



# Historic droughts in the UK: What can we learn to improve agricultural drought management in the future?

Dolores Rey, Ian Holman, Jerry Knox

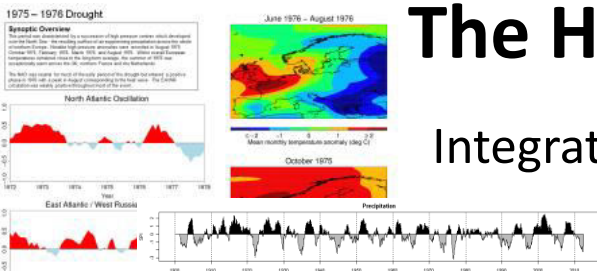
**May 2017– WWC (Cancun)**

# The Historic Droughts Inventory

Integrating timelines and narratives of drought from a range of sectors



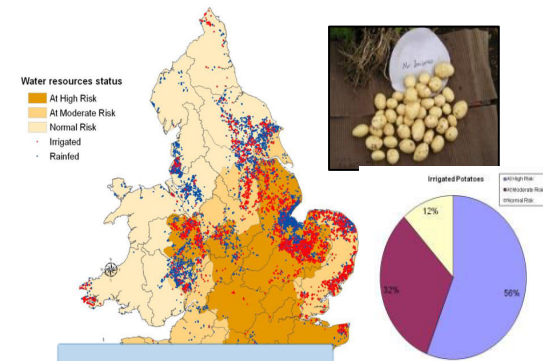
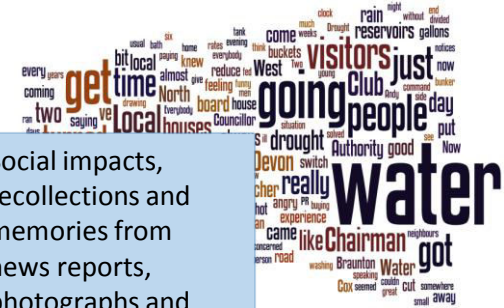
Narrative of public supply development, including reservoir development in response to droughts



Hydro-meteorological drought series, extended back to the 1880s and beyond with newly digitised Met Office rainfall, and model reconstructions of streamflow and groundwater.

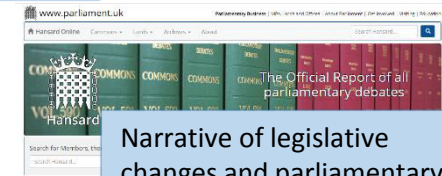
**Reported drought impacts in 19<sup>th</sup> C, 20<sup>th</sup> C, and contemporary newspapers, as well farming media**

Social impacts, recollections and memories from news reports, photographs and ~100 oral histories

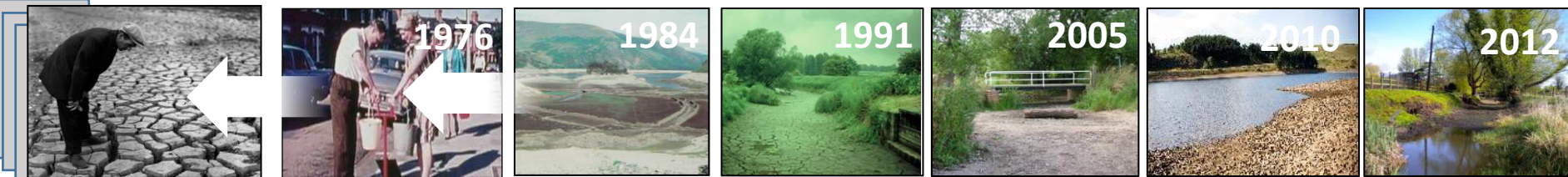


Agricultural impacts, including yields, production and income

To create a common knowledge-base of UK droughts  
Spatially located, and linked to specific drought events  
Extended back into the 19<sup>th</sup> Century



Narrative of legislative changes and parliamentary debates in response to drought events



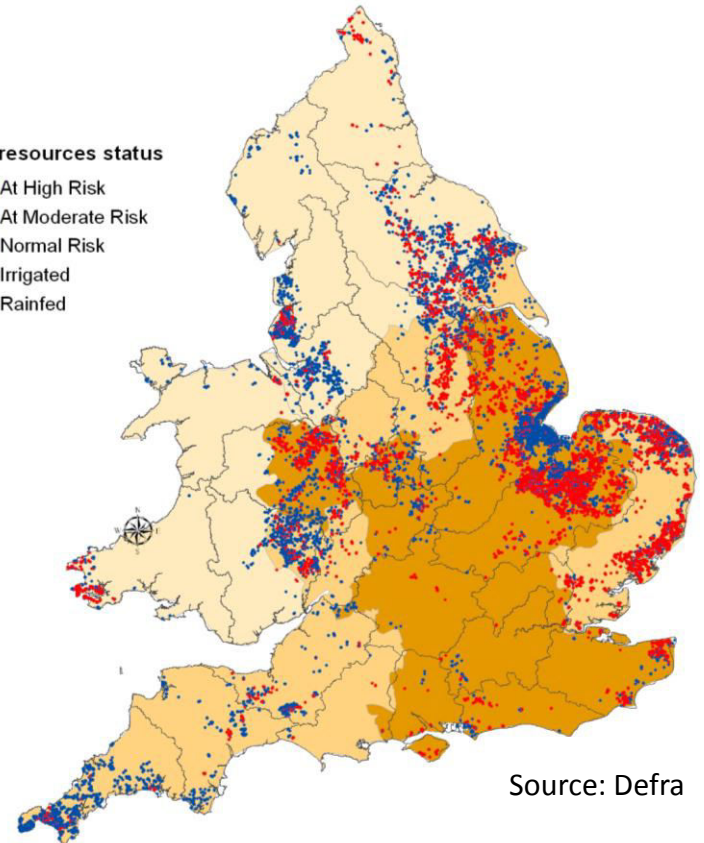


# Droughts and water scarcity - Agriculture

- Different impacts/responses on rainfed, irrigated and livestock
- Irrigation is mainly supplemental, high year- to – year variability
- Financial benefits from irrigation > £650 million in England and Wales
- Climate change will increase water availability risks

