Season and temperature humidity index related changes of productive and health parameters in dairy cows and pigs

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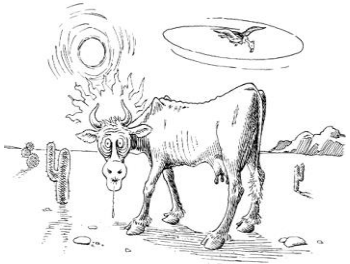
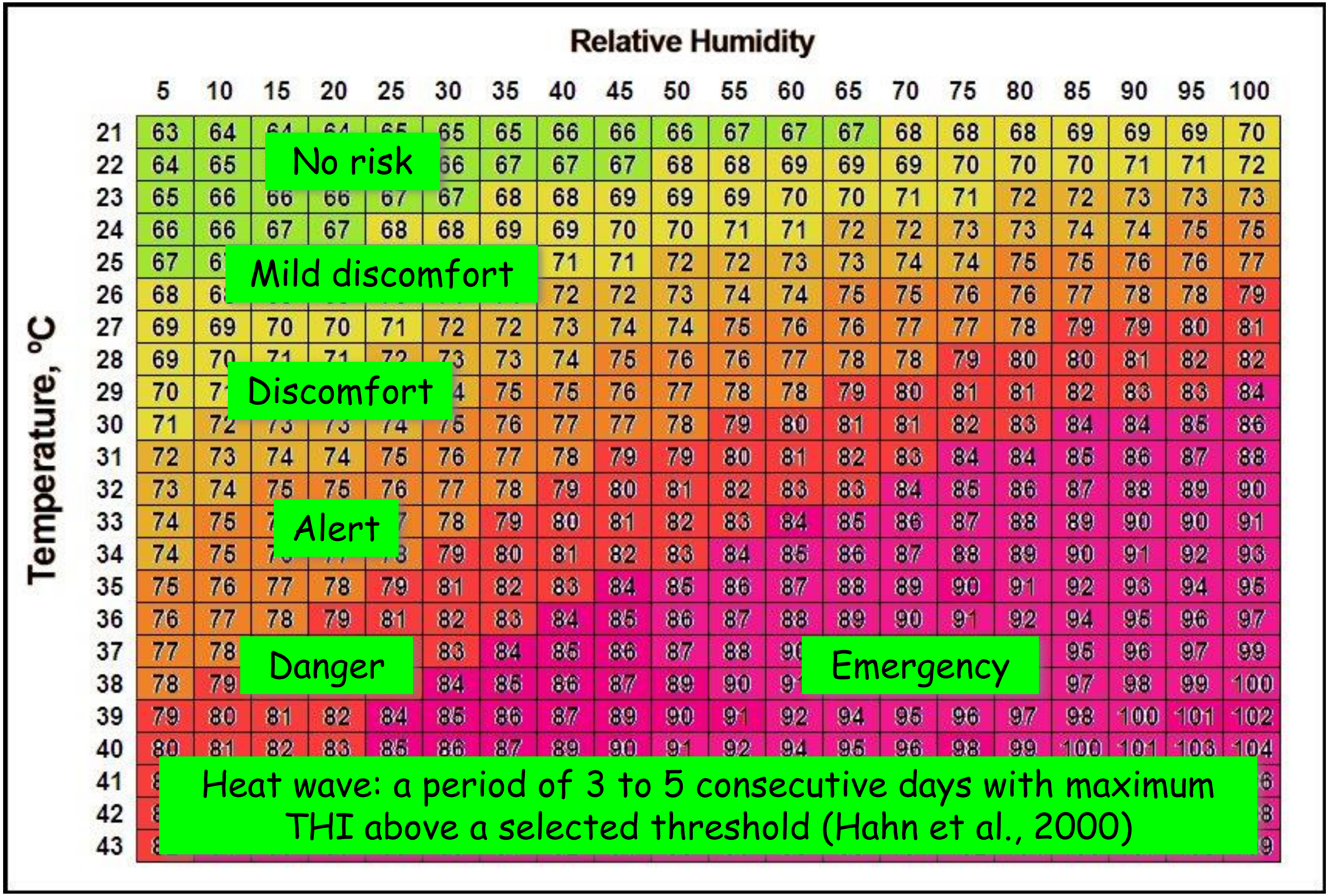
Aim

Describe the activities carried out within MACSUR by the LiveM-Task L1.2.* group.

***** Task description: This task was aimed at building and exploring a multi-year national and transnational datasets to measure the impact of air temperature and relative humidity on productive, reproductive and health performances in **intensively** and **extensively**–managed dairy cows, and to establish relationships between temperature humidity index (THI) and dairy cow performances.



Temperature Humidity Index (THI)



	Relative Humidity																			
Temperature, °C	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
21	63	64	64	64	65	65	65	66	66	66	67	67	67	68	68	68	69	69	69	70
22	64	65	[illegible]	[illegible]	[illegible]	66	67	67	67	68	68	69	69	69	70	70	70	71	71	72
23	65	66	66	66	67	67	68	68	69	69	69	70	70	71	71	72	72	73	73	73
24	66	66	67	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75
25	67	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	71	71	72	72	73	73	74	74	75	75	76	76	77
26	68	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	72	72	73	74	74	75	75	76	76	77	78	78	79
27	69	69	70	70	71	72	72	73	74	74	75	76	76	77	77	78	79	79	80	81
28	69	70	71	71	72	73	73	74	75	76	76	77	78	78	79	80	80	81	82	82
29	70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	75	75	76	77	78	78	79	80	81	81	82	83	83	84
30	71	72	73	73	74	75	76	77	77	78	79	80	81	81	82	83	84	84	85	86
31	72	73	74	74	75	76	77	78	79	79	80	81	82	83	84	84	85	86	87	88
32	73	74	75	75	76	77	78	79	80	81	82	83	83	84	85	86	87	88	89	90
33	74	75	[illegible]	[illegible]	[illegible]	78	79	80	81	82	83	84	85	86	87	88	89	90	90	91
34	74	75	[illegible]	[illegible]	[illegible]	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93
35	75	76	77	78	79	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
36	76	77	78	79	81	82	83	84	85	86	87	88	89	90	91	92	94	95	96	97
37	77	78	[illegible]	[illegible]	[illegible]	83	84	85	86	87	88	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	95	96	97	99
38	78	79	[illegible]	[illegible]	[illegible]	84	85	86	87	89	90	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	97	98	99	100
39	79	80	81	82	84	85	86	87	89	90	91	92	94	95	96	97	98	100	101	102
40	80	81	82	83	85	86	87	89	90	91	92	94	95	96	98	99	100	101	103	104
41	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
43	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

