Adaptation of European dairy farms to climate change: a case study approach

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Dairy systems adaptions to current climate

- Intensive cattle (dairy) systems
  - Grassland-based in regions with year-round grass growth (suitable rain and temperatures around the year)
  - Mixed systems (grass in rotation with fodder crops) in regions with large seasonal cycles causing need for fodder storage or with suitability for growing high-productivity feed crops

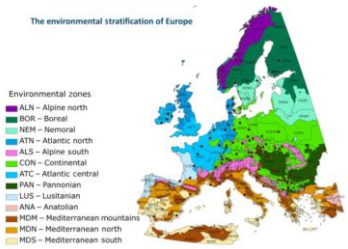


Climate change effects to consider

- Increasing atmospheric CO_2 concentration
- Increasing temperatures
- Changes in rainfall
- Changes in extreme events
  - Heat waves
  - Droughts
  - Floods
  - Hail
  - Storms

Projected change in indicators of agriculture in Europe by 2050

Environmental Zone	Effective global radiation change (%)			Effective growing days change (days)			Huglin index change (%)			Date of the last frost change (days)			Proportion of dry days in AMJ change (%)			Proportion of dry days in JJA change (%)			Proportion of sowing days – early spring change (%)			Proportion of sowing days – fall change (%)		
	E	H	N	E	H	N	E	H	N	E	H	N	E	H	N	E	H	N	E	H	N	E	H	N
ALN	4	8	11	31	29	47	23	29	35	−8	−10	−14	1	1	2	−2	−2	−2	11	11	11	2	3	5
BOR	7	8	10	23	16	33	22	42	27	−6	−11	−7	−2	−1	1	−7	2	−7	7	9	9	6	9	10
NEM	6	8	7	22	12	36	23	40	24	−6	−10	−7	1	1	1	3	11	−2	10	9	12	8	8	11
ATN	0	−1	5	14	5	31	19	28	21	−9	−11	−14	−4	−4	−6	15	21	6	6	6	8	5	6	5
ALS	−1	−1	4	4	0	14	22	30	19	−11	−15	−11	−2	−2	−2	16	18	5	7	8	5	7	6	8
CON	−6	−6	1	−2	−6	10	20	29	19	−8	−12	−10	−2	−2	−4	16	20	8	7	7	6	7	7	9
ATC	−3	−6	1	1	−9	11	19	28	18	−11	−15	−15	−5	−4	−8	15	24	8	4	4	4	4	3	5
PAN	−23	−19	−14	−24	−19	−14	19	28	18	−9	−11	−8	4	5	−1	26	25	18	5	5	4	1	4	6
LUS	−19	−17	−6	−40	−39	−15	22	29	18	−11	−11	−11	10	14	8	38	39	18	4	5	3	2	0	3
MDM	−18	−14	−6	−20	−15	−6	22	27	18	−4	−5	−4	12	10	5	22	21	11	5	5	2	3	3	3
MDN	−15	−11	−6	−16	−11	−4	16	21	14	−27	−28	−27	15	13	5	13	11	5	2	2	0	−1	1	2
MDS	−23	−23	−12	−22	−20	−10	15	21	14	−15	−18	−17	14	13	9	1	1	1	−8	−6	−4	−8	−6	0



EEA, 2012

Impacts of Climate Change on dairy farms

- Direct – animal performance
  - Heat stress / Cold stress
  - Land accessibility
  - Water availability
  - Diseases

Impacts of Climate Change on dairy farms

- Indirect effects
  - Forage and crop production and quality
    - Thermal growing season
    - Drought
    - Heat stress
    - Waterlogging
    - Diseases

Dairy systems

Location	Climate	Description
Ireland	Maritime	Grass-based system + concentrates – spring calving – milk yield 5000 kg/yr
The Netherlands	Maritime	Grass-based with maize silage & concentrates – milk yield 8100 kg /yr
Italy	Mediterranean	Grass-based system + concentrates – milk yield 5500 kg/yr
France	Continental	Grass-based with maize silage & concentrates – milk yield 8100 kg /yr

Research questions & methodology

- Impacts & adaptations will be
  - affected by climate change experienced
  - Vary with dairy system
- Identify the most important adaptations measures for each of the representative case studies dairy system
- Experts identified
  - Impacts
  - Adaptations
  - Benefits / disbenefits with mitigation measures