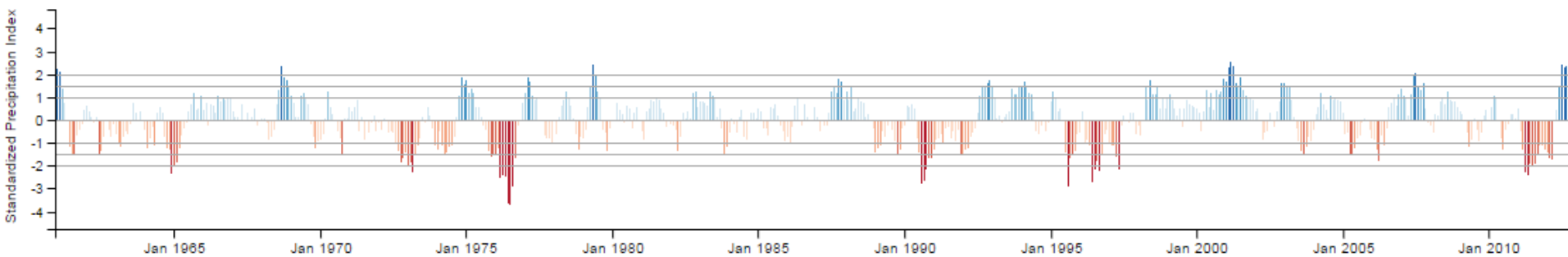
Water resources status

- At High Risk
- At Moderate Risk
- Normal Risk
- Irrigated
- Rainfed



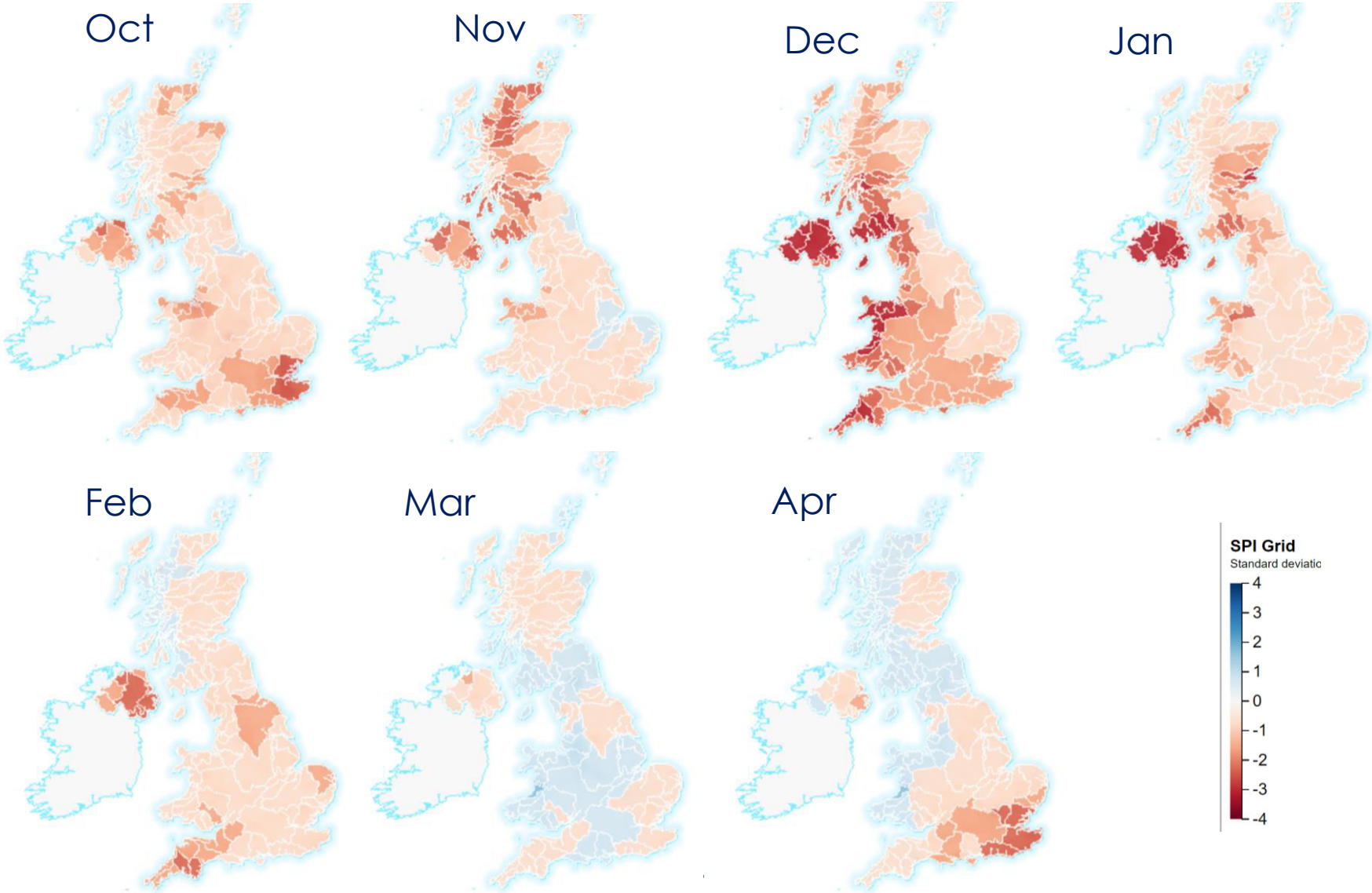
Source: Defra

Source: CEH





# Next drought coming?



# Drought could slash crop yields by up to 50%

Saturday 29 April 2017 6:15

Joe Burn

Some farmers are being forced to irrigate crops as the dry spell continues, with concerns that up to 50% of crop yields may be lost in wheat if the drought is prolonged.

The average rainfall in England is down to 7.6mm this April, compared with 66.8mm last April, with farmers across the country enduring the driest April to March period since 1995.