No risk

Mild discomfort

Discomfort

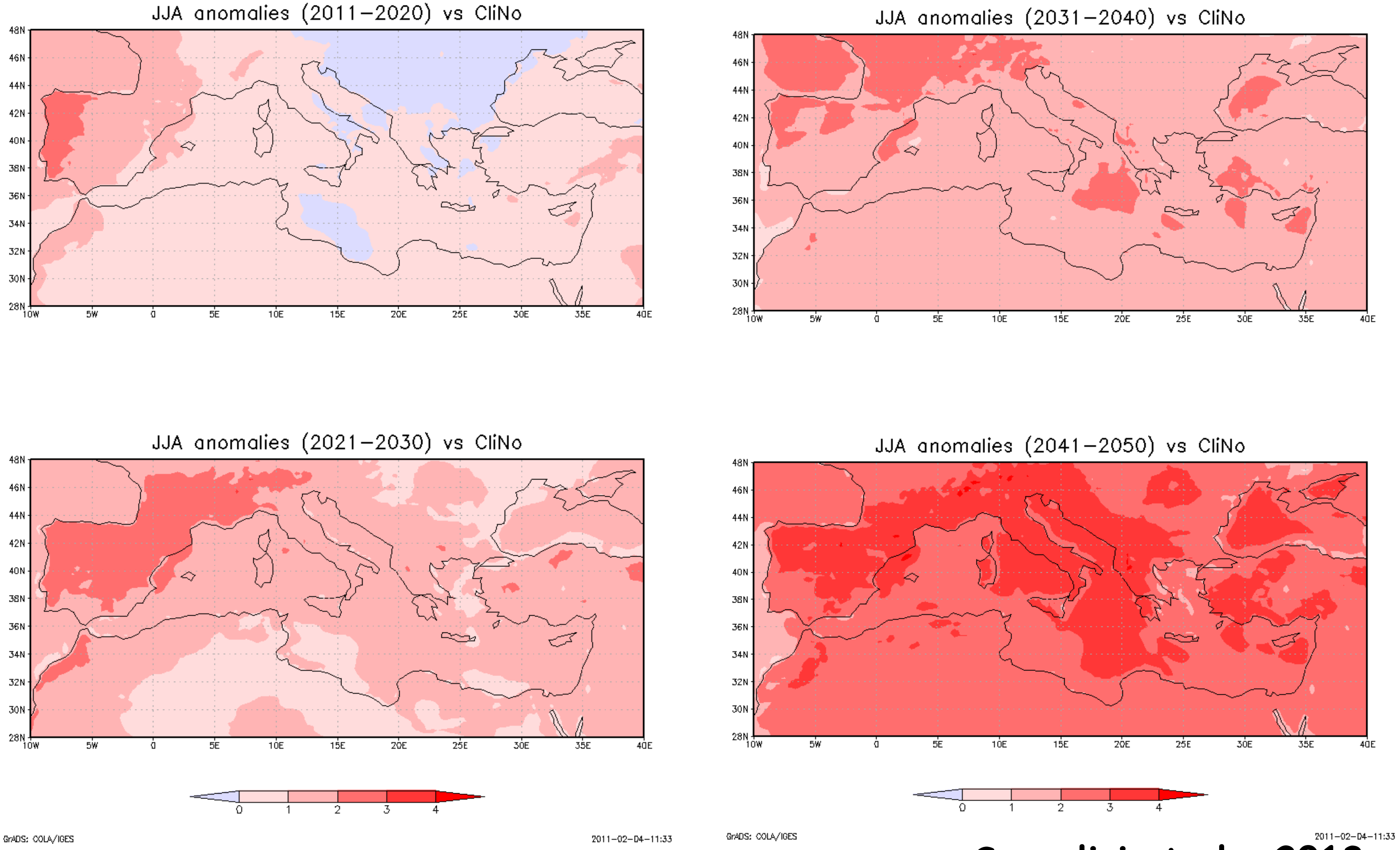
Alert

Danger

Emergency

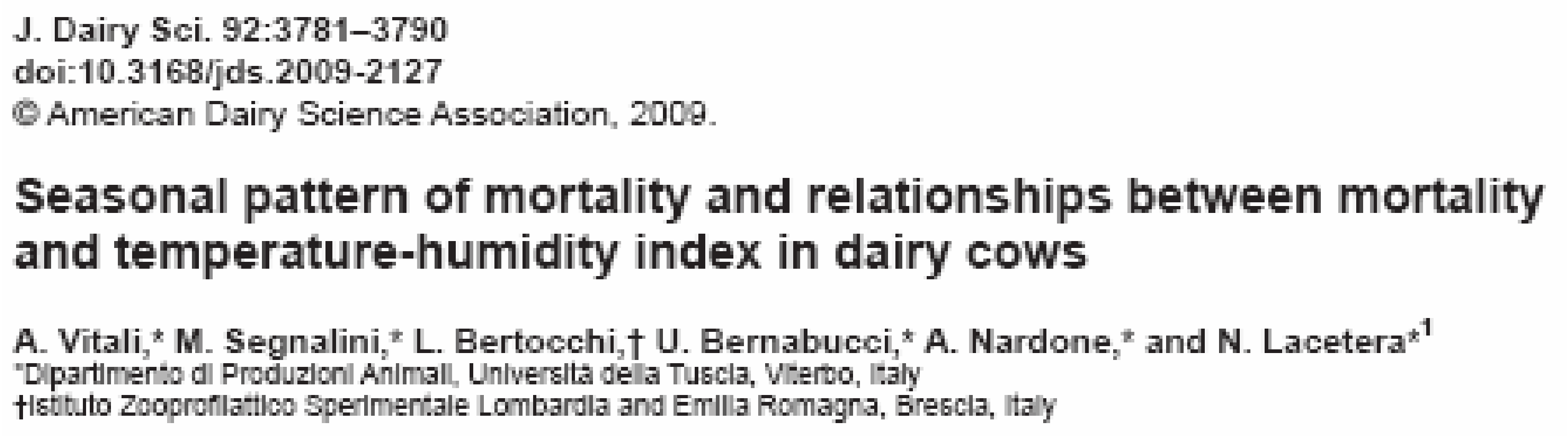
Heat wave: a period of 3 to 5 consecutive days with maximum THI above a selected threshold (Hahn et al., 2000)

Distribution of Mediterranean summer THI anomalies versus CliNo (climate normal, 1971–2000 period) for the four decades 2011–2020, 2021–2030, 2031–2040 and 2041–2050



Segnalini et al., 2013

Dataset cows mortality # 1



J. Dairy Sci. 92:3781–3790
doi:10.3168/jds.2009-2127

Seasonal pattern of mortality and relationships between mortality and temperature-humidity index in dairy cows

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†Istituto Zooprofilattico Sperimentale Lombardia and Emilia Romagna, Brescia, Italy

Dataset cows mortality # 2

The impact of heat waves on dairy cow mortality

A. Vitali, A. Felici, S. Esposito, U. Bernabucci, L. Bertocchi, C. Maresca, A. Nardone, N. Lacetera

Journal of Dairy Science (in press)

