Inorganic contaminants issue

Impact on the Italian rice sector

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CDG Rice - 21/06/2024

ENTE NAZIONALE RISI MILANO

copa cogeca
uropean farmers european agri-cooperatives

Inorganic contaminants – an issue for the EU rice sector

- The proposed introduction of a nickel limit (finally amended positively), alongside the recent reductions in the maximum levels of cadmium and arsenic in rice, raises concerns about the impact it may have on European rice farming.
- To fill the knowledge gap, in 2023 the Ente Nazionale Risi launched a 3-year (2023-2025) research project, in collaboration with the Università Cattolica del Sacro Cuore in Piacenza (Department: DISTAS) and the University of Turin (Department: DISAFA). **The project aims to study the main factors that may influence the accumulation of nickel in grain, also considering the delicate balance with the other two important inorganic contaminants, cadmium and arsenic.**

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Regulation of contaminants in rice

ARSENIC

		Arsenic (inorganic) mg/kg
EUROPEAN UNION (EU) 2023/465	White rice	**0.15**
	Parboiled and husked rice	**0.25**
	Rice for baby food	**0.10**
CODEX ALIMENTARIUS	Polished rice	**0.2**
	Husked rice	**0.35**

CADMIUM

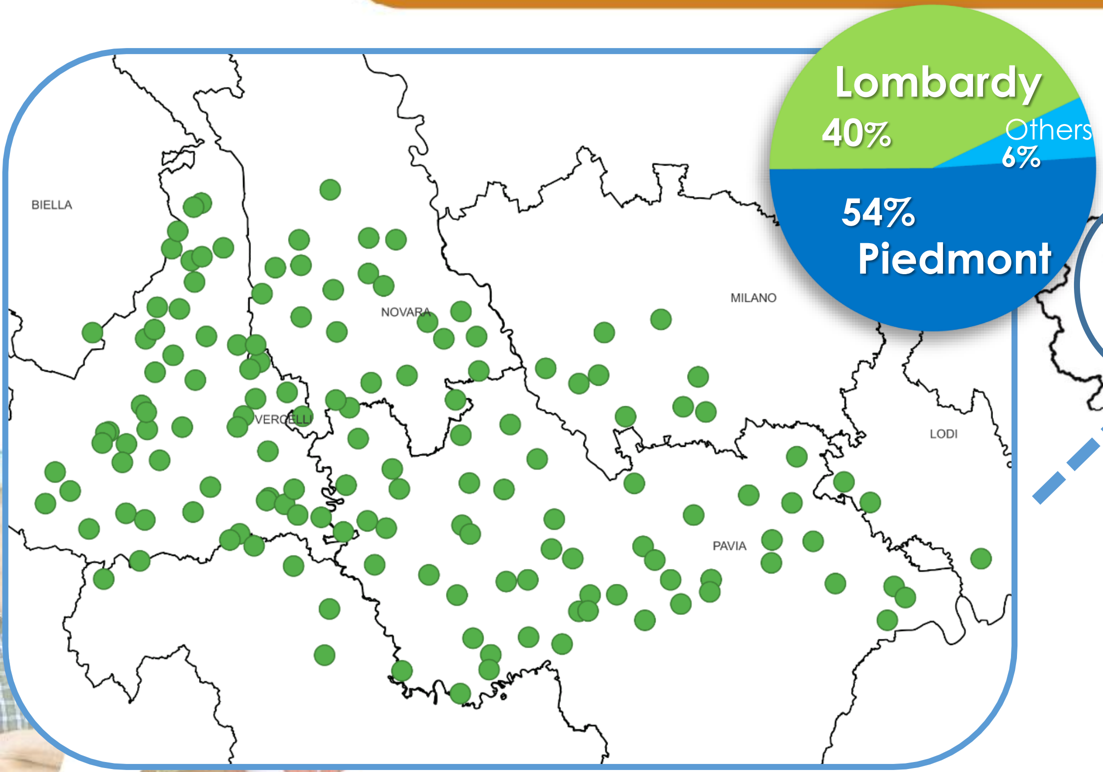
		Cadmium mg/kg
EUROPEAN UNION (EU) 2021/1323	Rice	**0.15**
	Rice for baby food	**0.040**
CODEX ALIMENTARIUS	Polished rice	**0.4**

