Indicators and trends

Monitoring climate change adaptation

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Indicator name				Version
NA22: Area of cultivation under glass or plastic structures				07/03/16
Indicator type:	**Risk/opportunity**	**Impact**	**Action**	
	X			
SCCAP Theme	**SCCAP Objective**	**CCRA risk/opportunity**		
Natural Environment	**N3: Sustain and enhance the benefits, goods and services that the natural environment provides**	**AG3: Risk of crop pests and diseases**		

At a glance

- The area of crops grown under glass or plastic structures has increased rapidly in recent years
- Growing under such structures can improve resilience to extreme weather; increasingly important with climate change
- There is an increased incidence of aphids and other pests attacking crops in polytunnels, although this may be countered by key predators that thrive in them
- Integrated Pest Management is therefore needed
- There are many unknowns about the impacts of glass and plastic structures on the surrounding environment

Latest Figure	Trend
2014: 1122 hectares	Increasing

Why is this indicator important?

The area of crops grown under glass or plastic structures has increased rapidly in recent years (see Figure 1). With strawberries and raspberries accounting for 90% of cultivation under cover, this growth has been driven by demand from supermarkets for large amounts of high quality soft fruit (Evans, 2013). Growing under cover enables continuous production throughout an extended season, as demanded by supermarkets, rather than the traditional short season that was subject to vagaries of the weather. Use of glass or plastic structures such as polytunnels can mitigate the effects of extreme or unpredictable weather, in addition to improving productivity by extending the growing season. The warming climate has extended the growing season over the last fifty years (Scotland's Environment, 2014), however weather variability and extremes mean this does not necessarily translate into a reliable longer season for soft fruit. The primary driver for the growing use of polytunnels appears to be consumer and supermarket demand, however both the natural variability of the weather and climate change driven extreme events, such as the prolonged heavy rainfall experienced in 2012, are factors.

Climate projections indicate warmer, drier summers on average, but also more frequent intense rainfall events in future. This might suggest that the use of polytunnels is a suitable adaptive action; however, there is evidence of an increased risk of pests and diseases, particularly aphids, within polytunnels.

According to the Climate Change Risk Assessment for Scotland (HR Wallingford, 2012) 'The numbers of pests and diseases is expected to increase, and there is expected to be an increased risk from new pests and diseases. This would be expected to increase damage to some crops and affect livestock welfare (e.g. see indicator NA 21 Risk of liver fluke (*Fasciola hepatica*) in cattle and sheep) and product quality'.

Pest-resistant crop cultivars (plants bred for resistance to pests and diseases) tend to rely on a small number of resistance genes. However, many pests such as aphids can evolve very rapidly and overcome single genetic or pesticide controls more quickly than new methods of control can be developed for some crops (Dogimont et al, 2010; cited in Birch et al, 2011). This process whereby pests co-evolve to overcome control measures speeds up significantly in glass or plastic structures because the temperature, humidity, levels of CO_2 and shelter are all favourable for aphids and similar pests (Birch et al, 2011).

For example, the window of attack by *Amphorophora idaei*, the primary virus vector aphid, is 2-3 months in open fields. For raspberries grown in polytunnels this window increases to 10-11 months. The micro-climate in polytunnels has also enabled other, formerly minor pests of raspberries, to thrive and persist throughout an extended cropping season. There are a significantly higher number of aphid species attacking tunnel-grown raspberry crops, compared to crops grown in open fields (Birch and Begg, 2010; cited in Birch et al, 2011). Birch et al (2011) point out that 'This indicates that changing climate and crop management are interacting to make some pest problems dramatically more serious than 10 years ago'.

However, polytunnels and greenhouses do provide good conditions for some key predators of aphids such as spiders and hoverflies. Compared to open fields, an increase of 2-6 times of different natural enemy groups has been found on raspberry (Birch et al, 2011). This suggests an opportunity for biocontrol to be used for high-value crops such as soft fruits in polytunnels as part of an Integrated Pest Management (IPM) solution (Birch, 2008; Birch and Begg, 2010; cited in Birch et al, 2011).

'Integrated Pest Management (IPM) is an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops and minimize the use of pesticides' (FAO, 2015).

