About Drought

Maximising the impact of UK research on drought & water scarcity

BRIEF

Which farming regions in England and Wales are most at risk of economic losses due to droughts?

Climatic change causes greater unreliability of rainfall in wetter countries like the UK, as well as increased frequency of droughts, leading to higher demand for irrigation to supplement rainfall. The yield and quality of crops, fruit and vegetables can be lowered by short-term drought in the UK summer – this can be avoided by using irrigation to supplement rainfall, enabling farmers to continue to provide supermarket-quality produce.

Researchers from Cranfield University have mapped the irrigation needs and financial benefits associated with irrigation in England and Wales in a dry year.

Main findings

- The net economic benefit of agricultural irrigation in England and Wales in a dry year is around £665 million at farm level.
- Quality of fruit and vegetables grown in a drought year lessens without irrigation, leading to misshapen and scarred produce – a challenge for farmers to meet the high standards set by UK supermarkets.
- The farms at greatest financial risk in a drought year are in Norfolk, Suffolk, Essex and Kent, where high-value crops (soft fruit, potatoes and vegetables) are concentrated.
- Increased water scarcity will lead to changes in agricultural land use as relative crop and farm profitability change within the UK and Europe.

Context

Over the last 30 years the number and intensity of droughts in Europe has increased, and climate change, combined with an increasing population, means this trend is likely to continue.[1,2] Climatic change causes greater unreliability of rainfall in wetter countries like the UK and increased frequency of droughts, leading to higher demand for irrigation to supplement rainfall.

The yield and quality of crops, fruit and vegetables can be lowered by short-term drought in the UK summer – this can be avoided by using irrigation to supplement rainfall, enabling farmers to continue to provide supermarket-quality produce.

Figure 1 Water resources - sustainable catchment management vital for farming, and business and domestic users in the future. Source: José Manuel Suárez [CC BY 2.0], via Wikimedia Commons

Economic benefit of agricultural irrigation

Researchers from Cranfield University have mapped the irrigation needs and financial benefits associated with irrigation in England and Wales in a model dry year. Their study showed the potential losses if farmers were unable to irrigate in England and Wales in a dry year, due to water shortages or restrictions – annual farm losses up to a maximum total of £665 million were estimated. The research demonstrates the large financial impacts of abstraction restrictions in the sector, and will help to improve drought management strategies that balance the needs of different water users (including the environment). Further details of the study can be found in an interactive resource created by the team of researchers.

How crops benefit from irrigation

The study showed that the crops that benefitted most from supplemental irrigation were soft fruits such as strawberries, orchard apples, and high-value crops like potatoes (see Table 1). The extra irrigation maximised monetary gain through a combination of crop-specific increased yields and quality improvements illustrated in Figure 2.

Figure 2 Crop quality and yield benefits attributable to supplemental irrigation[3]

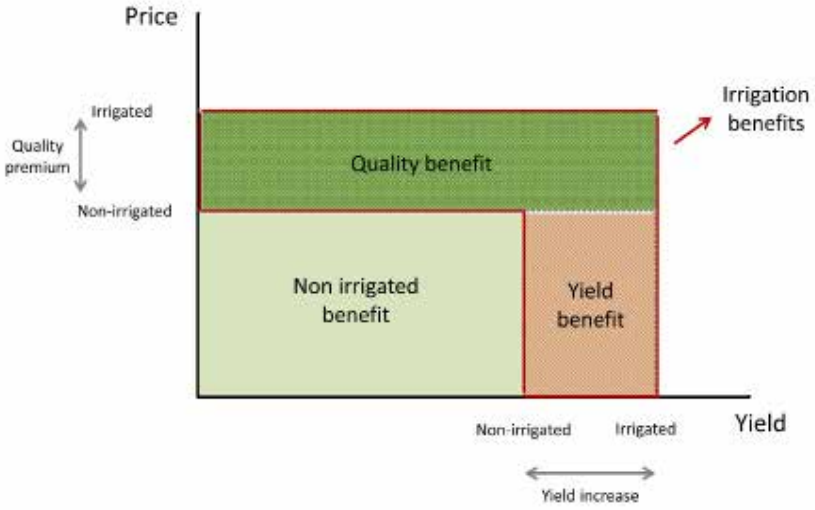

Table 1 Comparison of estimated water productivity of different crops in a dry year (£/m3 of water applied)

Crop Type	£ per m³
Early potatoes	1.94
Main crop potatoes	1.18
Cereals	0.08
Sugar beet	0.22
Vegetable	1.16
Soft fruit	52
Grass	0.11
Top fruit	1.20

Climate change and drought

The same team from Cranfield mapped the risk of economic losses for irrigated crops in England and Wales arising from drought management decisions and more uncertain climate change conditions. This study used rainfall and river flow as triggers to impose water abstraction restrictions on irrigation abstraction from rivers during drought events. This data was analysed with an estimation of losses per crop to produce monetary losses by river catchment. This research shows the impact of three uneven climatic periods: past (1975-2004), near future (2020-2049) and far future (2070-2099) – using a hydro-meteorological dataset from the MaRIUS project (Managing the Risks, Impacts and Uncertainties of Droughts and water Scarcity).