Definition of heat wave
(Perkins and Alexander, 2013)

*Three or more consecutive days when the daily maximum temperature exceeds at least the 90th percentile of the reference distribution**

Descriptive statistics

• Study period (years)	2002-2007
• Months/year (summer)	May-Sept.
• Geographic area	12 provinces*
• Deaths/all causes (dairy cows older than 24 mo)	46,582
• Average number of cows	896,959
• Weather stations, n 12	(1/province)

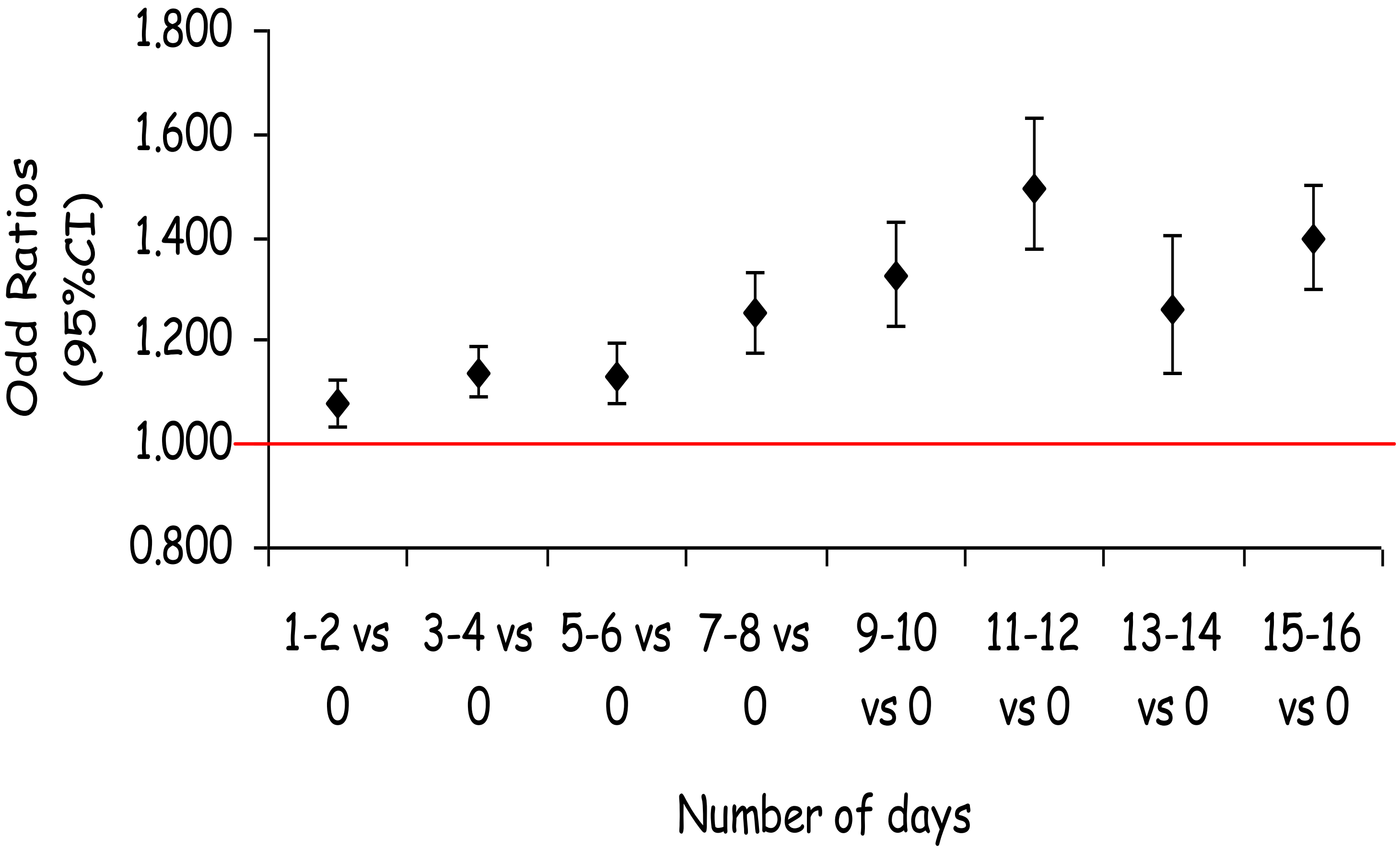
**The 12 provinces were selected on the basis of completeness of weather data and numerousness of dairy cows.*


Image Landsat
© 2014 Google
US Dept of State Geographer
Map Data © 2014 AND
Google earth
Data di acquisizione delle immagini: 4/10/2013 Lat 41.518160° Lon 13.114340° elev 223 m alt 1355.56 km