See also: [12 tweets showing how crops are coping in dry conditions](#)

Scotland has had 40.2mm of rain this month, compared with 13.6mm this month, compared with

## Growing concern

Andrew Blenkiron, who farms on light soils, says concerns are growing for unirrigated crops.

"We have 1,400 acres of irrigated crops and two reservoirs," he says.

However, Mr Blenkiron's farm has seen that unirrigated crops will face a 20% per cent yield loss.

"We are back to where we were in 2012. We took 30% out of our cereal crop yield last year because of the drought.

Mr Blenkiron has noticed that several crops are being affected.



Last edited on: 10:05:2017

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## Dry weather: NFU in close contact with Environment Agency



After one of the driest winters in 20 years, more than four-fifths of the country's rivers have low levels and there are growing concerns about the potential impact of dry weather on the environment.

**NFU Vice President Guy Smith said:** "The situation is patchy with farmers, particularly in the south, reporting as low as 10% of their expected March and April rainfall. While decent rains in many crops back on track, some crops like spring barley have clearly already lost their first harvest and growers are looking at the 'changeable' forecast for the end of this week hoping it will be a relief."

"We are growing increasingly concerned about the fruit and vegetable sector, but reserves of water sources are still available, albeit at lower than normal levels. Water transfer operations in the Stour Marsh and Romney catchment area in Kent started six weeks earlier than usual, so there is a demand for water from soft fruit growers."

"The livestock sector has also been hit with the dry weather leading to a shortage of grass, which will be an impact on silage crops."

"One of the best ways farmers can manage risk of prolonged, dry spells is installing on-farm reservoirs. Since the dry weather we experienced in the 1990s, the NFU government will help farmers with a future reservoir building programme through tax relief policies."

"While there are currently no environmental or water supply issues, the NFU is working closely with the Environment Agency, public water supply companies, Defra and The Met Office to assess the impact of dry weather continues."

# Recent articles in the media

## Food bills set to soar as drought threatens to wipe out UK crops: Farmers warn lack of rain is hitting barley, wheat and sugar beet

- Farmers have warned that bone-dry conditions are wiping out crops which could hit shoppers with high bills
- Following the driest winter in 20 years, a water drought could cause food supermarket bills to soar in the UK
- The dry weather has also led to a shortage of grass, which is affecting beef production, the NFU said

By COLIN FERNANDEZ ENVIRONMENT CORRESPONDENT FOR THE DAILY MAIL

PUBLISHED: 01:44, 9 May 2017 | UPDATED: 20:47, 11 May 2017

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**266**  
View comments

Bone-dry conditions are wiping out crops which could hit shoppers with higher food prices, farmers have warned.

In the latest stark warning, farmers have said that spring crops of barley, wheat and sugar beet are all suffering damage from a lack of water.

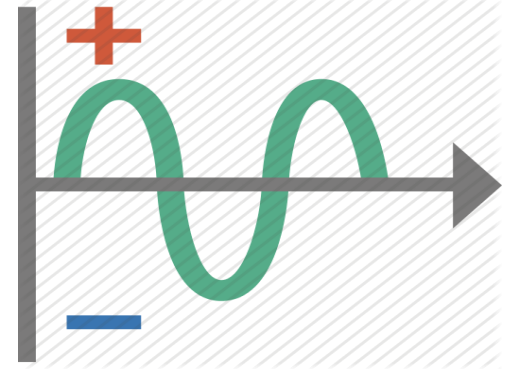
If the dry conditions continue over the coming month, shoppers could be facing higher food bills, according to the National Farmers Union.





# Where is the data coming from?

- Time series from official sources
- Farmers Weekly (1975-2012)
- Online survey UK Irrigators Association
- Semi-structured interviews with growers and regulator



Library Drought concern remains

## NEWS DROUGHT

### Drought concern remains despite heavy rain

By Johann Tasker

Recent rainfall has improved river flows in East Anglia, but the drought remains cause for concern.

Farm leaders met Environment Agency officials for talks at NFU regional headquarters in Newmarket on Monday (23 April).

River flows in Norfolk and Suffolk have improved, but recent rain will make little difference to groundwater and spray irrigation.

The worst is likely yet to come for many eastern region farmers – despite a voluntary 20% cut to their irrigation licences in the hope of staving off an outright ban.

Cambridgeshire grower Andrew Nottage, of Russell Smith Farms, near Duxford, said: “We’ve missed most of the rain here in south Cambridgeshire.”

The River Cam continued to have one of the lowest flows, said Mr Nottage. But the main irrigation period was yet to come.

“We did some early irrigation on onions about three weeks ago and we haven’t had to irrigate again. But we’ll start thinking about it again in three weeks or so.”

The respite from the exceptionally dry conditions of March has seen between 15-50mm of rain fall in a fortnight, bringing immediate relief to water-stressed wheat.

This time last year some growers were irrigating cereals. This year the tramlines in fields are waterlogged. The wet spell has been very welcome and timely for kick-starting most of the rain here in south East Anglian pig producers take denied suggest three independent UK agronomists.

Lincolnshire agronomist Sean Sparing said the main difference over the past six weeks is that the drought is now history. “Despite a hosepipe ban, we’re likely to have some serious rain over the next three weeks.”

“The significance of this for me is that yellow rust is no longer the main target; my main concern has now shifted to septoria.”

“We have to go back four or five years since the last serious septoria pressure hit our wheat crops and I think a lot of people have forgotten how destructive it can be.”

The wetter weather came as BPEX published advice to help East Anglian pig producers take steps to save water and money.

BPEX environment project manager Anna Davis said: “Both drought and flooding can cause water shortage and lead to higher costs for the water used.”

“There are plenty of things producers can do to limit the impact on their businesses. First steps include checking for leaks, pipe-work maintenance and checking pig drinkers are correctly positioned to limit waste.”

“Some producers may also want to look at longer-term solutions such as rainwater harvesting. All pigs must by law have ready access to good-quality, clean water.”