With wider relevance in the context of climate change, Birch et al (2011) also note that 'These studies also demonstrate how small changes in climatic conditions which are accumulated over an extended growing season can have a large effect on the complex interactions in agricultural food webs and lead to new pest and disease problems'.

What is happening now?

In 2014, 1122 hectares of crops were grown under glass or plastic structures. The vast majority of these crops, 1079 hectares, were cultivated under walk in plastic structures (polytunnels), with 42 hectares being grown under glass-clad structures (Scottish Government, 2013).

As Figure 1 shows, in recent years there has been huge growth in the use of polytunnels, representing a significant change in crop management systems over a very short period of time. Indeed, growing

crops under cover is one of the fastest growing land uses changes to occur in recent years (Squire, 2015).

What has happened in the past?

The area of cultivation under glass or plastic structures has been increasing. It has risen from 80 hectares in 2003 to 1038 hectares in 2013, as shown in Figure 1.

It should be noted that from 2009, the data collection method changed (see Table 2: Indicator data - Uncertainties). It is not known whether this contributed to the apparent increase from 2008 to 2009.

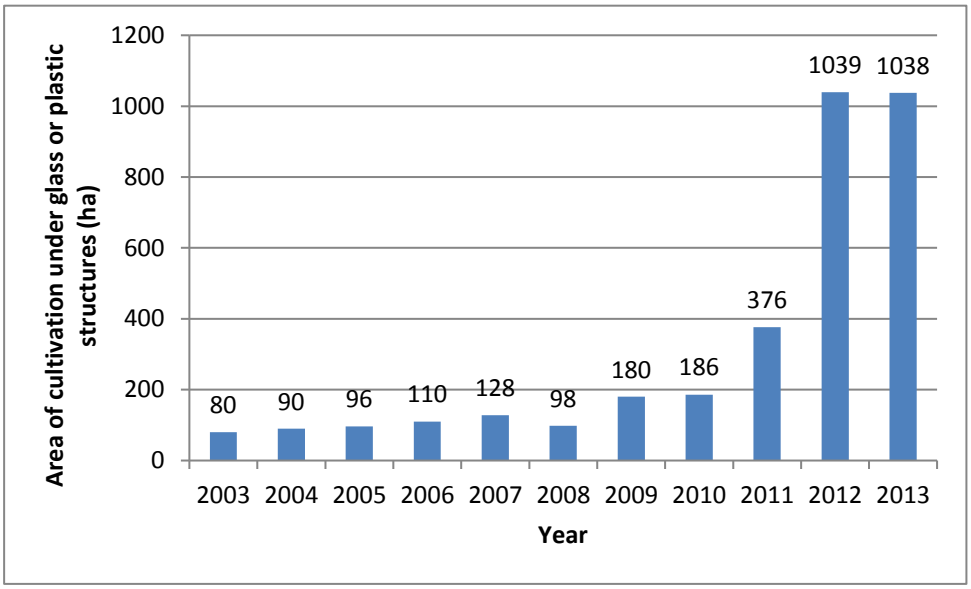

Figure 1: Area of cultivation under glass or plastic structures, 2003 - 2013
Source: June Agricultural Census, 2013.

For a more detailed breakdown of area of cultivation under glass and plastic see www.scotland.gov.uk/Topics/Statistics/Browse/Agriculture-fisheries/PubfinalResultsJuneCensus

What is projected to happen in the future?

The growth in the area of cultivation under glass or plastic structures, especially use of polytunnels, while largely consumer demand driven, can also be interpreted as an adaptive measure to climate change. The structures can protect crops from extreme weather events. However, experience suggests they could potentially be an example of maladaptation, as they create conditions that can exacerbate pest and disease problems. Due to their nature, providing an enclosed space, it is also the case that such issues can be managed more easily. There are also many unknowns regarding their impact on the surrounding environment (the section 'Interpretation of indicator trends' below provides more detail). Additionally, should the area cultivated under glass and plastic continue to increase rapidly, the visual effect on Scotland's rural landscapes may be significant. Therefore, it is important that the extent of structures, together with the efficacy of pest and disease management and impacts on surrounding land, are monitored to ensure they contribute to successful adaptation and not maladaptation.