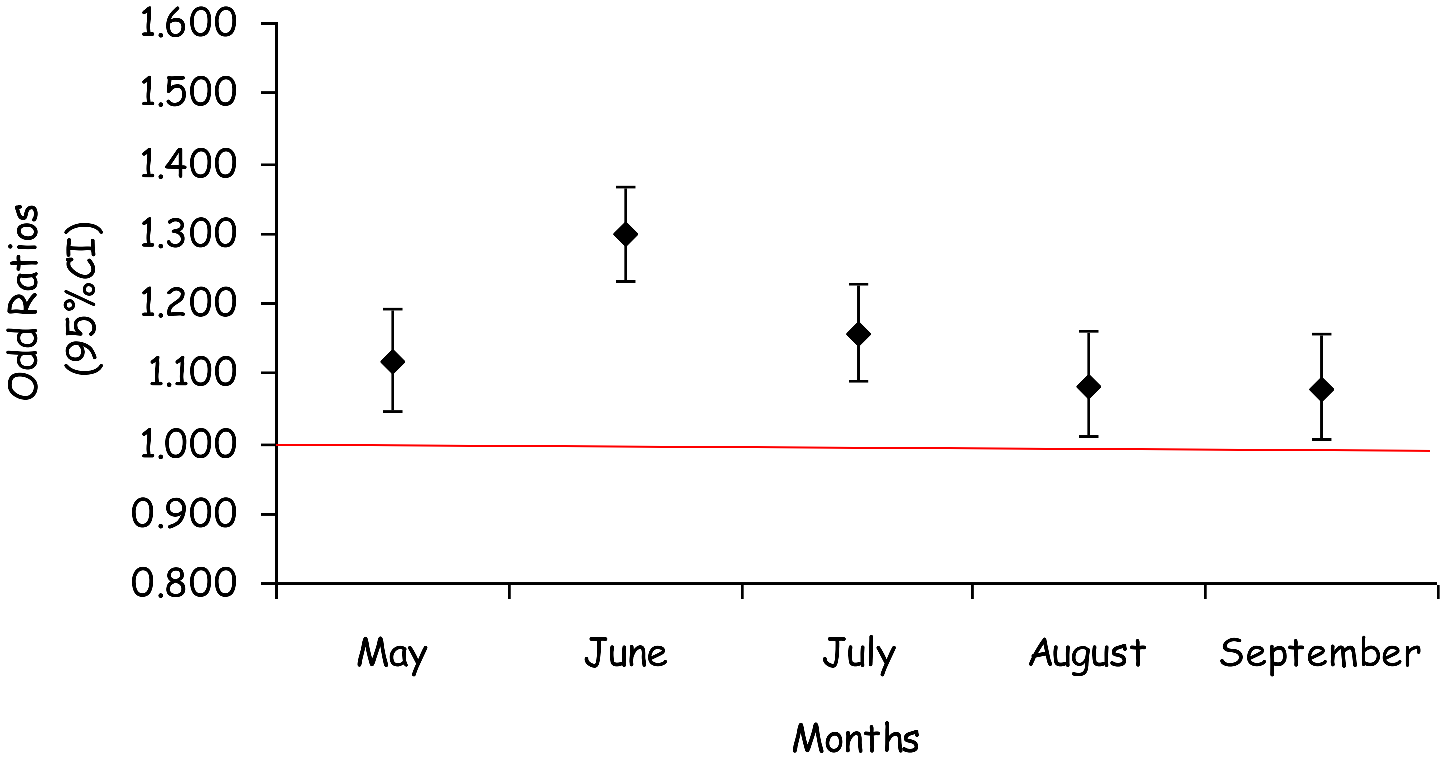
Results

Area	OR	p-value	C.I. 95%
Pooled	1,163	< 0,0001	1,132 - 1,196
Northern	1,186	< 0,0001	1,149 - 1,225
Central	1,105	< 0,003	1,036 - 1,179
Southern	1,075	< 0,178	0,968 - 1,194