Summary of all measures

Adaptation Measure	Irish	Dutch	Italian	French
Fertilisation rate	X	X	X	X
Use of mixtures of plant species	X	X	X	X
switching crops		X	X	X
novel crops		X	X	X
forage legumes	X	X	X	X
grain legumes		X		
Irrigation	X		X	X
improve field drainage	X		X	X
Water management	X	X	X	X
Conservation of feed as buffer	X	X	X	X
Supplemental feeding - purchased	X	X	X	X
Cooling of animals			X	X
Animal breeding (breeds with higher tolerance to climate)	X		X	X
Length of the housing period		X		X
Integrate livestock and crop production		X		X
Shifts in livestock systems		X	X	

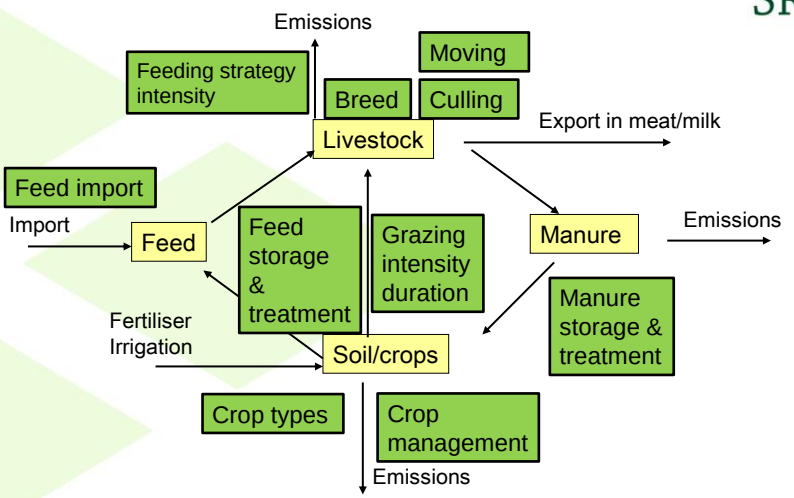
Top four measures

Adaptation Measure	Irish	Dutch	Italian	French
Fertilisation rate	x	x		
Use of mixtures of plant species			x	
novel crops				x
Irrigation			x	
Water management	x	x		x
Conservation of feed as buffer			x	x
Supplemental feeding - purchased	x	x	x	
Cooling of animals		x		x
Animal breeding (breeds with higher tolerance to climate)	x			

Reason for choice

Adaptation Measure	
Fertilisation rate	Extended growing season – increase rate
Use of mixtures of plant species	Greater drought tolerance / deep rooted
novel crops	Less severe winters give opportunities to use cover crops
Irrigation	Summer:Reduced rainfall and higher evapotranspiration
Water management	Storage of water for irrigation – due to higher temp drainage due to increased rainfall (Dutch)
Conservation of feed as buffer	Variability in feed supply
Supplemental feeding - purchased	Variability in feed supply
Cooling of animals	Maintain animal performance
Animal breeding (breeds with higher tolerance to climate)	Durability and robustness in terms of health

Adaptation options at farm level?



Ireland - Trade-offs with mitigation measures

Mitigation Measures	Adaptation Measures			
	Water management	Fertilisation rate	Animal breeding	Supplemental feeding
Genetic improvement in dairy cattle	No Effect	-/+	++	No Effect
Change the grazing management	+	-/+	-/+	-/+
Improving pastures	+	+	++	+
Grass-legume swards	+	--	No Effect	-/+
Fertilisation rate	No Effect	--	-/+	-

Note ++ is highly positive, + is positive, - is negative and – is highly negative, boxes coloured green are associated with low uncertainty, yellow is medium uncertainty and red is high uncertainty

Italy - Trade-offs with mitigation measures

Mitigation Measures	Adaptation Measures			
	Feed storage	Irrigation	Use of mixture of plant species	Supplemental feeding
Biogas	No effect	No effect	No effect	No effect
Feeding nitrate	No effect	No effect	No effect	No effect
Acidified slurry	No effect	No effect	No effect	No effect
Irrigation	+	++	++	+
Nitrification inhibitors	No effect	+	+/0	+

Note ++ is highly positive, + is positive, - is negative and – is highly negative, boxes coloured green are associated with low uncertainty, yellow is medium uncertainty and red is high uncertainty

Summary

- Northern Europe
  - concern over extreme events
  - Benefits from extended growing season
- Southern Europe
  - Risk of droughts
  - Increases in temperature reducing production
- Synergies and trade-offs with mitigation measures
  - Increasing fertiliser applications (Ireland and The Netherlands)
    - Increased GHG emissions
- Impacts and adaptations measures differ across Europe

Conclusions

- Adaptations of the dairy sector is required to remain productive and profitable
- Varies across Europe
  - Climate change
  - Impacts
  - adaptations strategies
  - Mitigation strategies
  - Trade-offs / synergies between adaptation and mitigation

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