It shows that the impact of drought varies greatly across different river catchments in England and Wales, as well as across time, with the highest risks of economic losses occurring in highly irrigated areas with high value crops. Overall, it indicates that under future climatic conditions, there will be a higher likelihood of more severe and longer periods of water restrictions with associated larger economic impacts.

Figure 3 River in low flow. Source: Hugh Venables [CC BY 2.0], via Wikimedia Commons

Rainfall, irrigation and farming in the UK

- In 2006 UK drought restrictions were imposed on 600 spray-licensed irrigators.
- In 2012, 300 irrigators were affected by restrictions.
- In 2012 the UK experienced the driest spring in over a century.
- Nationally, the majority (80%) of irrigation demand is concentrated in central and eastern England, notably in the Environment Agency (EA) Anglian and EA Midlands regions.
- Predicting where the biggest losses occur from droughts is important when deciding where to prioritise mitigation strategies and water restrictions to maximise benefit whilst minimising economic loss.

Mapping irrigation in England and Wales

Irrigated cropping is most common (Figure 4b) in areas with the driest soil (Figure 4a) i.e. eastern and southern England, notably Norfolk, Suffolk, Essex and Kent. There is also a large amount of potato and vegetable production in East Anglia and fruit production in Kent, high value crops which have high volume water requirements. The location of irrigated cropping in these areas matches an Environment Agency Map (Figure 4c)[4] showing over-licensed, and hence over-abstracted, areas with too much water being removed which negatively impacts the local aquatic environment. This illustrates the high potential for monetary loss in these areas when irrigation bans are imposed on farmers.

(a) Agroclimate (Maximum potential soil deficit ($PMSD_{max}$) (mm)) in 2010

(b) Irrigated cropping by grid cell (2kmx2km) in 2010

(c) Water resource availability (EA, 2008)

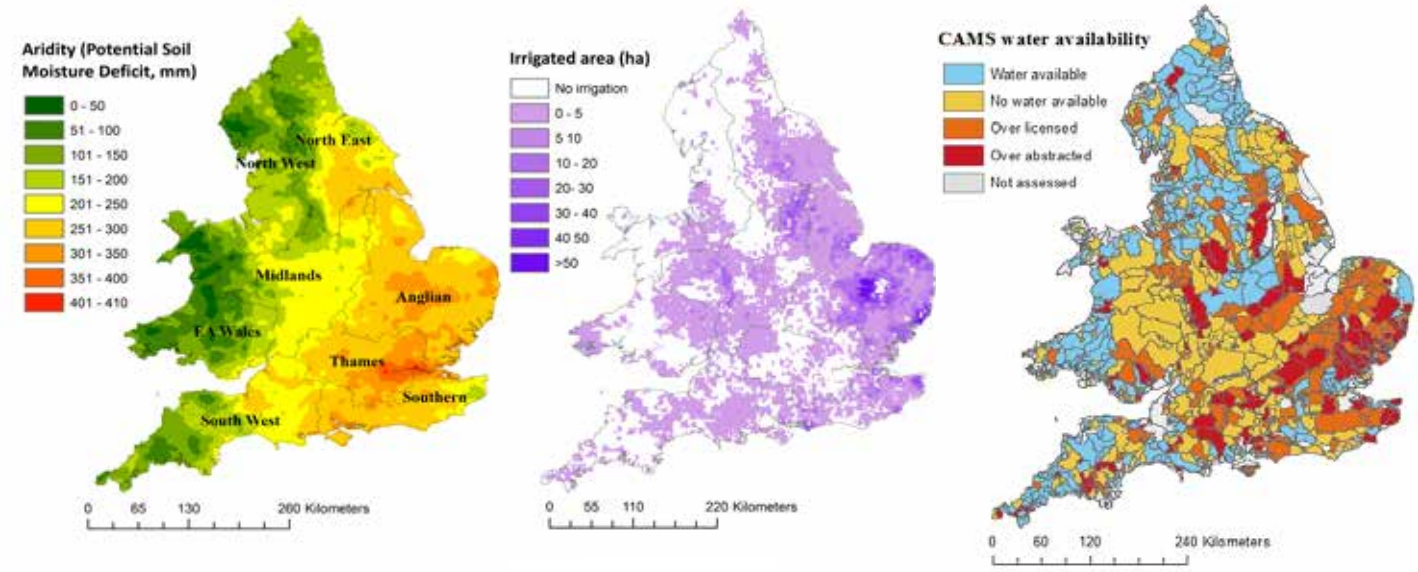

Figure 4. (a) Soil aridity (PMSDmax) (mm): (b) Irrigated cropping (ha): (c) EA water resource availability for England and Wales by EA region[4]. Source: Rey et al. (2016)