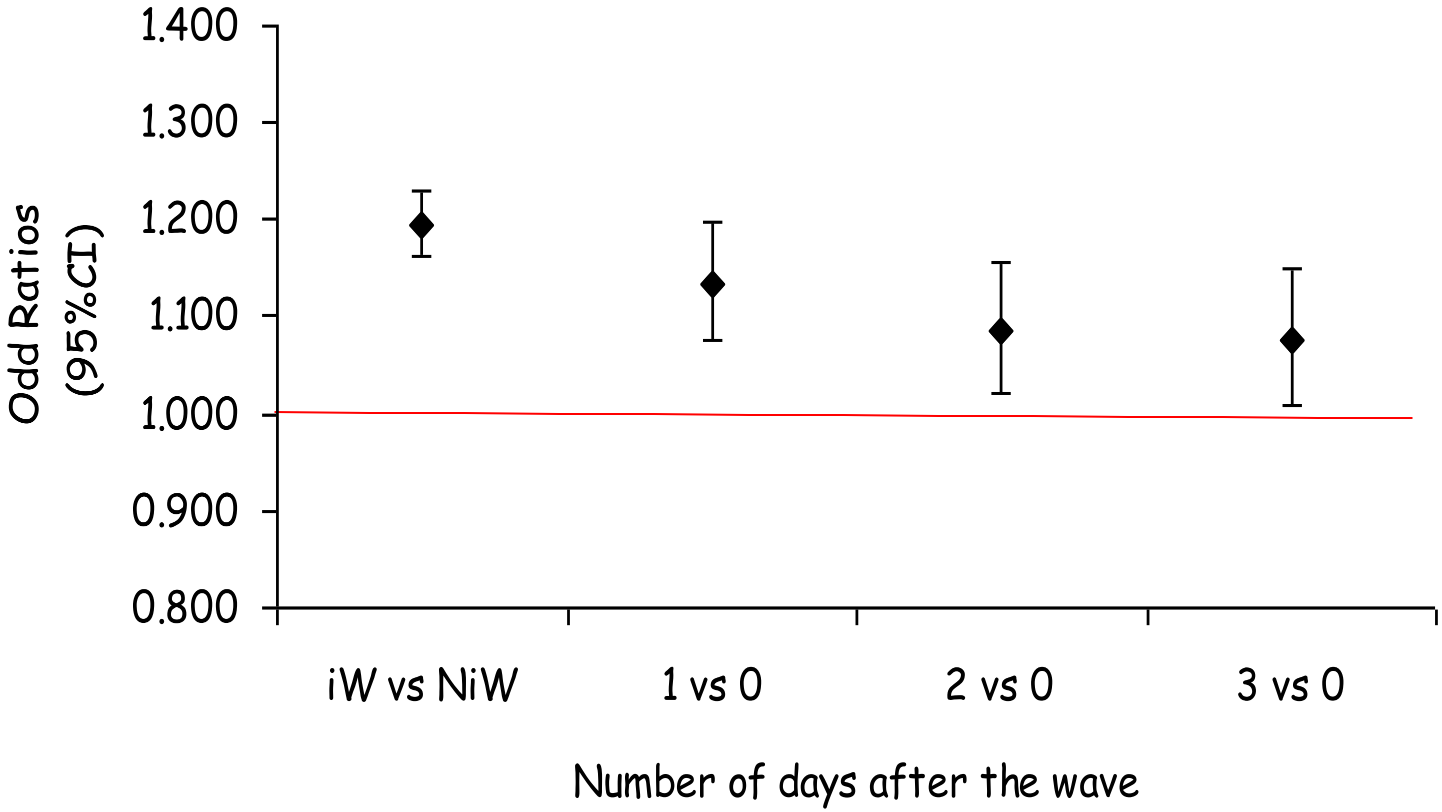
Risk of death/wave length



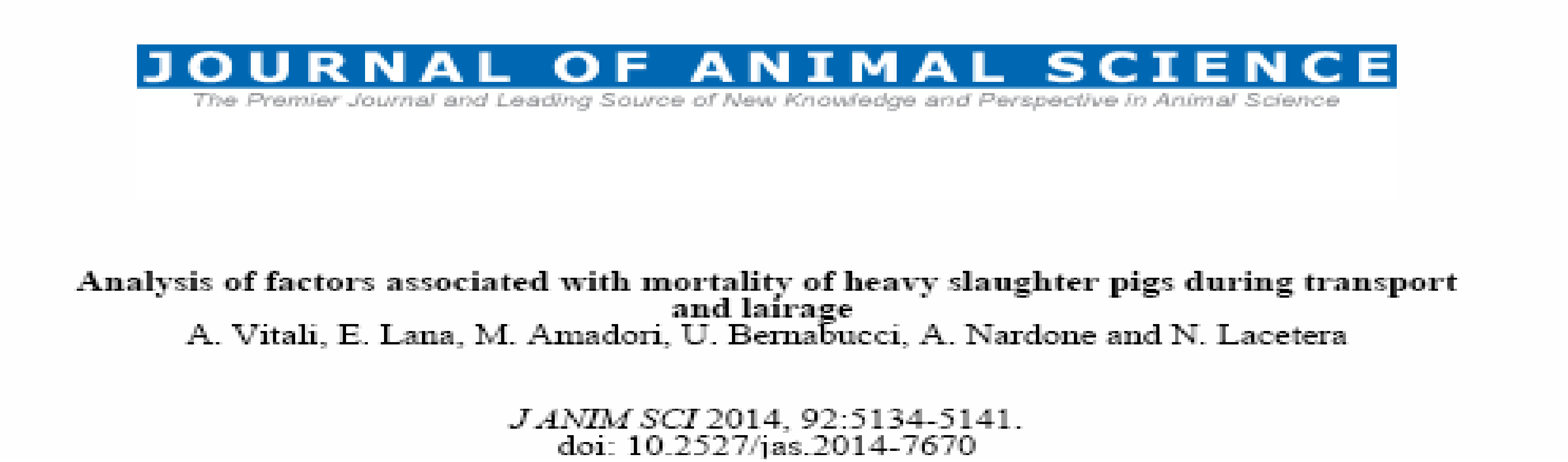
Risk of death/month of wave occurrence



Risk of death/days after the wave



Dataset pigs mortality



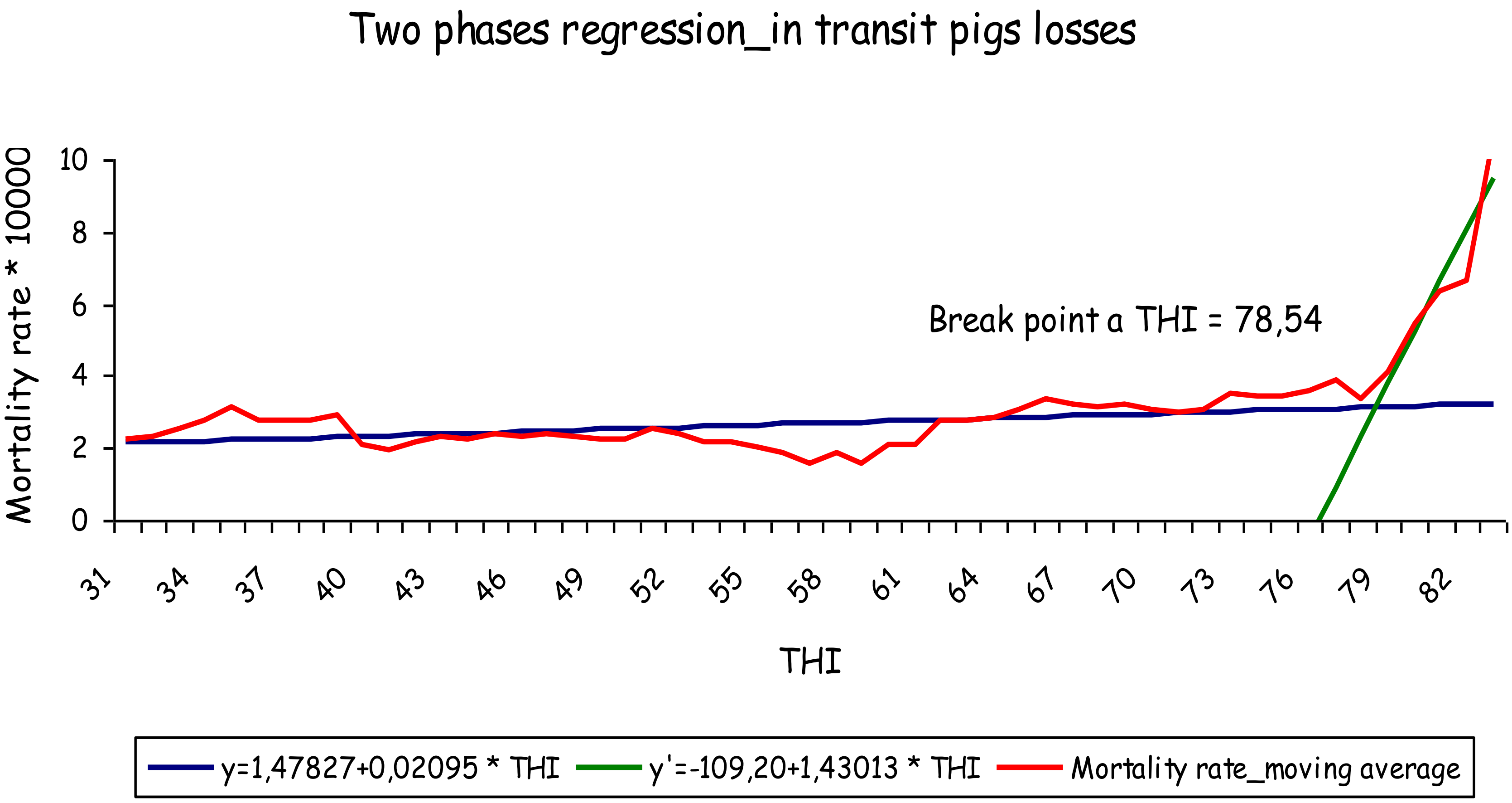
JOURNAL OF ANIMAL SCIENCE

The Premier Journal and Leading Source of New Knowledge and Perspective in Animal Science

Analysis of factors associated with mortality of heavy slaughter pigs during transport and lairage

