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MED

CHANGE
Global Change and Sustainability Institute

Water Quality: Manganese in drinking water for dairy cattle

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Summary

1. Contextualization

Water?

Agriculture?

Dairy cattle?

Quality?

Milk production?

Largest water-consuming sector in the world (FAO and WWC, 2015).

It accounts for 70% of the world's water withdrawals (FAO, 2012).

Livestock production accounts for 29% of the water used in agriculture (Mekonnen and Hoekstra, 2012).

Dairy cattle production accounts for 19% of water use (Mekonnen and Hoekstra, 2012)

In dairy cattle farms, the use of quality water is essential to maximize milk production and animal health (Boudon, 2018).

Factors that limit the quality and palatability of drinking water reduce well-being, limit growth and production (Schütz et al., 2019).

Every day we see news about water scarcity…

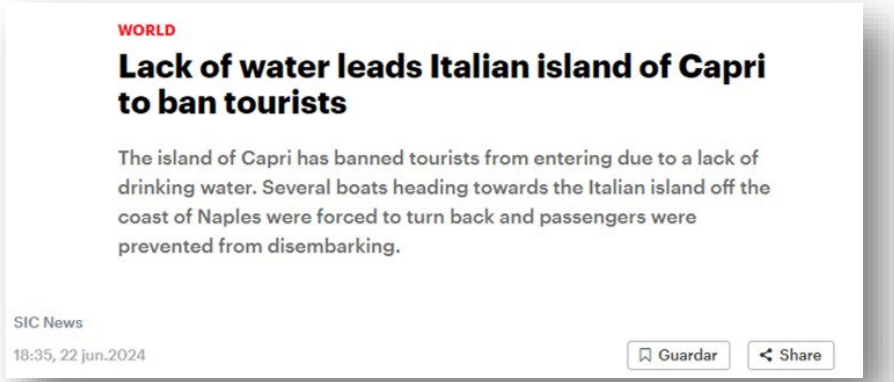

How 'water stress' will plague Latin America in the next 25 years

GETTY IMAGES

Continent will suffer twice as much as the rest of the world

Cecilia Barria
From BBC News World

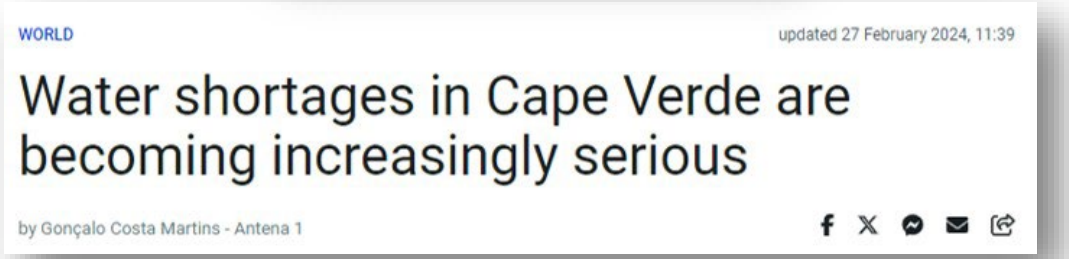
21 July 2024


WORLD

Lack of water leads Italian island of Capri to ban tourists

The island of Capri has banned tourists from entering due to a lack of drinking water. Several boats heading towards the Italian island off the coast of Naples were forced to turn back and passengers were prevented from disembarking.

SIC News
18:35, 22 jun.2024
Guardar Share


WORLD
updated 27 February 2024, 11:39

Water shortages in Cape Verde are becoming increasingly serious

by Gonçalo Costa Martins - Antena 1


Home / Forbes Agro / Water management will be one of the biggest food trends in 2024