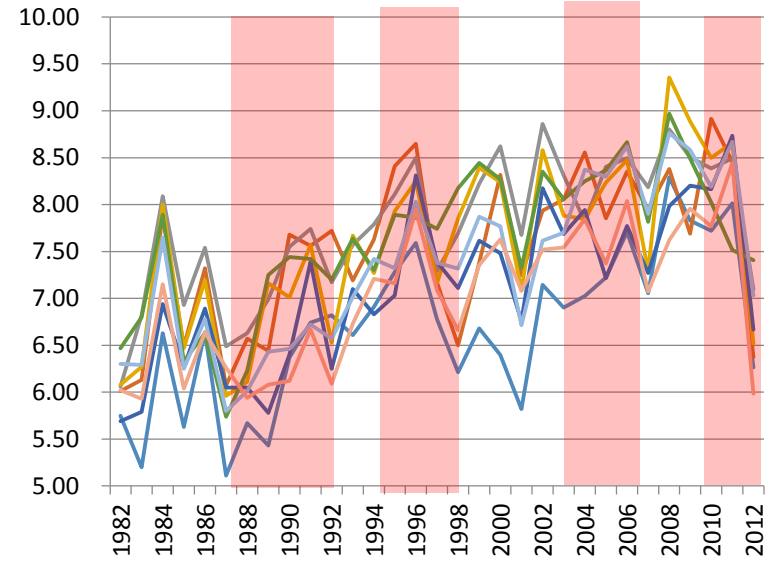
Recent rain will make little difference to groundwater levels.





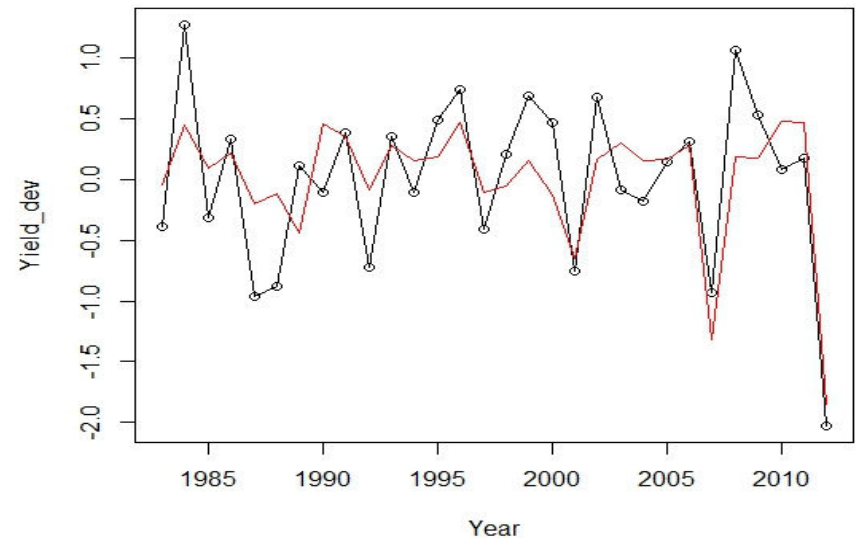
# Yield – drought severity

Correlation coefficients for wheat yield and DSI in East Midlands



	SPI		SPEI		PSMDmax
	3	6	3	6	
Jan	-0.03	0.03	0.01	0.00	0.13
Feb	0.11	0.13	0.12	0.18	
Mar	0.17	0.01	0.14	0.01	
Apr	-0.24	-0.13	-0.25	-0.17	0.11
May	-0.26	-0.11	-0.28	-0.17	
Jun	-0.51	-0.39	-0.50	-0.43	
July	-0.56	-0.60	-0.55	-0.63	0.35
Aug	-0.47	-0.49	-0.52	-0.65	
Sep	-0.20	-0.45	-0.21	-0.49	
Oct	0.04	-0.38	0.02	-0.43	0.07
Nov	0.16	-0.28	0.12	-0.32	
Dec	0.10	-0.06	0.08	-0.09	

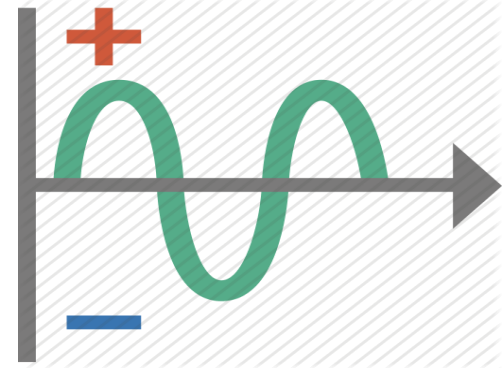
fitted vs observed





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## Farmers weekly (1975-2012)

*UK rainfall in March was only 60% of normal, with the south and East Anglia getting less than half their average*

*Drought has hit grass growth so severely in the south and west of England that farmers are being forced to strip- or zero-graze their green cereal crops to keep their stock fed*

*Milk output in England and Wales fell further last month forcing cuts in cheese production*

*Soil moisture deficits around the country continue to remain high at about twice the level expected at this time of the year...*

*In 2010 we had our worst yield of 2.5t/ha, after very poor establishment.*

*We used just £300 of diesel for drying - we usually spend £2500*

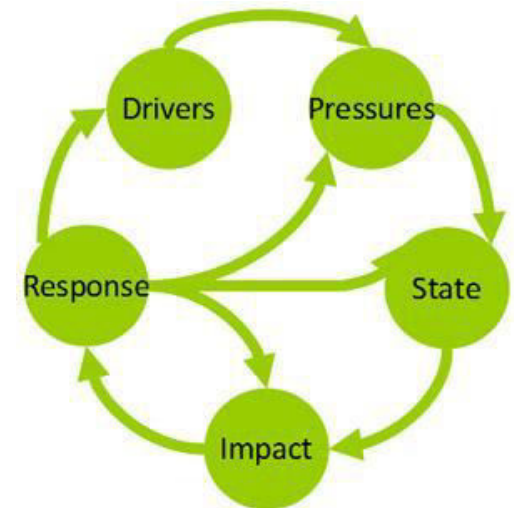
**> 2500 entries**



# How to categorize the information in a meaningful way?

## DPSIR framework

- Drivers, Pressures, State, Impact, Response
- Useful in describing the relationships between the origins and consequences of environmental problems
- To assist decision-makers in many steps of the decision process (system-oriented decision making)
- DRI framework (Lange et al., 2016)