Patterns of change

In 2014, the majority of cultivation under plastic and glass structures was for strawberries (818 hectares) followed by raspberries (188 hectares). Blueberries (42 hectares), other fruit (27 hectares),

bedding and pot plants (16 hectares), hardy nursery stock (14 hectares), vegetables (11 hectares) and tomatoes (3 hectares) account for the remaining area of cultivation[1]. See Figure 2.

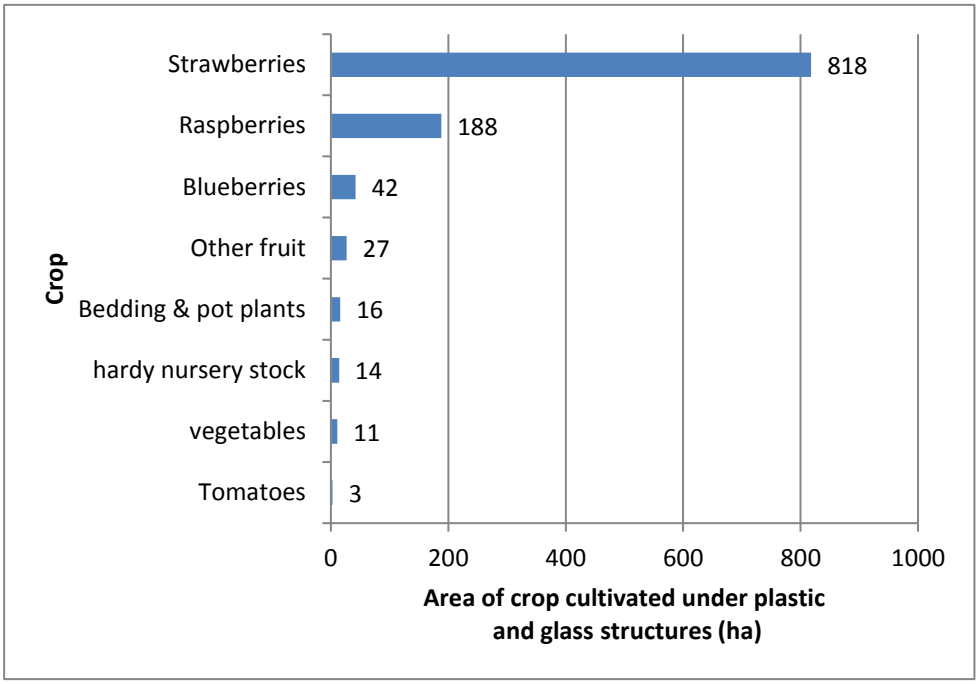

Figure 2: Area of cultivation under glass or plastic structures by crop, 2014. Source, June Agricultural Census, 2014.

Use of polytunnels is concentrated in Tayside (Evans, 2013).

There has also been an increase in plastic or fibre covers that are laid on the soil above germinating crops such as potatoes and vegetables (Squire, 2015). Data regarding the area under such cover is not currently available.

Interpretation of indicator trends

In addition to the pest and disease issue discussed above, there is little known about the likely impact of glass and plastic structures on the surrounding land and the land below them. Given the rapid increase in use of such structures, such effects may influence local resilience and adaptive capacity.

Professor Geoff Squire of the James Hutton Institute identifies the following potential impacts:

- 'the air temperature and the upper soil temperature will both increase, the effect on soil being to dampen the annual fluctuation - the effect of this on soil organisms will not have been looked at
- depending on the management regime inside, the soil under the structures will receive less or no water causing it to dry out, the long term effects of which are uncertain
- precipitation will in effect be increased in the area around the structures, leading to greater deep drainage and runoff, and soil might be saturated or near field capacity for longer, again with unknown effects on soil organisms and functioning

[1] Note: This totals 1119 ha; the overall total is 1122 ha. It is assumed the difference is due to rounding of the source data.

- the effects of the changed soil temperature, soil dryness inside and soil wetness outside on pesticide and fertiliser residues are unknown.
- depending on application 'rates' of fertiliser and pesticide per unit land area (i.e. averaging inside and outside) and the 'cost' of making and erecting the materials, the carbon footprint (GHG equivalents) could increase from the situation of crops grown in the field without cover.