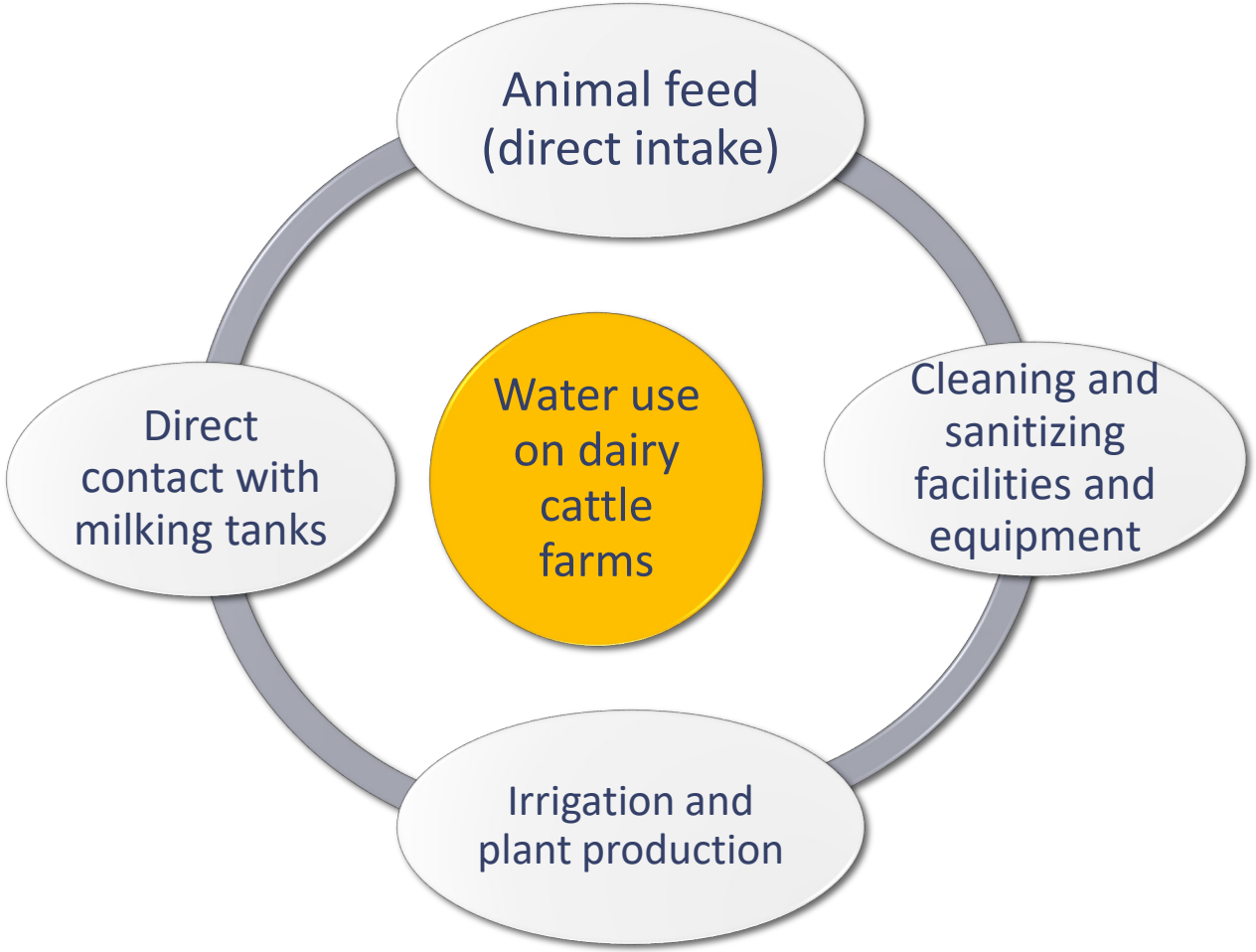
Water management will be one of the biggest food trends in 2024

Presented by DEFENDER

The use of water resources in agriculture for food production is firmly on the agenda of companies such as Unilever, Nestlé, McDonald's, Danone and General Mills

Forbes AGRO Daphne Ewing
07/11/2023
Updated 10 months ago

I. Is it important to talk about water on dairy farms?



II. Factors affecting water availability on dairy farms?

Climate Change

- Decrease in precipitation
- Prolonged droughts

Inefficient Use

- Lack of monitoring
- Excessive consumption

Population Growth

- Increased consumption
- Increased food production

Contamination of Aquifers

- Livestock effluents
- Industries

III. Factors affecting water intake?

Water intake in dairy cows is mainly influenced by:

(I) Animal-related

(II) Environmental factors

(III) Feeding practices

(IV) Water quantity and quality

2. Study Case: dairy cattle farm in Alentejo

SNR Own image: August 2019

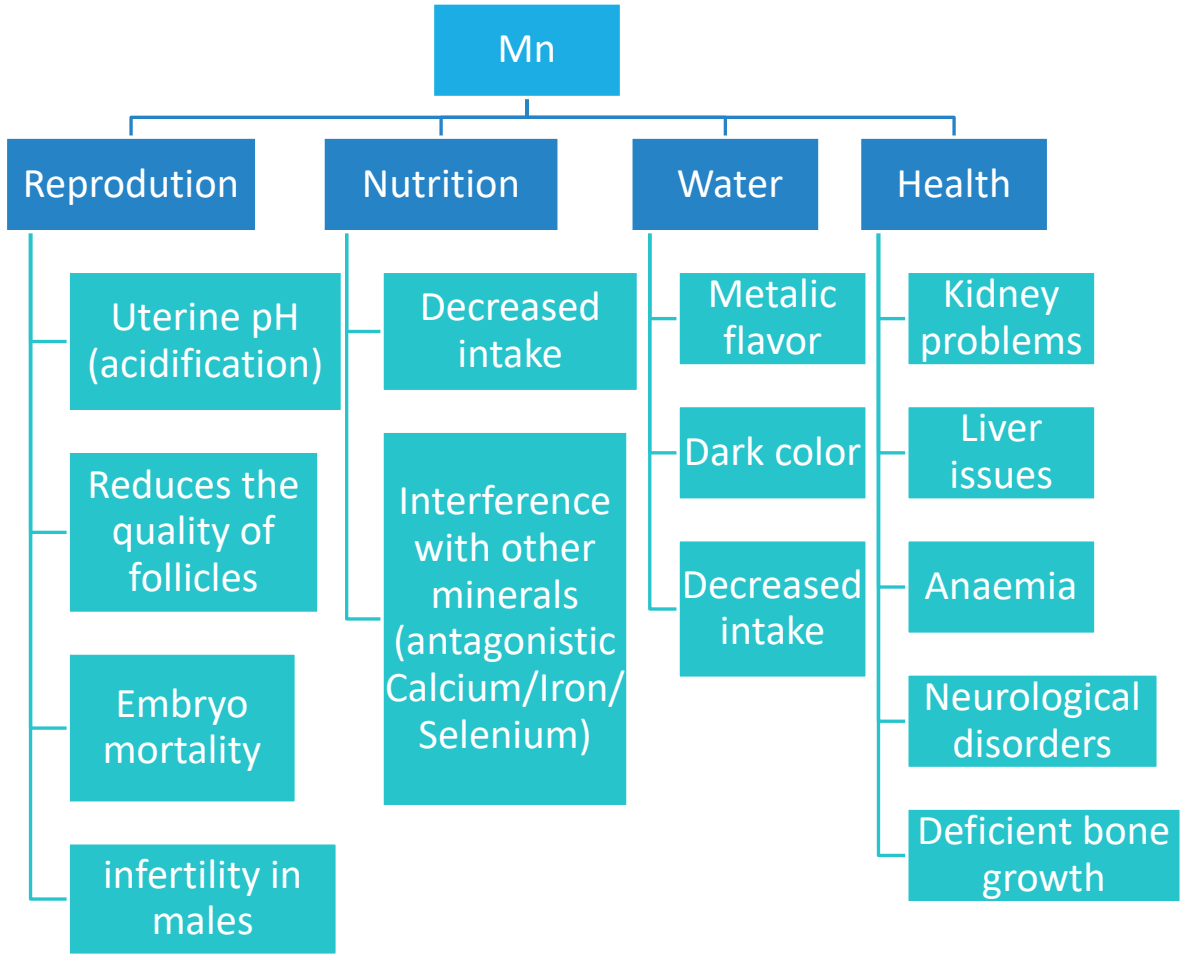
Boreholes without water...
New boreholes…

Problem:
Presence of Manganese in water

Objective:
Verify if the presence of manganese in the water affects it:

- Production
- Reproduction
- Animal health

I. Review: Toxicity Manganese?



Factors that limit the quality and palatability of drinking water reduce well-being, limit growth and production (Schütz et al., 2019).

Mn is an extremely dynamic element, its metabolism is "high speed", triggering a chain of events. The absorption, tissue renewal and re-excretion (diarrhea) of Mn proceeds at a rapid pace. Mn is essential for the functioning of various enzyme systems.

[..] manganese concentrations exceeding 0.05 mg/L are sufficient to cause unpleasant tastes in water that may cause reduced water intake and milk production."Jim Linn and Mary Raeth-Knight Department of Animal Science, University of Minnesota

Iron and manganese are very common pollutants that can occur naturally in groundwater. Both cause severe staining and a metallic taste to the water, resulting in reduced water intake and milk production (Swistock, 2016).

II. Material and Methods

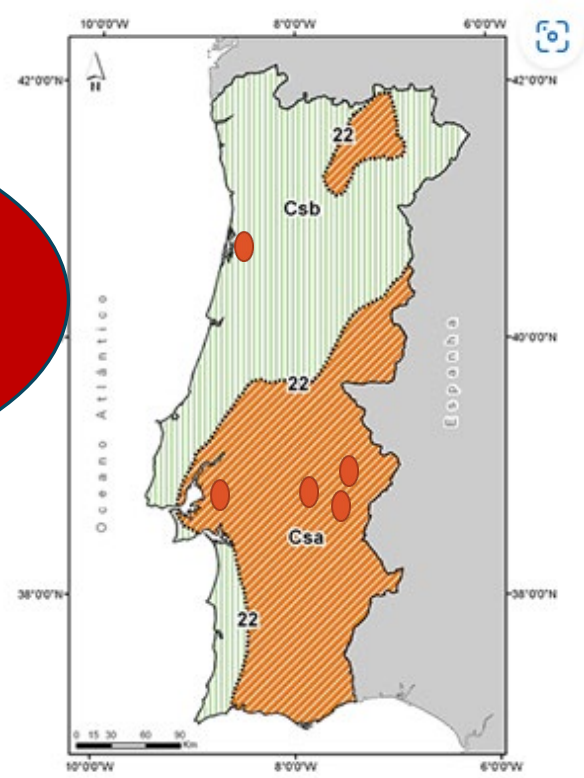
Climate in Alentejo

The climate of mainland Portugal, according to the Koppen classification, is divided by:

- temperate climate with a rainy winter and a dry, hot summer (Csa)

- temperate climate with a rainy winter and a dry, slightly hot summer (Csb).