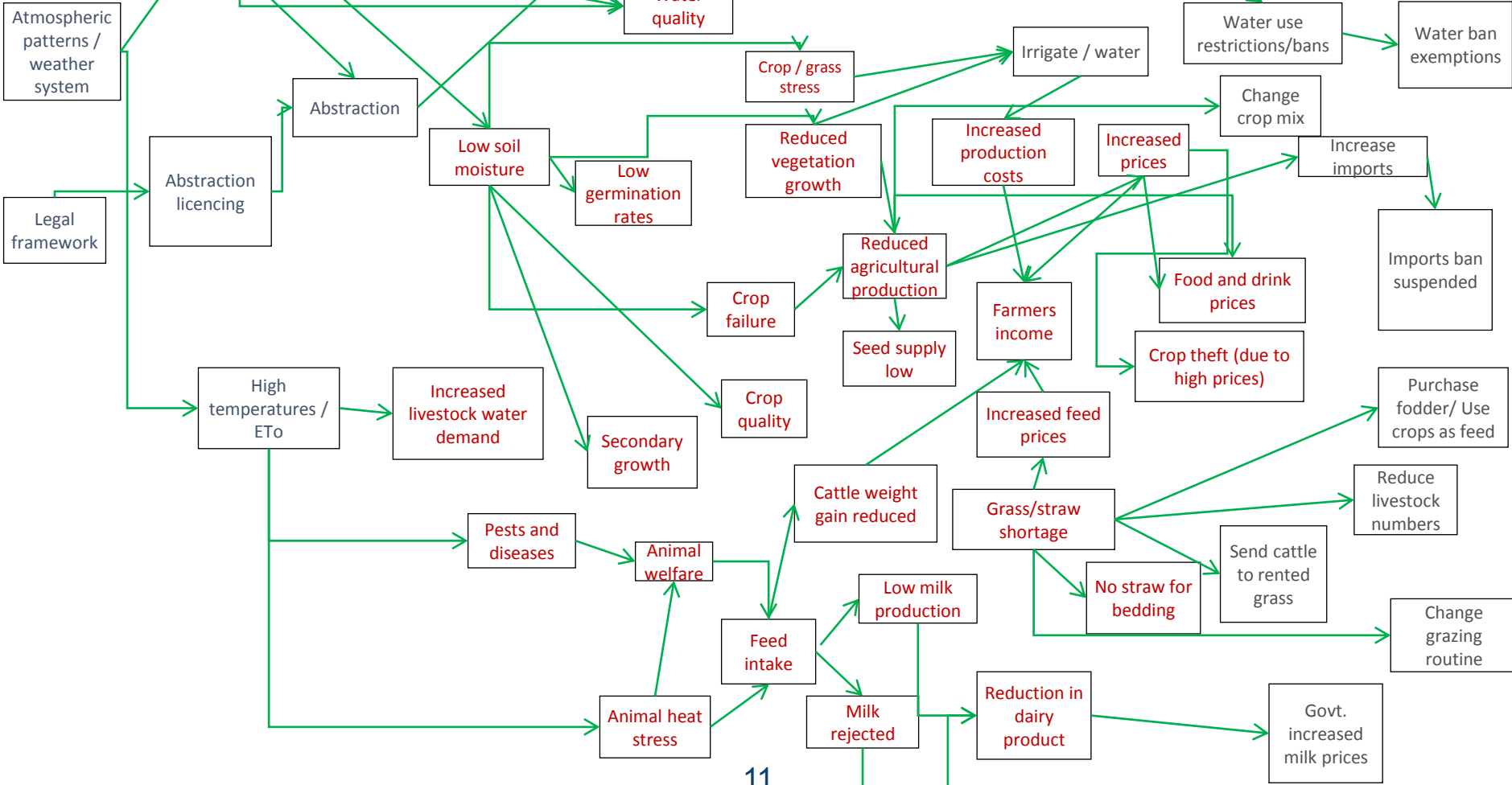
# [Pressure]

