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Linking multi-elemental and Sr isotopic data of milk, cheese, water, soil, and forage

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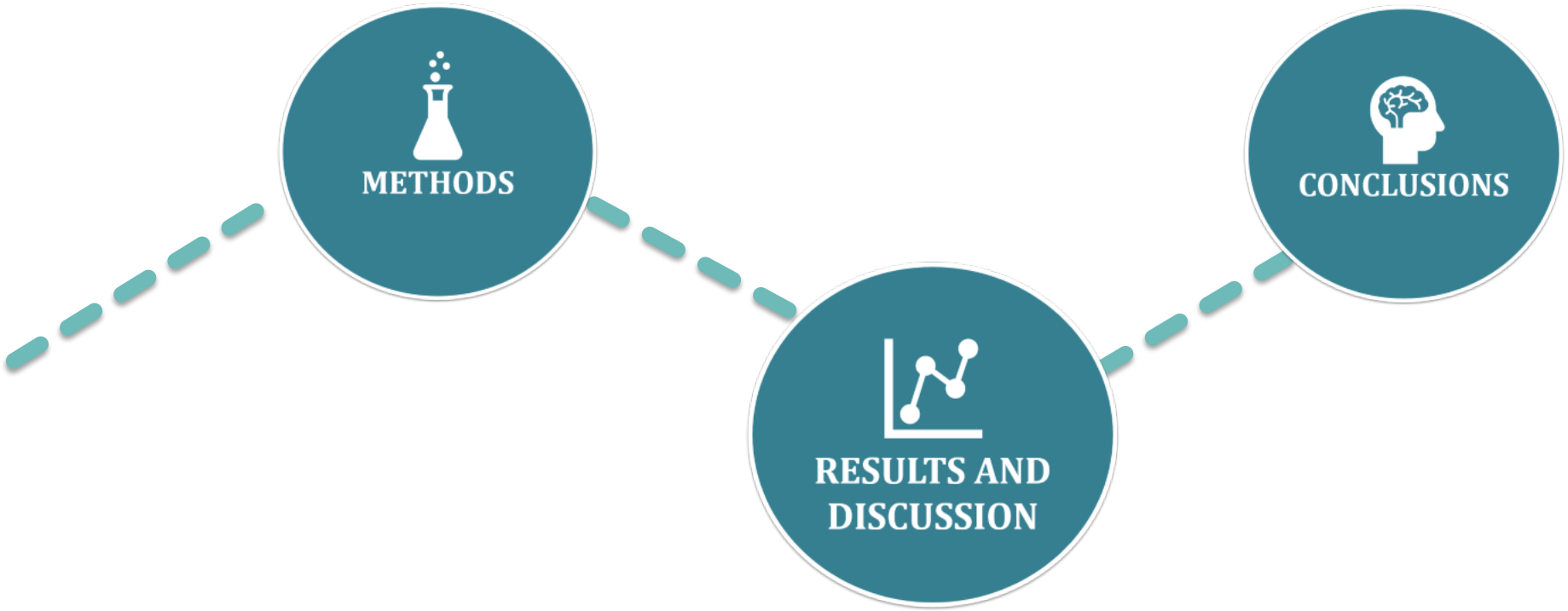

INTRODUCTION

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- Sr isotope ratio and multi-elemental analysis together represent a powerful tool for the designation of origin of many food commodities
- The $^{87}Sr/^{86}Sr$ ratio is not modified during the uptake of the plant, and it is transferred unchanged to the living organisms in the food chain
- The aim of the study was to make possible links between multi-elemental composition and Sr isotope ratios of soil, water, feed, milk and cheese from Naxos, Greece

Sampling campaigns

- Over the course of 3 years (2020, 2021 and 2022), 5 sampling campaigns were conducted
- In total, **211 samples** were collected and measured:

SOIL – August 2020

WATER – January 2021

FEED – August 2020, January 2021, June 2021

MILK – August 2020, January 2021, June 2021, July 2021, January 2022

CHEESE – August 2020, January 2021, June 2021, January 2022

GEOLOGY SETTINGS OF *GRAVIERA NAXOU P.D.O.* HOME

Figure 1. The map of Greece https://www.worldatlas.com/maps/greece

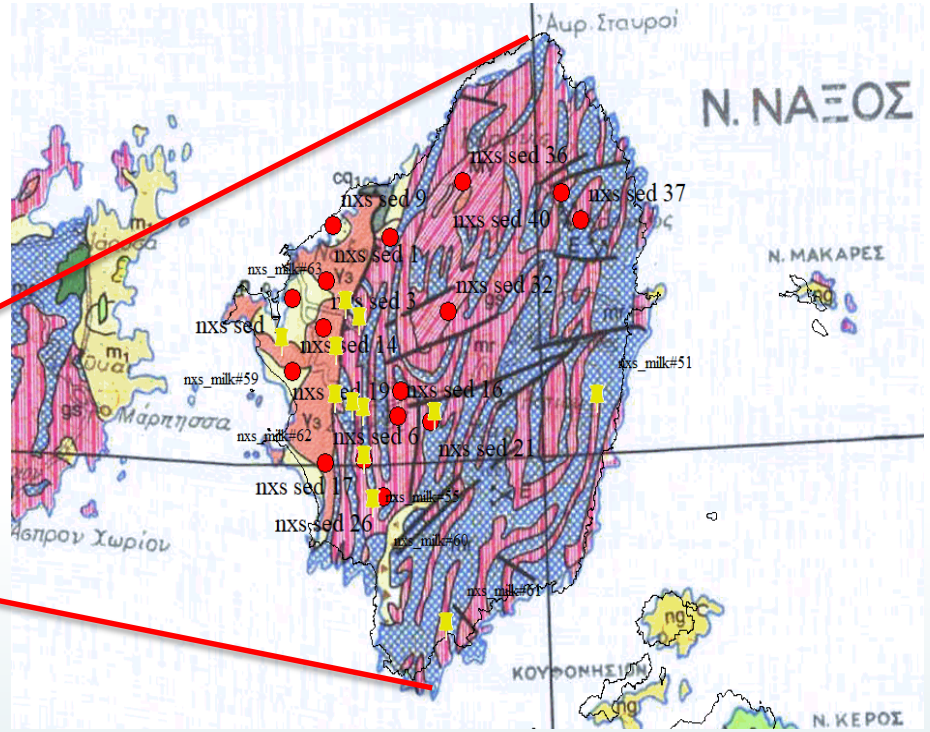

Figure 2. Sampling stations in Naxos (red – soil samples, yellow – livestock samples)

Figure 3. Naxou Graviera cheese, https://easnaxos.com/project/naxos-graviera-p-d-o/?lang=en

❖ **Graviera Naxou P.D.O.**

- min. 80% cow milk
- max. 20% sheep and goat milk
-1200 tons of the cheese is produced annually

Three main units can be identified on the island of Naxos:

the upper unmetamorphosed unit,

the Cycladic Blueschist unit and

the granodiorite unit

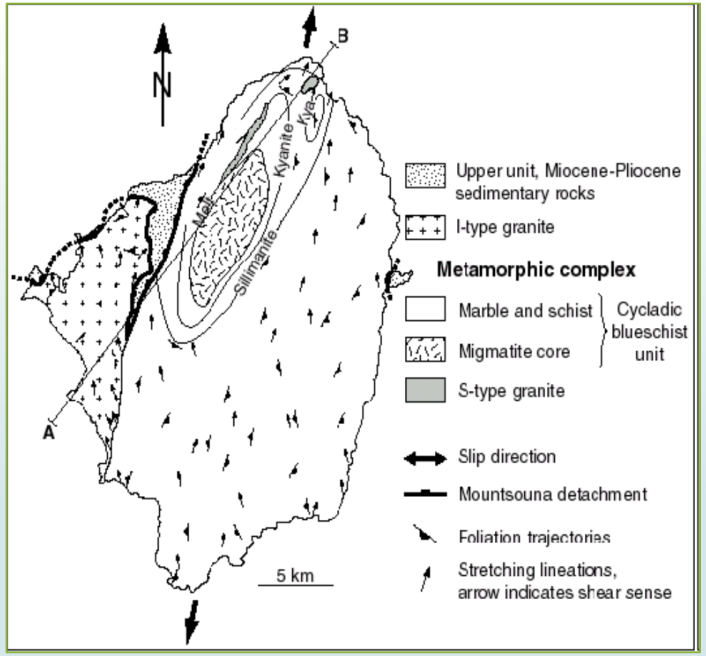

Figure 4. Simplified geological map of Naxos (Brichau, 2004)

METHODS

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Feed mixtures from different farms are ground and homogenized