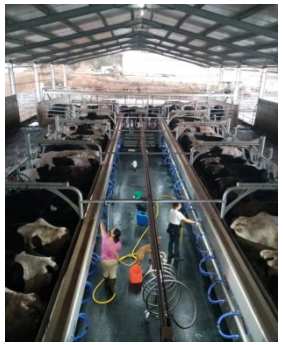
Last few Years
Temperature Rises
Prolonged Droughts
Less available water



Location of farms with high levels of manganese in the water

Fig 1: Climate of mainland Portugal, according to the Koppen classification
Instituto Português do Mar e da Atmosfera (ipma.pt).

II. Material and Methods



2012 2014 2016 2018

2012 2013 2015 2017 2019

Constant concern and control over:

- Production diseases
- Feeding/ Water quality
- Animal welfare
- Milk quality and quantity

2012

- CI: 480 days
- 22L Milk/cow/day
- 70 lactating cows
- breeding bull
- 2,1 lactations/cow
- 2 water boreholes (depth 21m e 138 m)

2018

- CI: 395 days
- 34 L Milk/cow/day
- 210 lactating cows
- 2,2 Ins/cow
- 3,4 lactations/cow
- 2 water boreholes (21m e 138 m)

II. Material and Methods

2019 → 2020

Water Problems

Presence of Manganese in water → The cows didn't drink water → Negative reproductive results → Reduced milk production → Animal health problems

2019

- CI: 440 days
- 30 L Milk/cow/day
- 5 Ins/cow
- 2,6 lactations/cow
- 1 water boreholes (138m)

II. Material and Methods

Water information:
- Quantity water intake
- Quality - physicochemical and microbiological parameters
- Water treatment systems
- Manganese concentration in the borehole

- "Evorlamp"- company
- UEvora's water laboratory
- "Microáguas" laboratory
- Water meter

TEAM WORK
- Veterinary
- Animal nutrition manager
- Exploited workers

Farm Information:
- Quantity and quality Feeding
- Reprodutive results (last years)
- Milk prodution and quality
- Mortality rate
- Livestock scrap rate
- Animal health

- Delpro and Bovinet (software)
- SNIRA: national animal identification and registration system
- Veterinary registrations
- Dairy contrast

Water Treatment System

II. Material and Methods

Experimental groups balanced for:
- Age
- Number of births
- Butyric content of milk
- Milk protein content

All experimental groups are in the same conditions:
- Farm / Stable
- Feeding
- Ambient temperature and humidity
- Same number of drinking fountains
- Same manger space
- Same time of food distribution

Collection of blood, urine and milk samples during 2 months.

Urine

Milk

Variation factor: Manganese (Mn) concentration

- Treated group <50 µg/L (DGAV, 2014)
- Untreated group >1000* µg/L

*Cows tolerate

Untreated group (n=15)

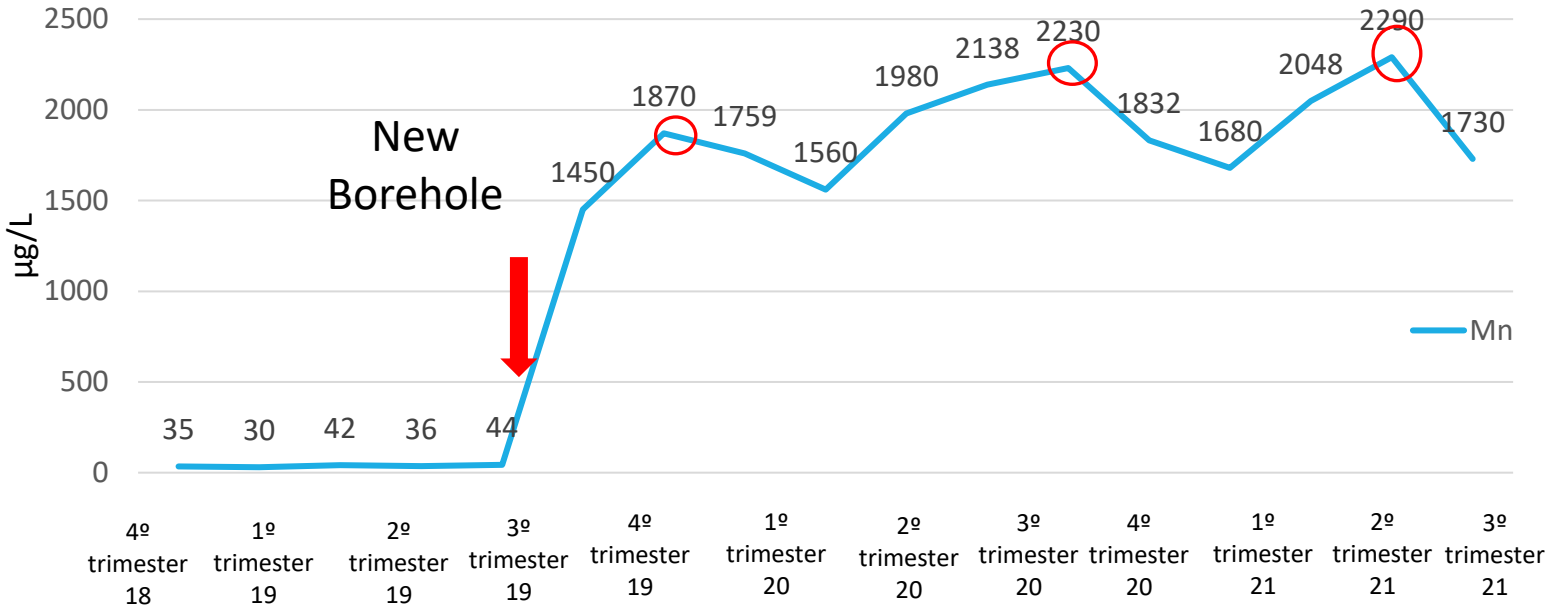
Treated group (n=15)

