Arable		Intensive and Extensive Grass		Rough Grazing	
	Freshwater	Saline	Freshwater	Saline	Freshwater	Saline
1 to 2 weeks						
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
2 to 4 weeks						
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.

Throughout the appraisal process, it is important to identify major sources of risk and uncertainty and the possible effect on benefit and cost estimates. It is advisable to derive a range of low, central and high estimates, with some assessment of relative likelihood, rather than any one single value estimate.

While this guidance generally applies, specific advice should, however, be sought from Defra for:

- High level strategic assessments;
- Large scale schemes of more than 10,000ha; and
- Agriculturally less-favoured areas where there could be significant impacts on vulnerable farming communities and local economies.

DATA NEEDS, SOURCES AND COLLECTION METHODS

It is advisable to start with an exploratory survey of the study area to define the geographical boundary of influence, that is the benefit area, and to determine current flood risk management standards and issues arising. Agricultural statistics can be obtained from Government sources (Defra, 2023b, 2023c, 2024a; AHDB, 2024), including geographically referenced data sets (RPA, 2023; Natural England, 2024b)

This 'overview' survey will also identify broad categories of land use, dominant farm types and systems, possible flood risk management options, the likely impact of these and the views of key stakeholders, especially farmers.

Key informants will include:

- Staff with flood risk management interests in regional offices of the Environment Agency and Defra;
- Local Internal Drainage Boards;
- Representatives of farmer organisations (such as the National Farmers Union);
- Local advisors and land agents;
- Environmental and conservation groups such as the local Wildlife Trusts, Farming and Wildlife Advisory Groups (FWAGs), River Trusts and National Parks;
- College and University Agricultural Economics and Agriculture Departments.

In most cases some form of farm survey will be needed, usually involving a sample of representative farmers that covers the major variations in farm circumstance (e.g. size, tenure, land type, flood risk), farm practices (e.g. enterprise mix, drainage improvements), and farmer characteristics (e.g. age, skills, preferences and motivation). Those embarking on such a survey should refer to Chapter 9 of the MCM (Penning-Rowsell et al., 2013).

For agricultural enhancement schemes, the extent to which flooding and drainage currently constrain farming will be a focus of enquiry, together with the factors that are likely to encourage farmer take-up of potential benefits (Morris et al., 2023). Conversely, the adoption NFM measures to provide FCERM benefits elsewhere may require changes in agricultural land use or result in increased flood costs to farmers that need to be assessed as part of a wider financial and economic appraisal of NFM interventions (Morris et al., 2023).

REMAINING ISSUES

- There is currently considerable uncertainty facing the agriculture sector in England and Wales associated with Post-Brexit policy reform, disruption in international commodity markets, and climate change.
- While FCERM tends to focus on surface inundation and erosion processes, groundwater flooding and waterlogging are critically important for the agricultural case.
- In line with government policy, appraisals in future will seek to integrate FCERM with other rural land use objectives such as agriculture, biodiversity and nature recovery, enjoyment of the countryside and adaptation to climate change;
- Farm surveys should be carried out by competent and experienced interviewers with knowledge of farming systems;
- Flooding from estuarine and coastal sources results in greater impact and higher losses than freshwater flooding, and agricultural land is likely to take longer for full production to be restored.

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