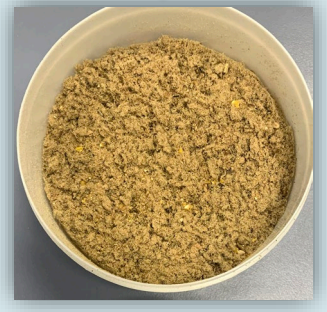

Figure 5. Feed samples

SOLID SAMPLE PRETREATMENT

Figure 6. Sample preparation procedure

1. microwave assisted acid digestion/extraction with 1M NH_4NO_3
2. sample preconcentration on a sand bath
3. isolation of Sr from the matrix

multi-elemental analysis

Sr isotope analysis

❖ **Water samples** are preconcentrated without being digested

RESULTS AND DISCUSSION

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Elemental composition of the samples

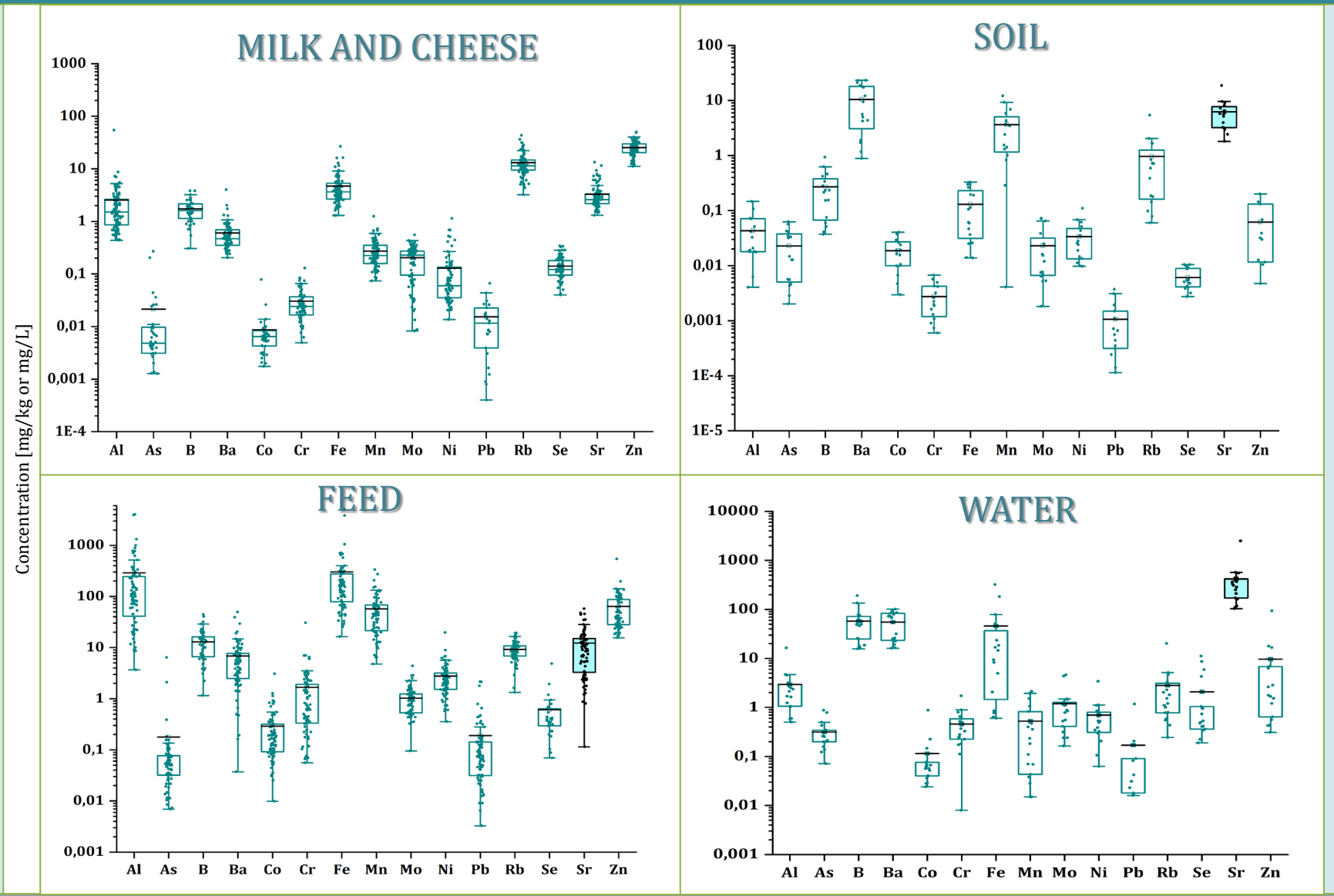
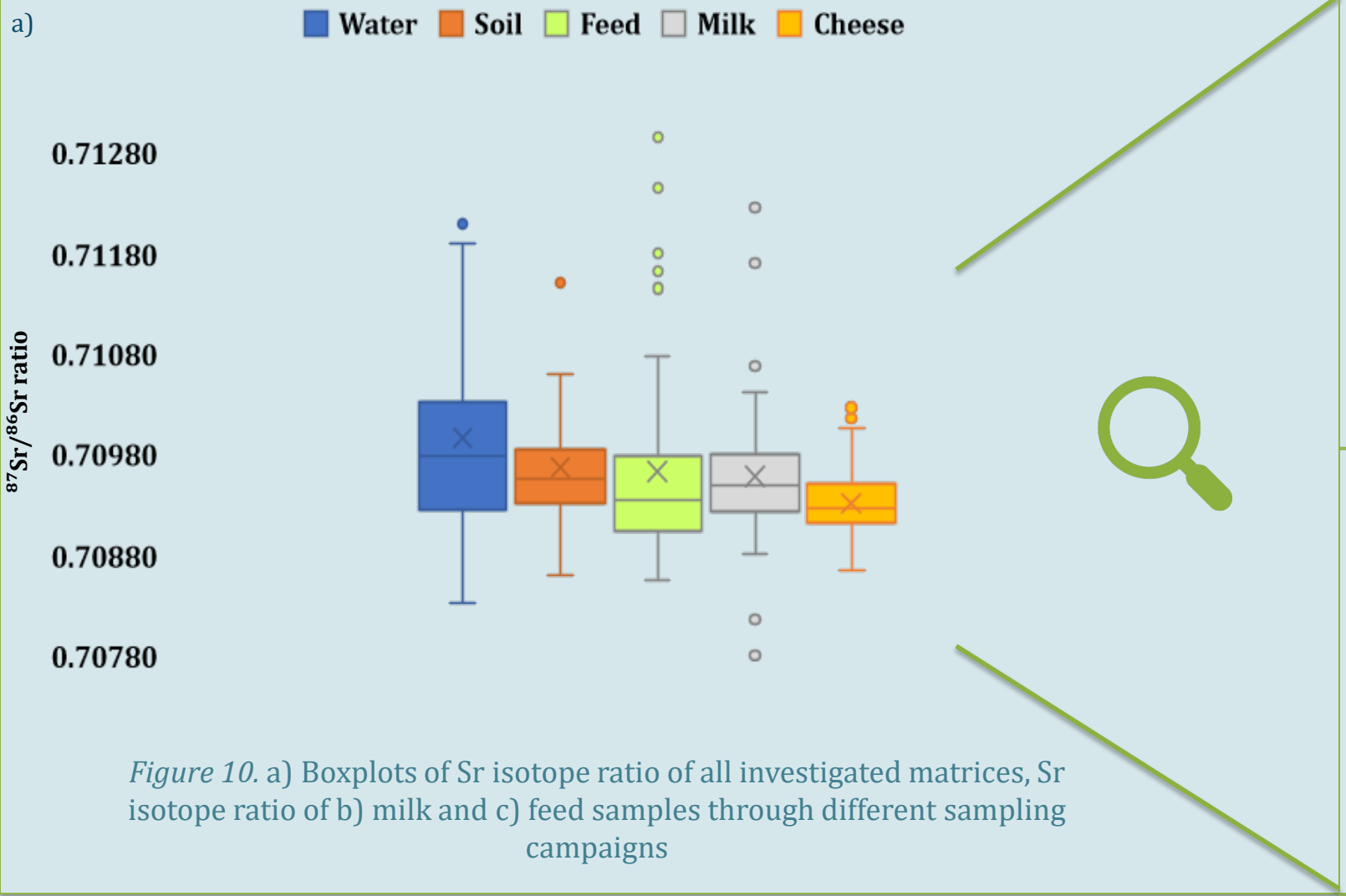
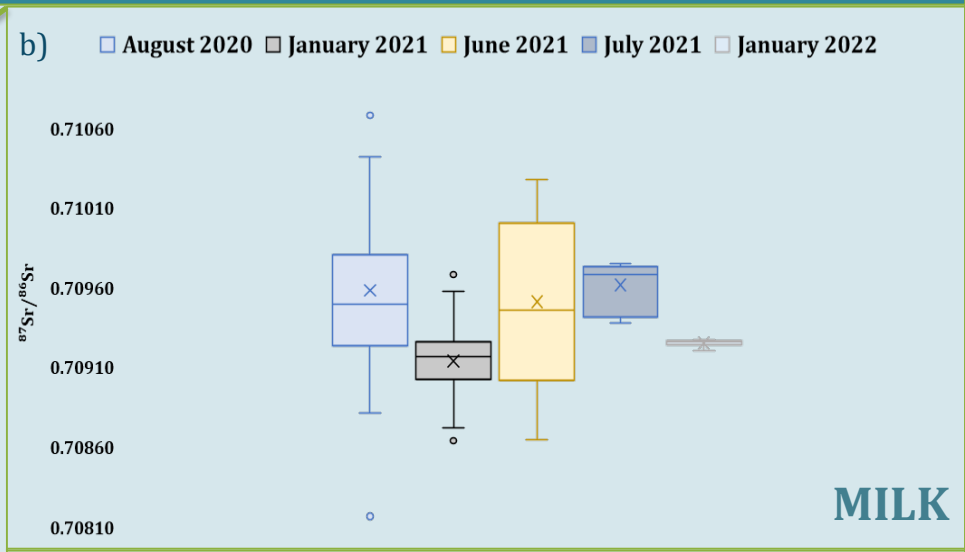