- **Serum** samples were tested for Urea, Creatinine, Aspartat aminotransferase- AST , Alanin aminotransferase - ALT, Gama glutamyl transferase- GGT.
- **Urine** samples were tested for Urea, Creatinine, and Mn.
- **Milk** samples were tested for Mn, Ca and Cu.

III. Preliminary Results

High levels

G1: Manganese concentration in the borehole

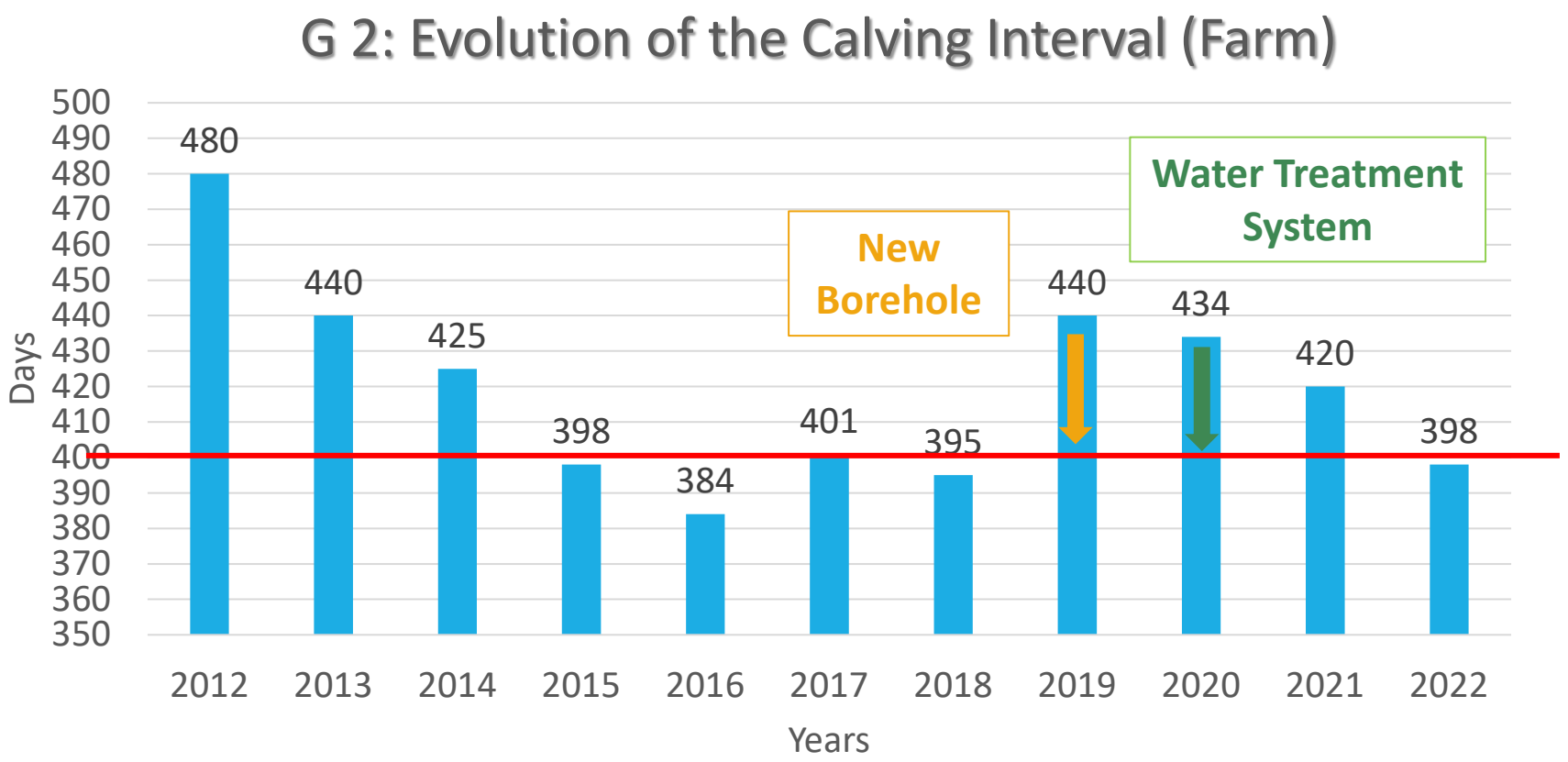


With the use of the new borehole, the values are higher than the recommendation value (50µg/L).
The values are higher during the winter months. This value is related to precipitation.