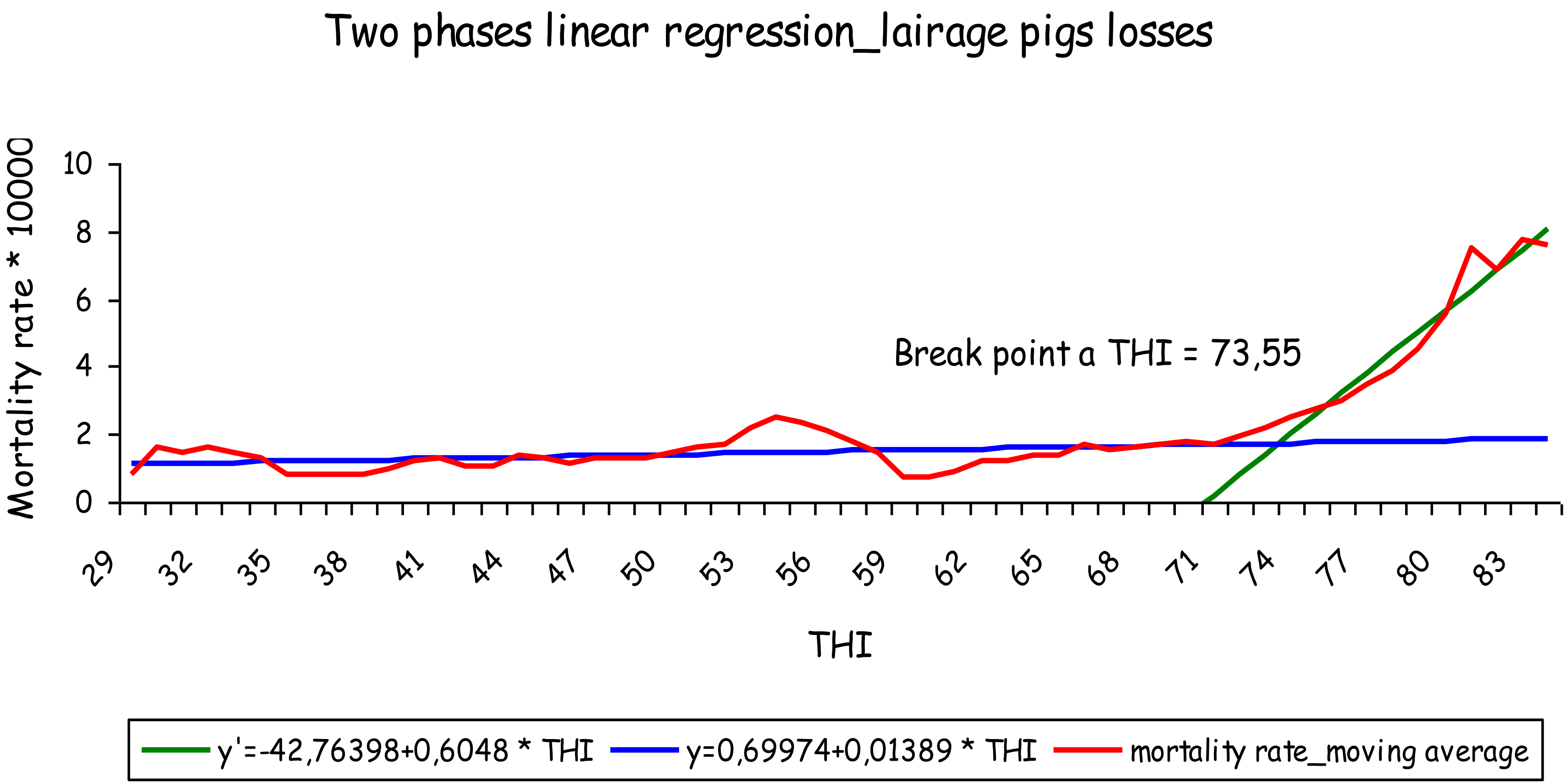
A. Vitali, E. Lana, M. Amadori, U. Bernabucci, A. Nardone and N. Lacetera

J ANIM SCI 2014, 92:5134-5141.
doi: 10.2527/jas.2014-7670



In-transit mortality rate of pigs in relation to temperature-humidity index (THI)

Vitali et al., 2014



Mortality rate of pigs at lairage in relation to temperature-humidity index (THI)

Dataset milk yield

J. Dairy Sci. 97:471–486
http://dx.doi.org/10.3168/jds.2013-6611

The effects of heat stress in Italian Holstein dairy cattle

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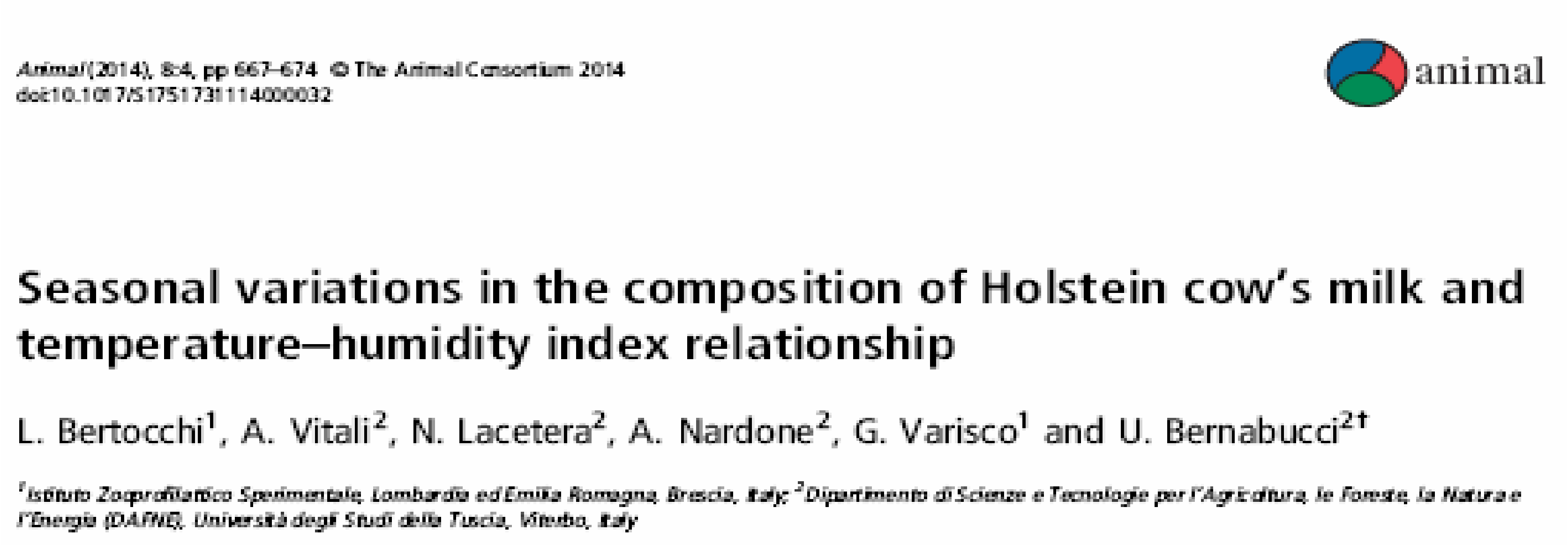
†Associazione Nazionale Allevatori Frisona Italiana (ANAFI), 26100 Cremona, Italy

Dataset milk quality



Animal (2014), 8:4, pp 667–674 © The Animal Consortium 2014
doi:10.1017/S1751731114000032

animal

Seasonal variations in the composition of Holstein cow's milk and temperature–humidity index relationship

L. Bertocchi[1], A. Vitali[2], N. Lacetera[2], A. Nardone[2], G. Varisco[1] and U. Bernabucci[2†]

[1] Istituto Zooprofilattico Sperimentale, Lombardia ed Emilia Romagna, Brescia, Italy; [2] Dipartimento di Scienze e Tecnologie per l'Agricoltura, le Foreste, la Natura e l'Energia (DAFNE), Università degli Studi della Tuscia, Viterbo, Italy

Furthermore, these results …

1. have been and are still being utilized by economists working within MACSUR at UNITUS for **<u>crosscutting studies</u>** aimed at establishing the economic impact of CC in the dairy sector;
2. are part of data utilized by researchers at University of Sassari who are working to identify how to support the **<u>adaptive responses to climate change</u>** through the combination of modeling approaches and stakeholder engagement.

ecoDREAMS-S: Modelling the impact of climate change on milk performance in organic dairy farms in Spain