Figure 8. Concentrations of selected elements in all analysed samples in mg/kg (mg/L) on a logarithmic scale

$^{87}Sr/^{86}Sr$ isotope ratio





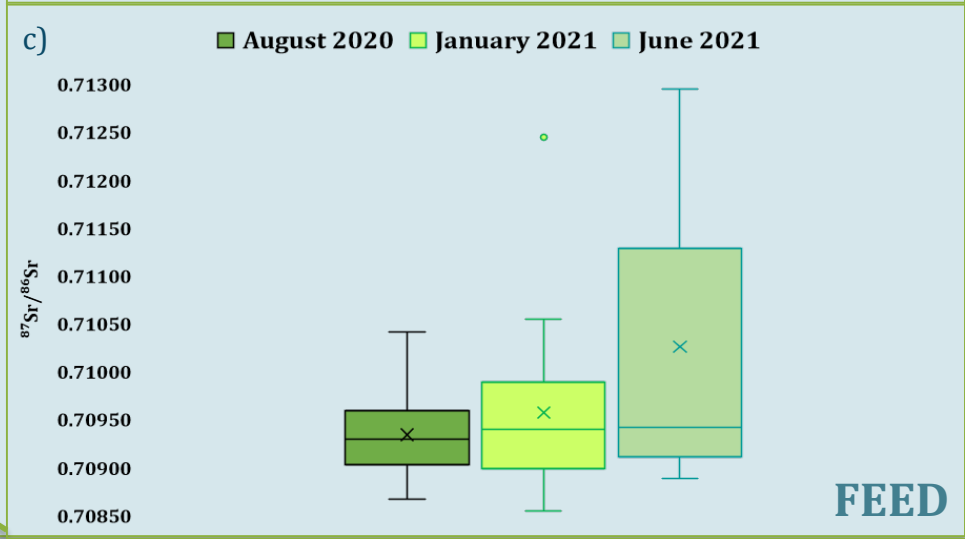


Figure 10. a) Boxplots of Sr isotope ratio of all investigated matrices, Sr isotope ratio of b) milk and c) feed samples through different sampling campaigns

CONCLUSIONS

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- Strontium isotope analysis supports the interpretation that the $^{87}Sr/^{86}Sr$ ratio of milk is dominantly influenced by feed instead of water and soil
- Imported feed, coming from an area with different geology, play a significant role in changing the $^{87}Sr/^{86}Sr$ ratio of milk, with respect to summer/winter, as it probably overprints the local Sr isotope composition
- In order to estimate source proportions in this case, stable isotope mixing models for partitioning an excess number of sources should be used instead of linear ones
- Even within areas with relatively homogenous bedrock geology, it might be challenging to use the $^{87}Sr/^{86}Sr$ ratio as a tool for control of geographic origin of foodstuffs

Thank you for your attention!