Mn in water can also reflect soil erosion (EAP, 2004).

Fonte: Microáguas, Agroleico, laboratório águas UE

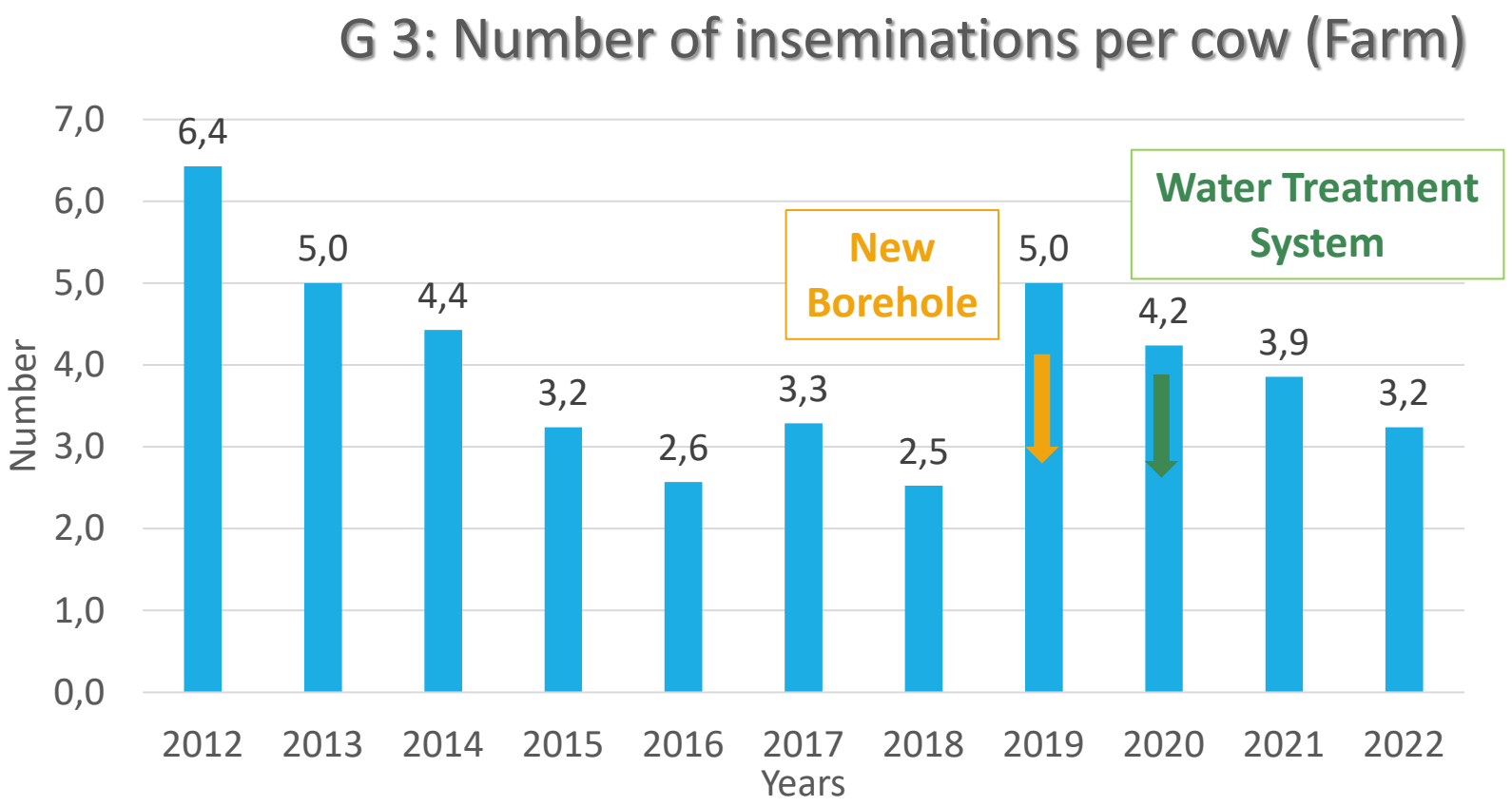
III. Preliminary Results



The objective is to reduce the calving interval as much as possible. This value was achieved in 2016 and 2018. The use of the new borehole seems to have contributed to an increase in the calving interval.