# [State]

# Impact

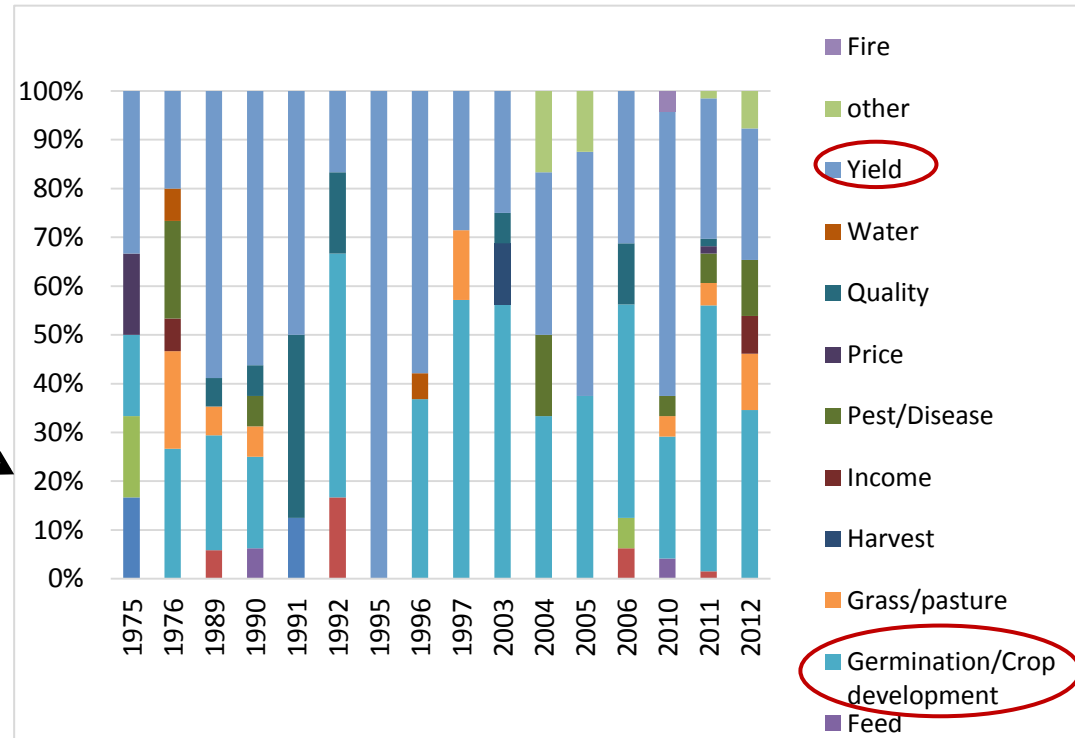
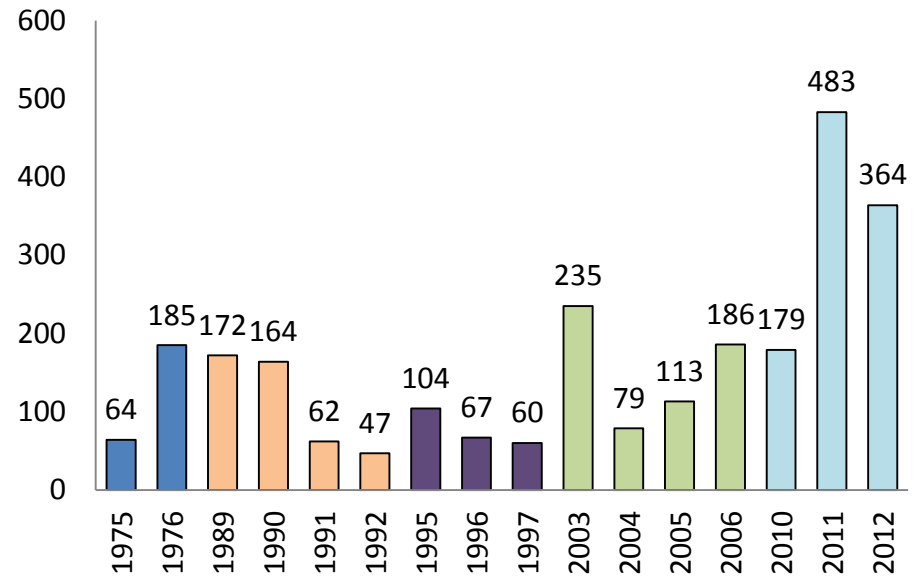
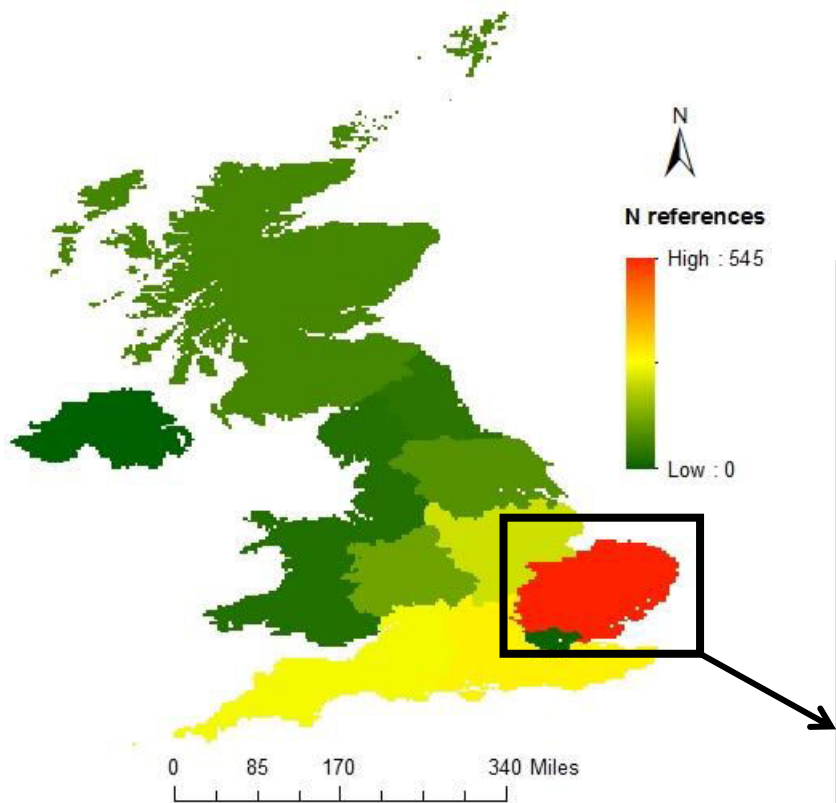
# Response