The mapping shows that the highest risk and the greatest losses are likely in the Anglian River basin district, followed by the Thames, Severn, and Humber River basin districts.

Financial Losses

These two studies show the extent of monetary losses that English and Welsh farmers could face under current and future dry conditions due to lower rainfall and continuing application of today's drought management rules during droughts. Together, these studies should enable better planning for priority areas, that is expected to help minimise the economic impact on farms.

Figure 5. Evelyn Simak / Potato harvest - the trailer is almost full [CC BY-SA 2.0], via Wikimedia Commons

Future pressures on water availability for agriculture

- **2018 UK licensing changes for water abstraction – less headroom[5] (difference between water available for use and demand).**
- Climate change – increasing occurrence of droughts.
- Population growth (predicted 8 billion people by 2030)[6] – increased consumer demand for food and water.

DEFRA introduced water abstraction regulatory reform on 1st January 2018. As part of this change many farming industry operations that were previously exempt from requiring a licence will now need one. The licence includes restrictions on when water can be abstracted – limiting abstraction when an agreed minimum flow occurs – so it may increase the number of farmers who suffer financial losses during a drought. The Cranfield researchers expect the new licensing system coupled with future water pressures, could lead to greater financial losses than the ones shown in this research.

UK's 2012 drought – examples of good practice

Supermarkets

The UK 2012 drought led to a crop of blemished and smaller British fruit and vegetables – but Sainsbury's supermarket decided to relax their cosmetic quality standards and accept the uglier produce to help British farmers[7] minimise financial losses. This was an informal arrangement organised ad hoc; however a similarly formalised approach – enabling flexibility in cosmetic appearance of produce with changing weather conditions – may be welcomed by UK food producers.

Some progress has been made in this area with some supermarkets rolling out wonky vegetable lines for some produce in 2016. Could this be more widely applied when there is drought to ease the financial pressure on producers?[8]

Supermarkets co operating to develop shared sustainability good practice within what is allowed by competition regulators, could be a way to take this forward.[9] This has potential to lead to less food wastage generally, as well as less pressure on water abstraction in times of drought.

Water abstraction groups

The Lark Valley Group of 80 farmers sought to voluntarily reduce their water abstraction by 20% to avoid an irrigation ban. They started discussions with the Environment Agency in January 2012 and adopted voluntary water saving measures – planting parsnips earlier and reducing onion crop by 40% – requiring less water over the 2012 growing season.[10,11]

The Lark Valley Group is an example of farmers forming a water abstraction group and working closely with the regulator to pre-empt potential water scarcity problems and prevent a total ban on abstraction being imposed. Future water management can be informed by looking at historical successes and applying similar solutions such as creating water abstraction groups.

Tool to help farmers with future water management decisions

D-Risk is a free decision support tool developed by Cranfield researchers to help irrigated farming enterprises rapidly understand their drought and abstraction risks, supporting robust decisions regarding future irrigation investment and management.

"Managing risk is a major part of business strategy and D-Risk will be a very useful tool in enabling us to do that."

Tim Jolly, Farm Owner and Chairman of the UK Irrigation Association, January 2018

Figure 6. Uglier Produce, now accepted by some supermarket ranges. By Dllu (Own work) [CC BY-SA 4.0], via Wikimedia Commons

Rethinking drought and water management in the future

The findings of these studies can be used to inform drought management within the farming industry – especially in areas with high potential risk during a drought, providing a firm evidence base for future drought mitigation strategies. Some options for drought mitigation strategies could be: forming water abstraction groups to share knowledge, making use of EA water trading being trialled in several catchments in 2018,[12] as well as choosing to invest in storage reservoirs and precision irrigation on farms. In addition, regulators could consider this information when considering changes to drought management planning and the licensing system, with consideration to minimising economic losses to farmers, whilst also minimising environmental impacts.