2020	
Untreated group	Treated group
478 days	411 days

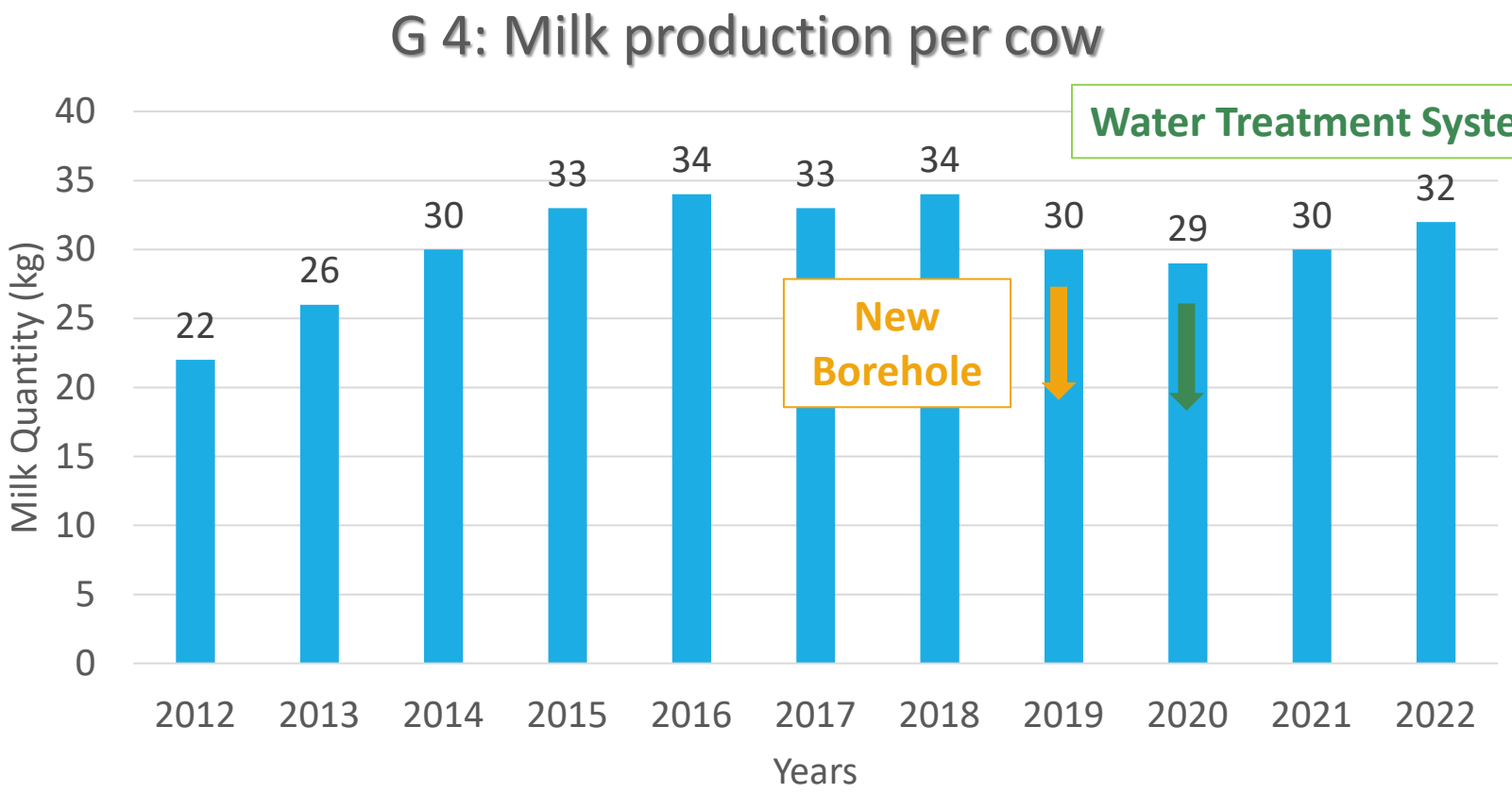
III. Preliminary Results



It is possible to see an increase in the number of inseminations in 2019 and 2020.
When we compare the experimental groups, we see an increase of 2.4 inseminations per cow.

2020	
Untreated group	Treated group
5,2	2,8

III. Preliminary Results



There is a reduction in milk production with the change of borehole.
The difference is 4 liters/cow/day in 2019 and 5 liters in 2020, when compared to the previous year.
Milk production begins to recover in 2021.