So while the area covered is small overall, the local effects could be substantial' (Squire, 2015).

Limitations

References

Birch, A.N.E., Begg, G.S. & Squire, G.R. (2011) How agro-ecological research helps to address food security issues under new IPM and pesticide reduction policies for global crop production systems. *Journal of Experimental Botany,* **62**, 10, 3251-3261.

Evans, N. (2013) Strawberry Fields Forever? Conflict over neo-productivist Spanish polytunnel technology in British agriculture. *Land Use Policy*, 35, 61-72

Food and Agriculture Organisation of the UN (FAO) (2015) *AGP – Integrated Pest Management* (online). Available from: http://www.fao.org/agriculture/crops/thematic-sitemap/theme/pests/ipm/en/ (Accessed June 2015).

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Scotland's Environment (2014) *Scotland's Climate Trends Handbook*. Sniffer and Met Office (online). Available from: http://www.environment.scotland.gov.uk/climate_trends_handbook/Chapter01/1_07.html (accessed August 2015)

Scottish Government (2013) June Agricultural Census www.scotland.gov.uk/Topics/Statistics/Browse/Agriculture-fisheries/PubfinalResultsJuneCensus

Squire, G. (geoff.squire@hutton.ac.uk), 22 April 2015. *CXC adaptation indicator, cultivation under glass or plastic structures.* E-mail to R. Monfries (r.monfries@rbge.ac.uk)

Further information

June Agricultural Census www.scotland.gov.uk/Topics/Statistics/Browse/Agriculture-fisheries/PubfinalResultsJuneCensus

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Suzanne Martin (RBGE) contributed to this indicator document.

Appendix One: Indicator meta data and methodology

Table 1: Indicator meta data

	Metadata
Title of the indicator	Area of cultivation under glass and plastic structures
Indicator contact: Organisation or individual/s responsible for the indicator	Ruth Monfries , Royal Botanic Garden Edinburgh/CXC
Indicator data source	June Agricultural Census
Data link: URL for retrieving the indicator primary indicator data.	www.scotland.gov.uk/Topics/Statistics/Browse/Agriculture-fisheries/PubfinalResultsJuneCensus

Table 2: Indicator data

	Indicator data
Temporal coverage: Start and end dates, identifying any significant data gaps.	2014 (2003 – 2013)
Frequency of updates: Planned or potential updates	Annual
Spatial coverage: Maximum area for which data is available	Scotland
Uncertainties: Uncertainty issues arising from e.g. data collection, aggregation of data, data gaps	From 2009 data on land use has been obtained from the Single Application Form for holdings claiming Single Farm Payments. This has been combined with land use data from all other holdings collected through the June Agricultural Census, to generate the overall results. This results in a step change in the data series which is evident for some land uses more than others. For the data underpinning this indicator there is an increase in the area of land cultivated under glass and plastic structures between 2008 and 2009 from 98 to 180 hectares. It is not clear if any of this increase can be attributed to the change in method.

Spatial resolution: Scale/unit for which data is collected	Hectares
Categorical resolution: Potential for disaggregation of data into categories	Breakdown of types of cultivation available online.
Data accessibility: Restrictions on usage, relevant terms & conditions	Free and publically accessible.

Table 3 Contributing data sources

Contributing data sources Data sets used to create the indicator data, the organisation responsible for them and any URLs which provide access to the data.
June Agricultural Census. Single Farm Payments. www.scotland.gov.uk/Topics/Statistics/Browse/Agriculture-fisheries/PubfinalResultsJuneCensus

Table 4 Indicator methodology

Indicator methodology The methodology used to create the indicator data
Since 2009 data has been collected from the Single Application Form for holdings claiming Single Farm Payments. This has been combined with data from all other farm holdings gained from the June Agricultural Census. The methodology is described in Section 4.4 of 'Results from June Agricultural Census 2014', available at www.scotland.gov.uk/Topics/Statistics/Browse/Agriculture-fisheries/PubfinalResultsJuneCensus