## Driver





# Data overview





# Drought severity - impacts correlation

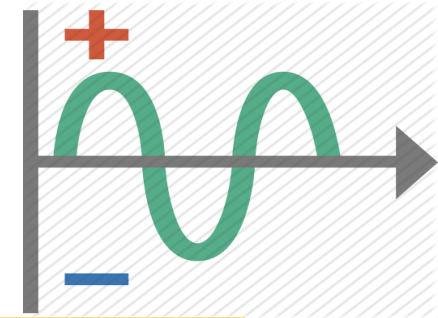


	SPI						SPEI						
	SPI_1	SPI_3	SPI_6	SPI_12	SPI_18	SPI_24	SPEI_1	SPEI_3	SPEI_6	SPEI_12	SPEI_18	SPEI_24	
UKM	0.10	0.02	-0.04	0.03	0.05	0.11	0.08	-0.03	-0.06	0.01	0.06	0.12	North
UKC	-0.03	-0.17	-0.17	-0.10	-0.12	-0.09	-0.06	-0.21	-0.18	-0.11	-0.11	-0.09	↓ South
UKD	-0.05	-0.08	-0.11	-0.03	0.00	0.05	-0.06	-0.11	-0.12	-0.06	-0.02	0.03	
UKE	-0.10	-0.22	-0.23	-0.11	-0.13	-0.07	-0.14	-0.25	-0.23	-0.11	-0.12	-0.07	
UKF	-0.04	-0.13	-0.12	-0.04	-0.03	0.00	-0.11	-0.18	-0.16	-0.08	-0.07	-0.03	
UKG	-0.21	-0.27	-0.32	-0.20	-0.20	-0.15	-0.20	-0.25	-0.25	-0.19	-0.19	-0.13	
UKL	-0.03	-0.13	-0.23	-0.08	-0.09	-0.06	0.01	-0.13	-0.19	-0.08	-0.09	-0.05	
UKH	-0.14	-0.29	-0.38	-0.19	-0.23	-0.15	-0.20	-0.30	-0.35	-0.20	-0.23	-0.18	
UKI	0.07	0.09	0.06	0.00	-0.02	-0.10	0.08	0.09	0.02	-0.01	-0.02	-0.07	
UKJ	-0.09	-0.24	-0.21	-0.07	-0.11	-0.09	-0.14	-0.25	-0.21	-0.11	-0.13	-0.11	
UKK	-0.02	-0.19	-0.26	-0.10	-0.15	-0.10	-0.06	-0.22	-0.26	-0.14	-0.18	-0.12	



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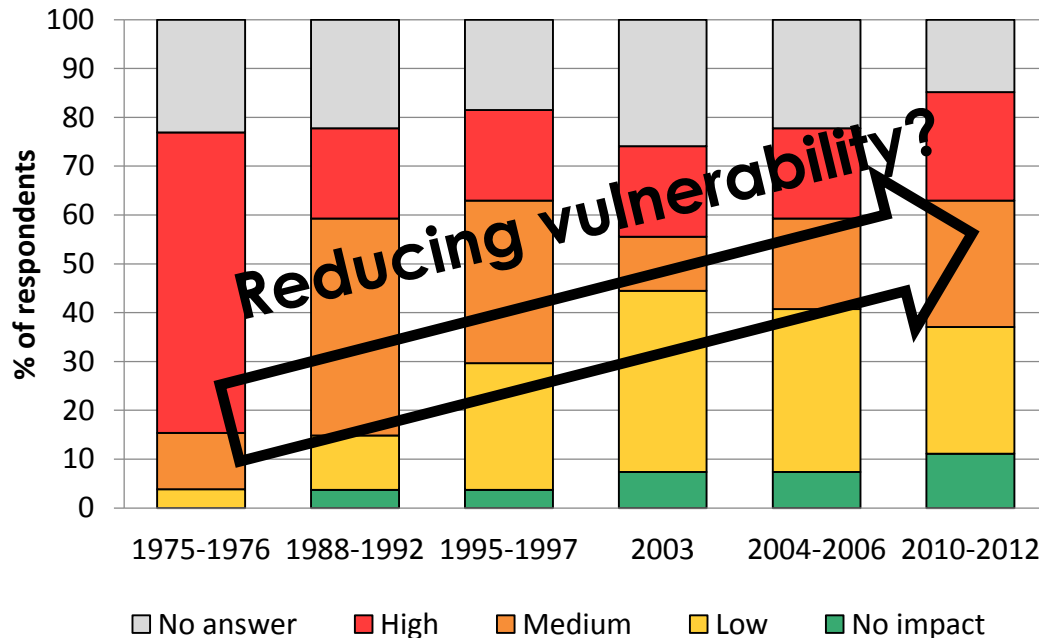
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**Recent rain will make little difference to groundwater levels.**




# Impacts of past droughts



## 1975-76

- Irrigation was not such a big thing
- The limiting thing was the machines we had to apply water
- We were not organized
- Market has changed a lot since then

## 2010-12

- We were able to manage the situation
- Sufficient warning, more information from EA

### Farm businesses:

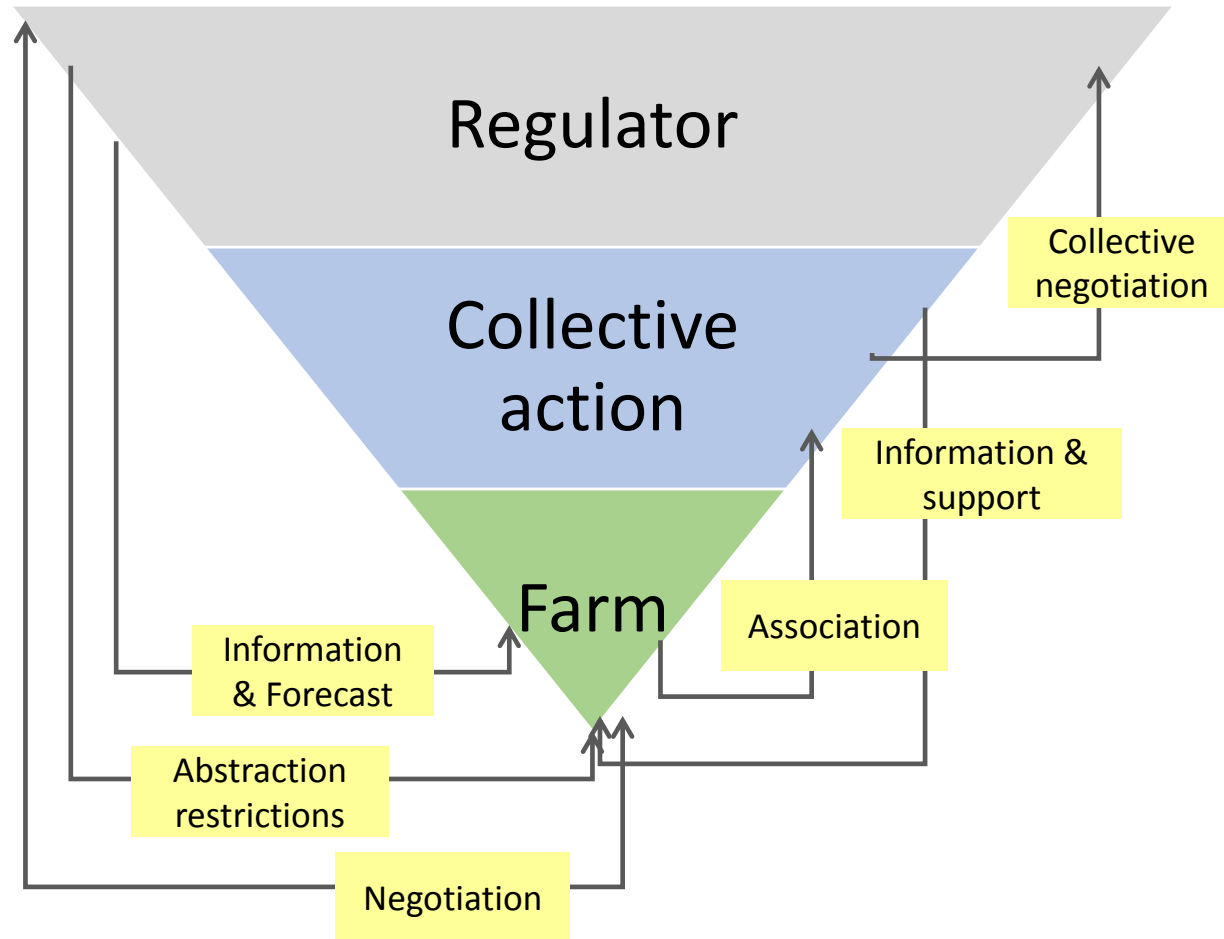
- Investment
- Organised
- Pro-active – voluntary restrictions