III. Preliminary Results

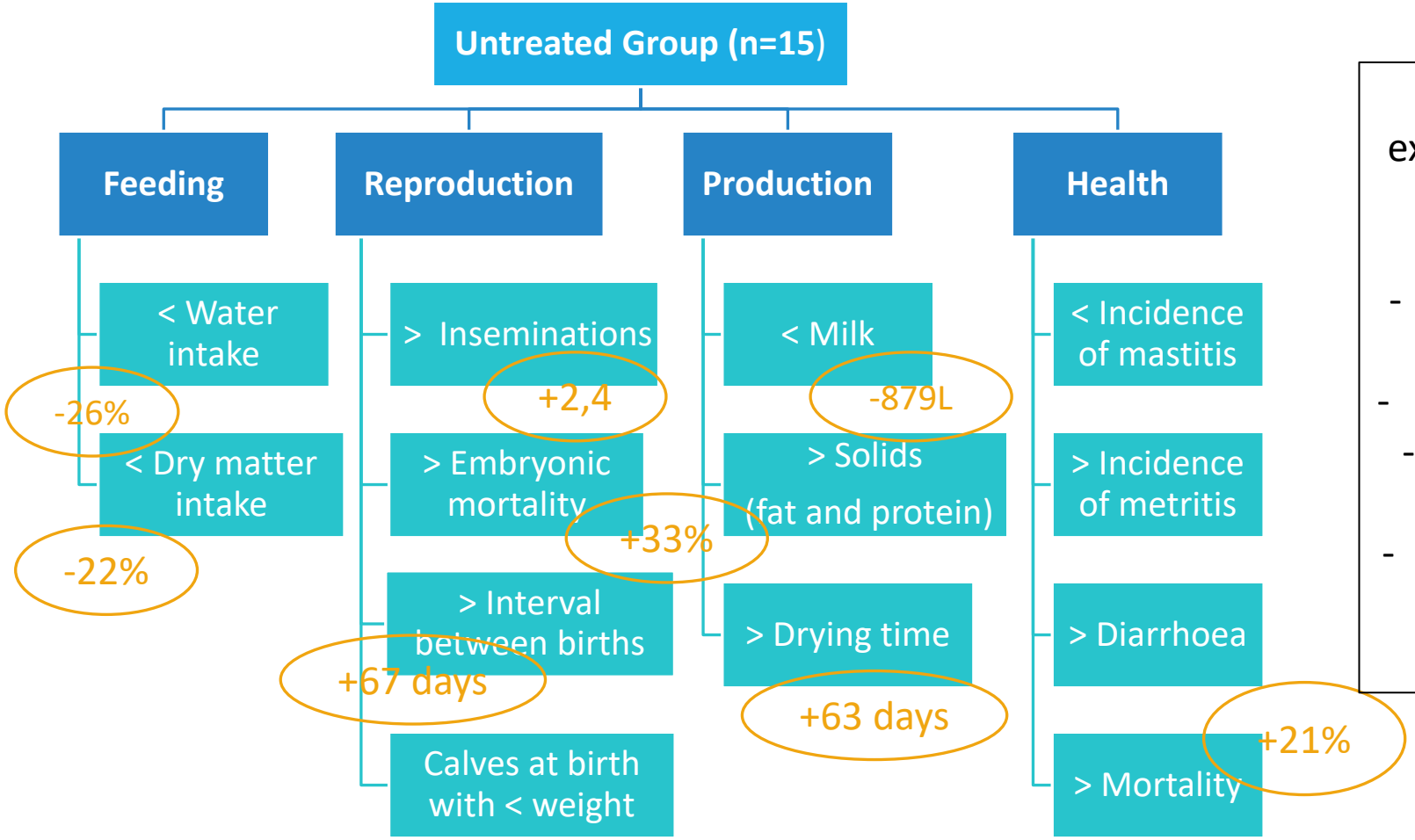
Table 1. Age, lactation number and production parameters of dairy cows in the year prior to the trial and in the year of the trial (n=15 per group)

	Group drinking untreated water		Group drinking treated water		Value de p
	Mean	EP	Mean	EP	
Cow age(d)	1501	78	1502	84	0,995
Lactation Number	1,96	0,19	1,96	0,19	1,000
Total Milk Production (kg)	**8216,4**	**399,7**	**9350,8**	**383,4**	**0,046***
Milk production per day (kg)	**26,9**	**1,3**	**30,7**	**1,3**	**0,046***
FAT (%)	3,85	0,08	3,92	0,08	0,568
Protein (%)	3,47	0,05	3,52	0,04	0,441

* p<0,05

When we compare the experimental groups, we see that the difference in production is statistically significant for milk production.

IV. Preliminary Results



When comparing the experimental groups, we found that the untreated group showed a greater:

- reduction in water and food intake.
- more reproductive problems;
- lower milk production and more days in the dry period
- more health problems which contributed to a higher mortality rate.

IV. Preliminary Results

Table 2: **Biochemical Analysis and Toxicology**

	Reference values*	Control Group	Untreated Group	Observations
	IU/L			
ALT		6.9-35.3	31.5-36.2	
AST	60-125	45.3-110.2	201.1-269.1	High values are found in cases of necrosis muscle and/or hepatic necrosis
GGT	6-17.4	4.9-25.7	32.9-135.7	High values related to liver disease of toxic origin

* Normal value, Merck Veterinary Manual, 2011

ATS and GGT values are higher than normal, which means that we may be in a situation of manganese toxicity.

Work in progress ?

The other analyses (serum, urine and milk) are underway, followed by the statistical analysis...

- DNA Tech laboratory
- INIAV laboratory

V. Conclusions

In the case of study, the excess of manganese it seems affected:

- The production (.< Milk).
- The reproduction (> Inseminations and > Interval between births),
- The health of animals (> Incidence of metritis and gastrointestinal lesions).
- But more data needs to be analyzed...

Thank you for your attention!

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