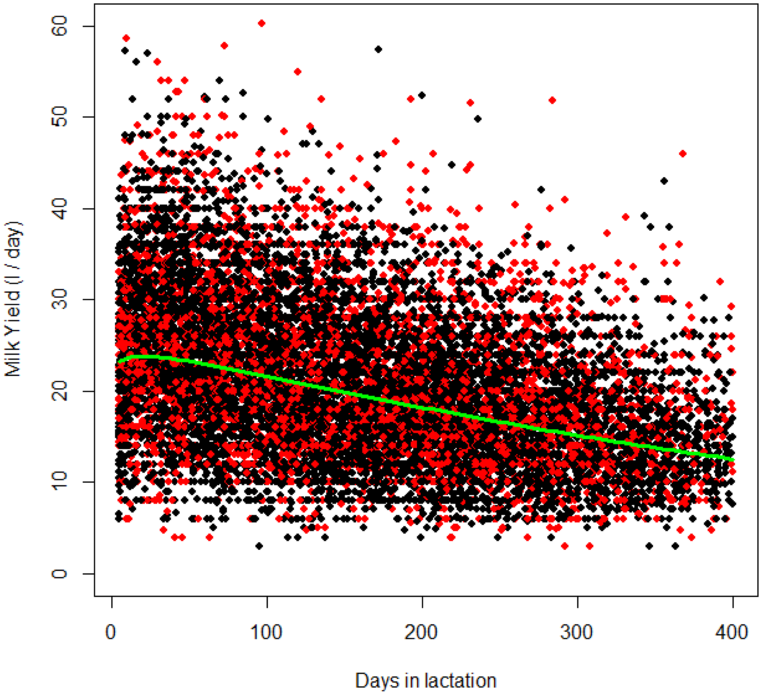
Alejandro Ruete, Antoni Velarde, Isabel Blanco-Penedo

Swedish Species Information Centre , Sweden

Animal Welfare Subprogram, IRTA, Catalonia

Selected farms/regions and Data source

- 35% of the total census of organic dairy farms in Spain.
- Cow Test-day milk records retrieved from the Spanish Milk Recording Scheme (CONAFE) from January 2012 to October 2013
- Meteorological data (for THI index calculation) retrieved from AEMET (State Meteorological Agency) for the same period



No evident effects of THI on milk yield were pointed out (THI values ranged from 65 and 75).

Conclusions

- Further studies in MACSUR#2 will extend these analysis to additional parameters of interest for dairy cows (i.e., incidence of some infectious or metabolic diseases, culling rate, reproductive efficiency, etc.).

- Combining this information with climate change regional scenarios may allow prediction of the impact of warming in dairy cows and the identification of adaptation measures that may be appropriate for specific geographic contexts.

Can global warming affect GHG emissions from livestock systems? Yes!

1. Lower quality of feedstuffs: ↑ CH_4 emissions from EF.

2. Reduced efficiency in feed utilization (heat stress or disease states): ↑ CH_4 emissions from EF.

3. Reduced life expectancy: a rapid turnover of milkers means that energy inputs and GHG outputs are 'wasted' in the process of rearing heifers before they reach first pregnancy and lactation.

4. Higher mortality rate: ↑ emissions of GHG for disposal of carcasses.

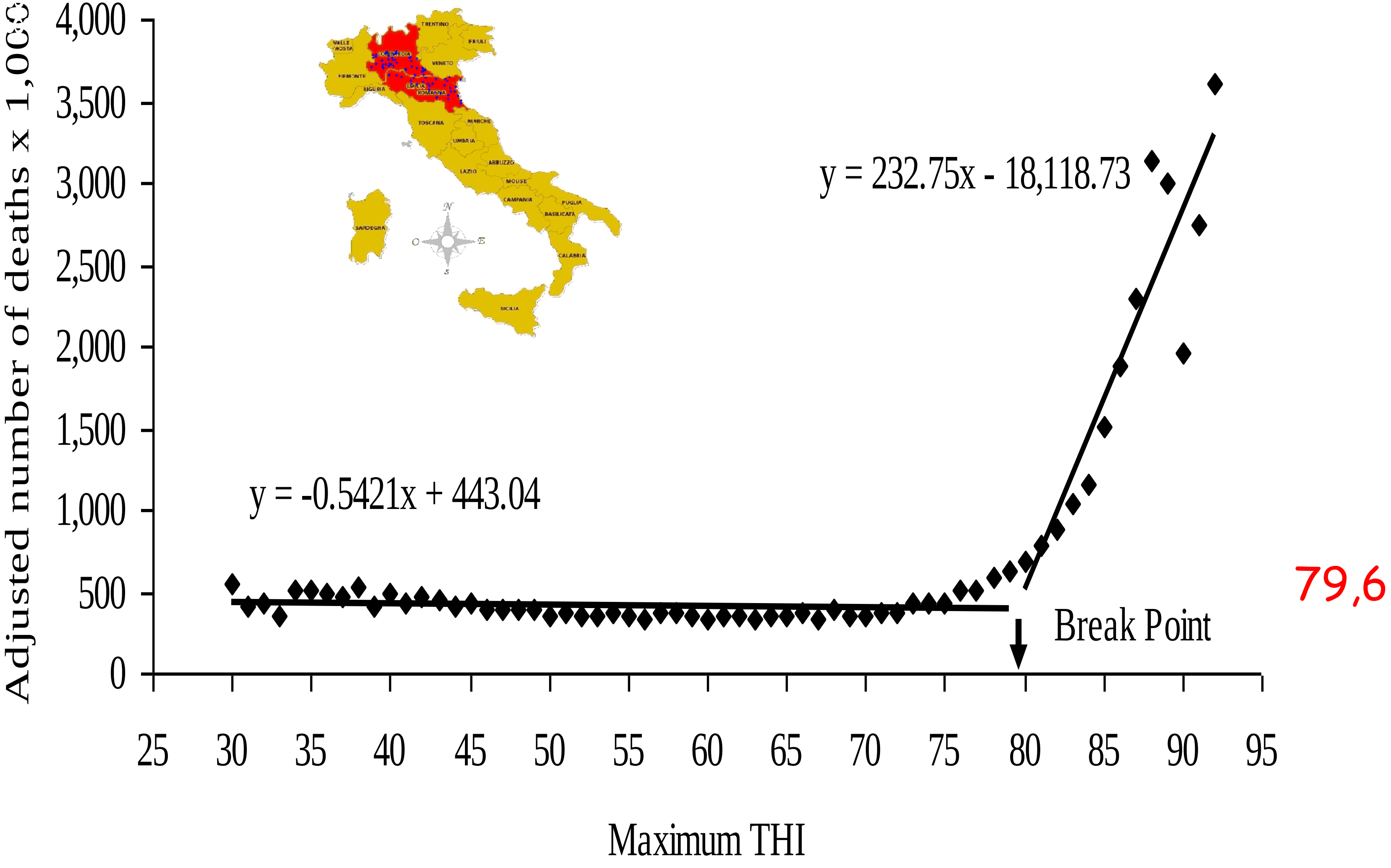
5. Higher environmental temperatures: ↑ CH4 emission from manure.