### Environment Agency:

- Pro-active – more information;
- Working with abstractors to minimise impacts



# The importance of vertically integrated drought management

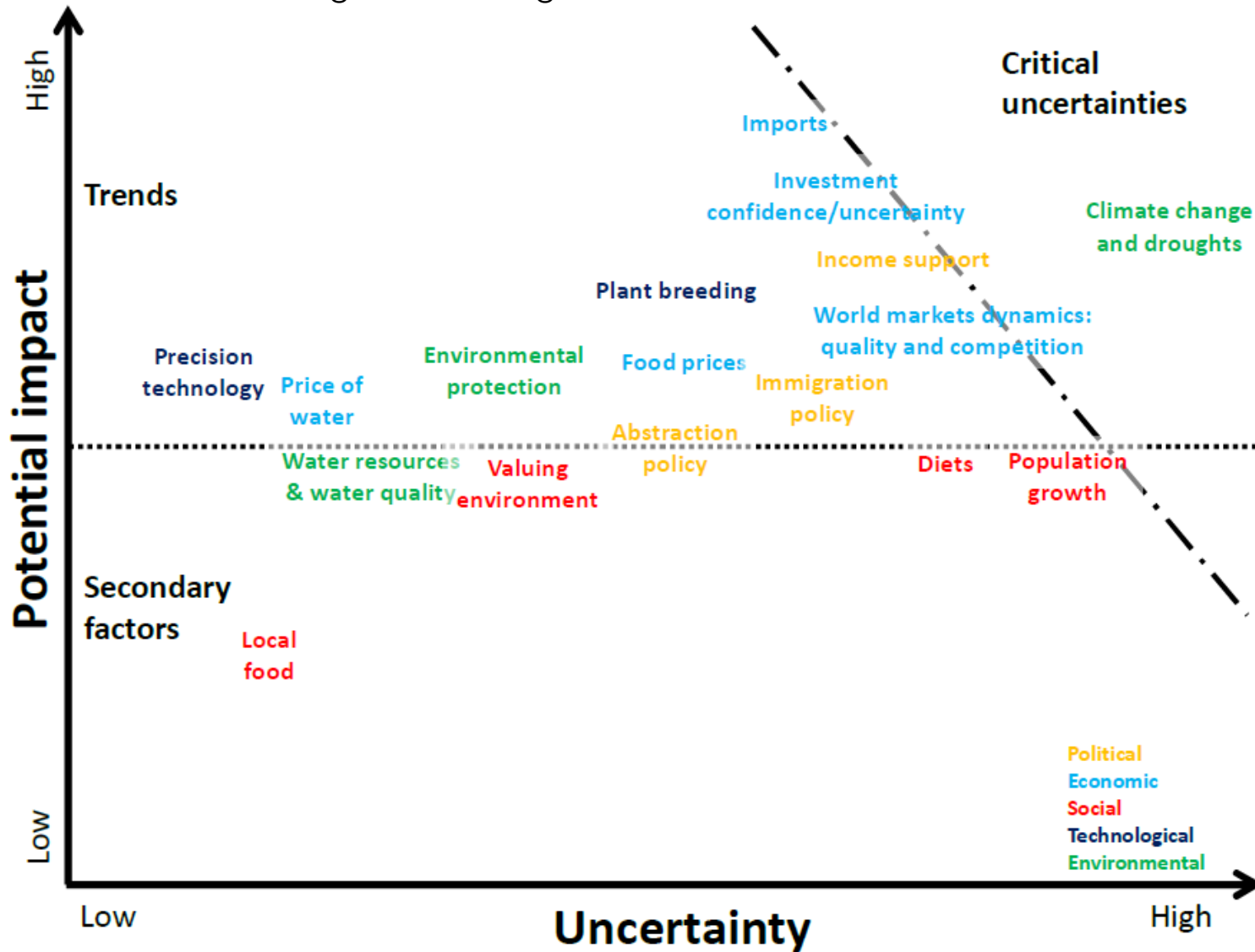






# What are the challenges of the future?

Drivers affecting the main irrigation sub-sectors in the UK





## Key messages

- Learning from the **past** can improve decision making in the **future**
- Useful **dataset** for researchers, practitioners, policy makers and the wider public
- Raise **awareness** of drought risk and its impacts
- Different regions and agricultural sectors have different “best” **indicators and thresholds**
- Identify meaningful indicators for **monitoring and early warning**



# Thank you!

[d.reyvicario@cranfield.ac.uk](mailto:d.reyvicario@cranfield.ac.uk)