Figure 6 Farm reservoir for irrigation. Source: Harold Toze [CC BY-SA 2.0], via Wikimedia Commons

Using this research, it has become possible for regulators, farmers and supermarkets to have a more informed conversation about preparing for a drier future, while at the same time meeting consumer demands for crop quality. Farm-to-catchment scale mitigation strategies may help to reveal alternative approaches, lessening the risks to farmers associated with total bans of supplemental irrigation in water-scarce areas. The importance of adopting a vertically integrated approach such as this in the farming sector, coupled with a better understanding of past drought impacts is crucial for improving decision-making during future drought events.[11]

These studies highlight the importance – and societal benefits – of irrigation, even in a wet climate, and the risks that future droughts and water scarcity might have for agricultural systems, livelihoods and the rural economy.

Economics losses due to droughts

Main Source:

Rey, D., Holman, I., Daccache, A., Morris, J., Weatherhead, E. and Knox, J. (2016). Modelling and mapping the economic value of supplemental irrigation in a humid climate. Agricultural Water Management, 173, pp.13-22.

Salmoral, G. et al. 2018. Risk of economic impacts to agricultural irrigation due to drought management. [Unpublished manuscript].

References:

1. European Commission, 2007. Mediterranean water scarcity and drought report, Technical report on water scarcity and drought management in the Mediterranean and the Water Framework Directive, Technical Report
2. IPCC, 2014. Climate Change 2014. Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, UK: Cambridge University Press, Final Draft.
3. Redrawn from Rey, D., Holman, I., Daccache, A., Morris, J., Weatherhead, E. and Knox, J. (2016). Modelling and mapping the economic value of supplemental irrigation in a humid climate. Agricultural Water Management, 173, pp.13-22.
4. EA (2008). Water resources in England and Wales – current state and future pressures. Report GEHO1208BPAS-E-E
5. Gov.uk. (2014, updated 2018). Water management: abstract or impound water - GOV.UK. [online] Available at: https://www.gov.uk/guidance/water-management-abstract-or-impound-water [Accessed 28 Mar. 2018].
6. House of Commons Environmental Audit Committee (2012). Sustainable Food. Eleventh Report of Session 2010–12. Volume I: Report, together with formal minutes, oral and written evidence. London: House of Commons.
7. Vidal, J. (2018). 'Ugly' fruit and veg make the grade on UK supermarket shelves. [online] the Guardian. Available at: https://www.theguardian.com/environment/2012/sep/27/ugly-fruit-vegetables-supermarkets-harvest [Accessed 28 Mar. 2018].
8. Morrisons adds new varieties to wonky fruit and veg range. [online] Available at: https://www.thegrocer.co.uk/home/topics/waste-not-want-not/morrisons-adds-new-varieties-to-wonky-fruit-and-veg-range/547330.article [Accessed 28 Mar. 2018].
9. House of Commons Environmental Audit Committee (2012). Sustainable Food. Eleventh Report of Session 2010–12. Volume I: Report, together with formal minutes, oral and written evidence. London: House of Commons.
10. BBC News. (2018). Farmers try to cope with drought. [online] Available at: http://www.bbc.co.uk/news/uk-england-17623607 [Accessed 28 Mar. 2018].
11. Rey, D., Holman, I. and Knox, J. (2017). Developing drought resilience in irrigated agriculture in the face of increasing water scarcity. Regional Environmental Change, 17(5), pp.1527-1540.
12. Hill, C. (2018). East Suffolk will be a pilot area for Defra water abstraction plan. Eastern Daily Press. [online] Available at: http://www.edp24.co.uk/business/farming/east-suffolk-will-be-a-pilot-area-for-defra-water-abstraction-plan-1-5340198 [Accessed 29 May 2018].

Interested? Want to know more? Please contact the researchers:
Dolores Rey (d.reyvicario@cranfield.ac.uk)
Gloria Salmoral (Gloria.Salmoral@cranfield.ac.uk)
Ian Holman (i.holman@cranfield.ac.uk)
Jerry Knox (j.knox@cranfield.ac.uk)

Maximising the impact of UK research in drought and water scarcity

About this Brief

This Brief is part of a series aiming to support improved decision-making in relation to droughts and water scarcity by providing research that identifies, predicts and responds to the interrelationships between their multiple drivers and impacts.

About Drought communicates about the UK Droughts & Water Scarcity research programme, a five-year, interdisciplinary, £12 million+ NERC programme in collaboration with ESRC, EPSRC, BBSRC and AHRC. It is supporting improved decision-making in relation to droughts and water scarcity by providing research that identifies, predicts and responds to the interrelationships between their multiple drivers and impacts.

The series of About Drought Briefs, as well as the latest news, events and tools and techniques can be found at http://aboutdrought.info
Contact: info@aboutdrought.info

About Drought is supported by

NERC SCIENCE OF THE ENVIRONMENT