6. Less need for warming in cold climates: ↓ on farm fossil fuel need.

Trade-offs: few examples

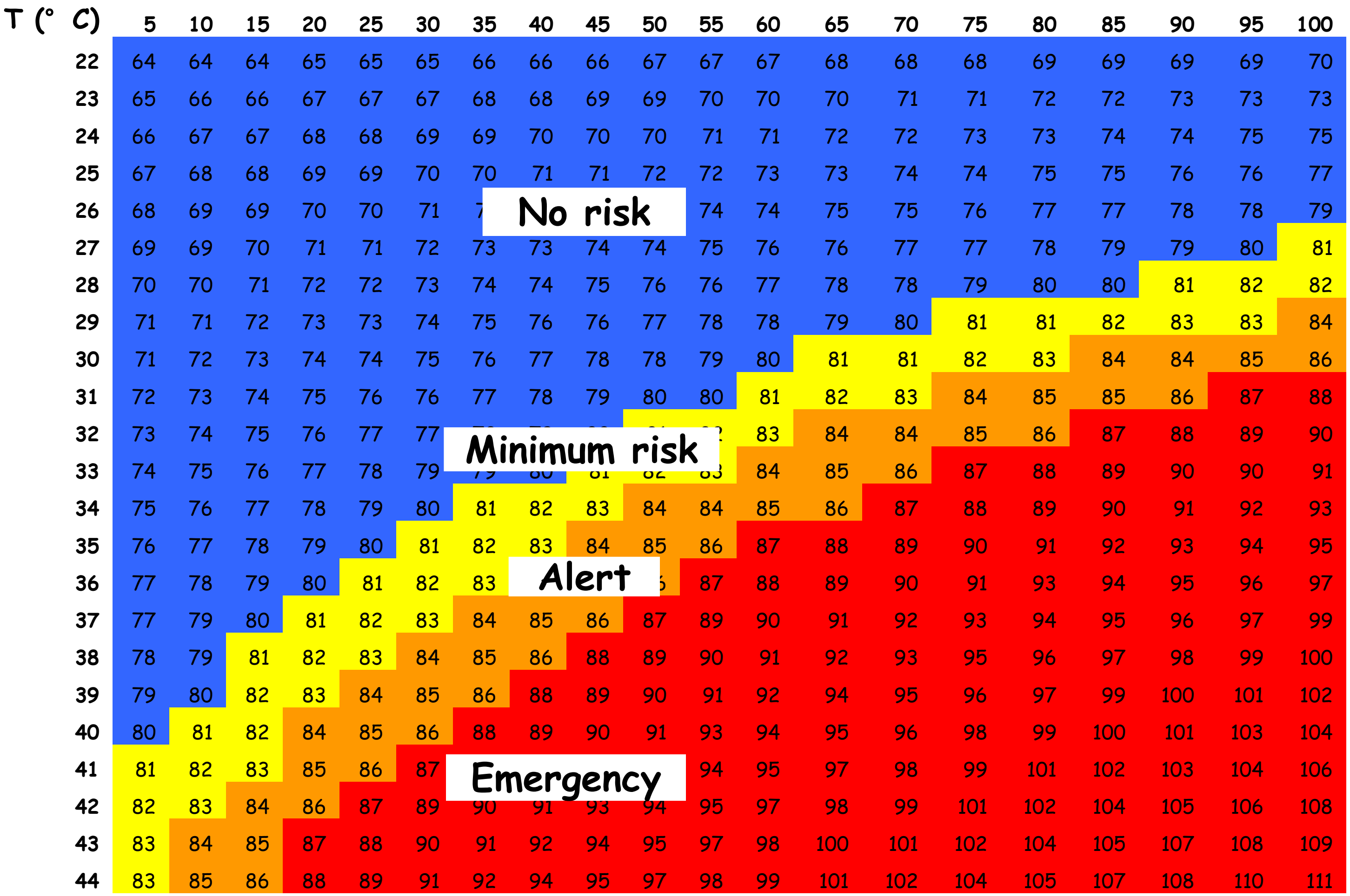
- **Adaptation**: Some adaptation measures (cooling) may improve health, welfare and productivity, and thus also reduce emissions, but cause higher use of energy and water.

- **Mitigation**: Utilization of breeds with a high efficiency in nutrient utilization may favour the expansion of highly selected/specialized breeds, but damage biodiversity.



Number of deaths in relation to values of maximum temperature humidity index (THI).

THI



RH (%)

T (° C)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
22	64	64	64	65	65	65	66	66	66	67	67	67	68	68	68	69	69	69	69	70
23	65	66	66	67	67	67	68	68	69	69	70	70	70	71	71	72	72	73	73	73
24	66	67	67	68	68	69	69	70	70	70	71	71	72	72	73	73	74	74	75	75
25	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75	76	76	77
26	68	69	69	70	70	71	7	No risk			74	74	75	75	76	77	77	78	78	79
27	69	69	70	71	71	72	73	73	74	74	75	76	76	77	77	78	79	79	80	81
28	70	70	71	72	72	73	74	74	75	76	76	77	78	78	79	80	80	81	82	82
29	71	71	72	73	73	74	75	76	76	77	78	78	79	80	81	81	82	83	83	84
30	71	72	73	74	74	75	76	77	78	78	79	80	81	81	82	83	84	84	85	86
31	72	73	74	75	76	76	77	78	79	80	80	81	82	83	84	85	85	86	87	88
32	73	74	75	76	77	77	Minimum risk					83	84	84	85	86	87	88	89	90
33	74	75	76	77	78	79	79	80	81	82	83	84	85	86	87	88	89	90	90	91
34	75	76	77	78	79	80	81	82	83	84	84	85	86	87	88	89	90	91	92	93
35	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
36	77	78	79	80	81	82	83	Alert		5	87	88	89	90	91	93	94	95	96	97
37	77	79	80	81	82	83	84	85	86	87	89	90	91	92	93	94	95	96	97	99
38	78	79	81	82	83	84	85	86	88	89	90	91	92	93	95	96	97	98	99	100
39	79	80	82	83	84	85	86	88	89	90	91	92	94	95	96	97	99	100	101	102
40	80	81	82	84	85	86	88	89	90	91	93	94	95	96	98	99	100	101	103	104
41	81	82	83	85	86	87	Emergency				94	95	97	98	99	101	102	103	104	106
42	82	83	84	86	87	89	90	91	93	94	95	97	98	99	101	102	104	105	106	108
43	83	84	85	87	88	90	91	92	94	95	97	98	100	101	102	104	105	107	108	109
44	83	85	86	88	89	91	92	94	95	97	98	99	101	102	104	105	107	108	110	111