Terrestrial food: Indicator document - Ecosystem Service Modelling & Rule-base development

Indicator	CICES classification
TERRESTRIAL FOOD PROVISION **Areas of land supporting food production (Nutrition from crops, livestock and wild food)**	**Section**: Provisioning **Classes:** • Cultivated crops • Reared animals and their outputs • Wild plants, algae and their outputs • Wild animals and their outputs • Animals from in-situ aquaculture **CICES IE Sub-class:** • Multiple classes (see CICES for Ireland_fordb.xlsx for details)
Scale	**CICES Cascade Level** [1]
Strategic/National/~~Regional/Local~~	~~Structure/Function/~~Service/~~Benefit/Value~~

[1] Potschin, M. and R. Haines-Young (2016): Frameworks for ecosystem assessments. In: Potschin, M., Haines-Young, R., Fish, R. and Turner, R.K. (eds) Routledge Handbook of Ecosystem Services. Routledge, London and New York, pp 125-143.

What the service is

The service mainly comprises land being used for producing crops and rearing livestock. In addition land which could be used to forage for wild foods such as fungi and berries or hunting game is included. Species used for food inhabiting freshwater bodies, and those which spend part of their lifecycle in freshwater and part in marine waters are also included.

The scientific framework outlined below helps to determine the type of data that could be used for modelling of this service, and provides general guidance which indicators are likely to have a positive or negative impact on service provision.

Scientific framework for modelling 'terrestrial food provision'

Overview:	Food provision is an important ecosystem service that relies on a range of supporting services provided by various habitats (both natural as well as managed) and the species associated with them (Swinton et al., 2007; Parikh and James, 2012). There is good supporting evidence regarding the role of agriculture, other land management, semi-natural areas, substrate and landform on terrestrial food provision. The most relevant material is summarised here.
Soil and soil systems	Agriculture varies from intensive production of arable crops in lowland areas and extensive permanent grazing regimes on open moorland to intensive small-scale horticultural fruit and vegetable production on allotments and in gardens (Foley et al., 2005). Enclosed farmland is managed for food production and underpins the agri-food sector, which contributes approximately 7% to Ireland's GVA (gross value added) (Teagasc, 2015). The most important supporting service for agricultural production is the maintenance of soil fertility, which is fundamental to sustaining agricultural productivity (Watson et al., 2002; Altieri and Nicholls, 2003; Parikh and James, 2012). Soil carbon plays a major role in soil structure, one of the major components of soil fertility (Swinton et al., 2007; Parikh and James, 2012). Mineral soils provide good productivity and afford some of the best soils for food production, due to the balance between mineral components, organic matter, oxygen supply and water retention (Parikh and James, 2012). Organo-mineral soils are generally poorer for food production, often associated with acid upland soil and cooler, wetter climatic conditions (Brady and Weil, 2002). Organic soils can provide very good food production conditions. However, they require artificial drainage, agro-chemicals are needed to maintain a neutral pH and high nutrient levels and cause peat wastage, resulting in loss of carbon stored in the soil (Holman, 2009). Well drained and nutrient rich brown earth soils require the fewest artificial inputs to allow for them to be used for cultivation. However, any intensive use depletes soils of nutrients, which can be countered by rotation or external inputs (Parikh and James, 2012). Due to the coarse structure causing large pore spaces, sandy soils tend to drain fast and not retain enough water and nutrients for effective agricultural usage (Brady

	and Weil, 2002). Waterlogged systems can require substantial drainage operations to allow for them to be suitable for cultivation (Robinson and Armstrong, 1988; Ritzema, 1994; Holman 2009). The underlying geology is an important determinant of food production capability through its effect on soil type and texture (Jenny 1994; Brady and Weil, 2002). Underlying geology also affects other features of soil type, such as depth and stone content, both of which have an impact on food production (Jenny, 1994; Brady and Weil, 2002). Good information regarding soil composition, particle size, pore spaces, and peat content in Ireland have been recorded by Teagasc (Teagasc Soils Guide[6]; Teagasc, 2007).

[6] http://gis.teagasc.ie/soils/soilguide.php

Landform	Landform has an important influence on food production. Intensive agricultural production is limited to flat or gently sloping ground (Spencer, 1978). The maximum cut-off for the effect of slope on agriculture are generally recognised as >18° - Land too steep for arable production (machinery cannot operate) and with limited suitability for grazing (MAFF, 1988). This is particularly important when considering additional areas where agriculture could take place, whilst, when looking at existing agriculture, the relevant information is mostly contained within the land cover information.
Semi-natural habitats	Food provision is an important ecosystem service that relies on a range of supporting services provided by various habitats, natural as well as managed, and the species associated with them (Swinton et al., 2007; Parikh and James, 2012). Some semi-natural habitats are not commonly used for intensive food production and are mostly associated with wild food provision. However, many habitats are maintained by agricultural grazing systems. In these cases, maintenance of the habitat is the priority, but the area does still contribute to food production (Bullock et al., 2011). Some habitats contribute to wild food production in minor ways, such as bilberries from moorlands (Acreman et al., 2011).
Management	Management systems are one of the most important factors for food production and also influence the impact of agriculture on the delivery of other ecosystem services

	(Swinton et al., 2007; Davari et al., 2010). Conservation management on farmland can be seen as reducing inputs, particularly on grassland based systems. This can have the effect of lowering productivity and, therefore, food production (Lichtfouse, 2011). Grazing (both cattle for dairy and beef, and sheep) is the major land use in Ireland. Managing grassland for grazing can affect biodiversity (Anderson, 2013) as well as the provision of ecosystem services (particularly water quality) through nitrogen application, slurry, pollution, and methane. This effect can be mediated through agri-environment management (Van Rensburg et al., 2009). Below ground physical features can be modified by machinery and by some specialist grassland types to develop deep rooting systems and an open soil structure (Carter, 2004; Pagliai et al., 2004). This improves the soil aeration, drainage and nutrient availability for the grasses themselves and for subsequently planted crops, improving growth and yield (Fitter, 1991; Carter, 2004). The ecological assemblages of soil fauna and flora can be important factors in maintaining soil structure by encouraging strong root systems (Brussaard, 1997; Wall and Moore, 1999) and, therefore, more productive crop growth. Earthworm numbers are particularly significant for soil system health (Brussaard, 1997; Lavelle et al., 2006). Additionally, some crops are selectively bred to have a well-developed root system (Fitter, 1991). In some instances the soil is prepared to enhance below ground biodiversity, which encourages crop growth (Brussaard et al., 2007). Crops are generally monocultures and, therefore, low in species richness (McCracken et al., 2011). However, hedgerows, beetle banks and headlands provide a greater abundance of flora species diversity to be present within the intensive agricultural environment (Benton et al., 2003). This in turn can support more birds and insects, which provide natural pest control and pollination (Carvell et al., 2007; Osborne et al., 2008; Blake et al., 2011; Fabian, 2013).

Supporting Evidence: References

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