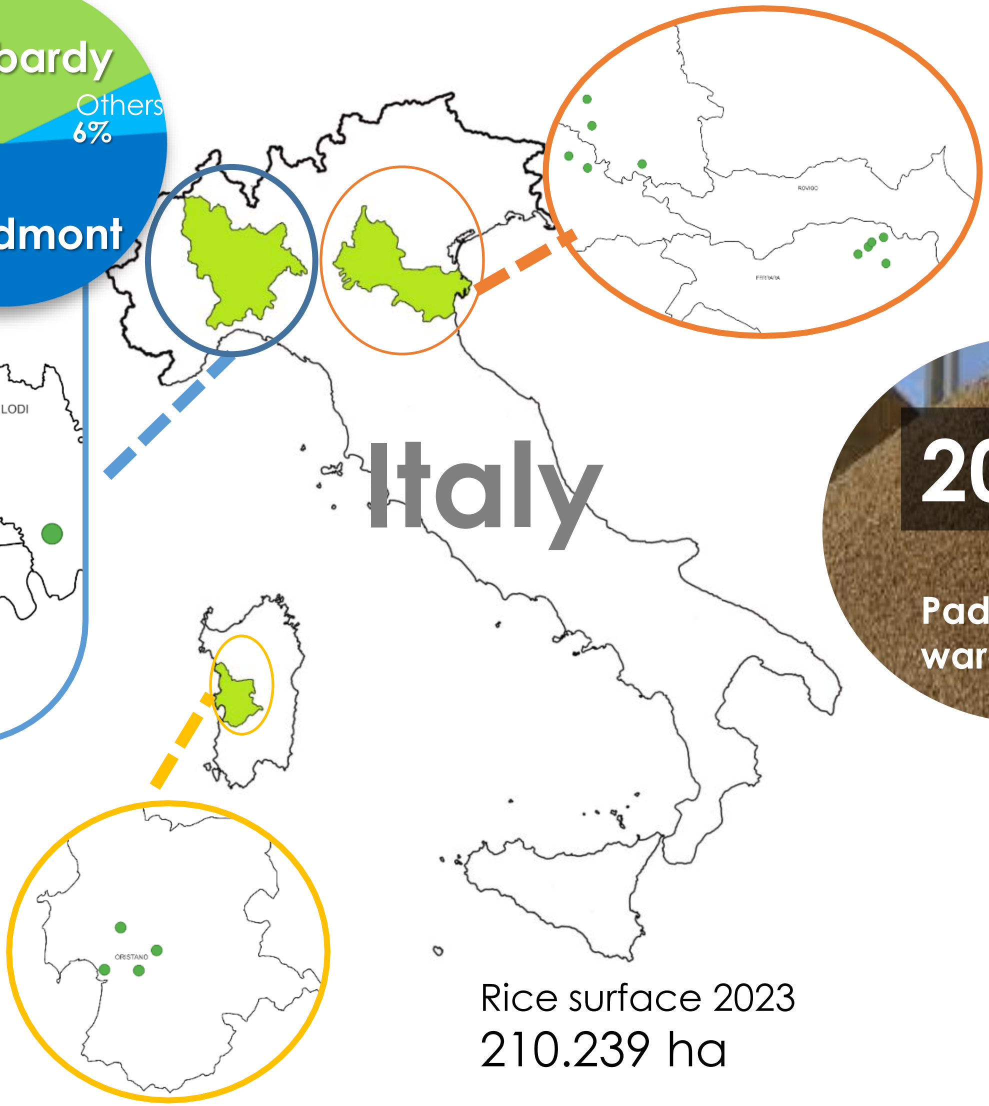
NICKEL

		Nickel mg/kg
EUROPEAN UNION	Rice	**1.5**
	Husked rice	**2.0**

Set from 1 July 2026

Contaminants monitoring 2021-2023
Arsenic, Cadmium and Nickel



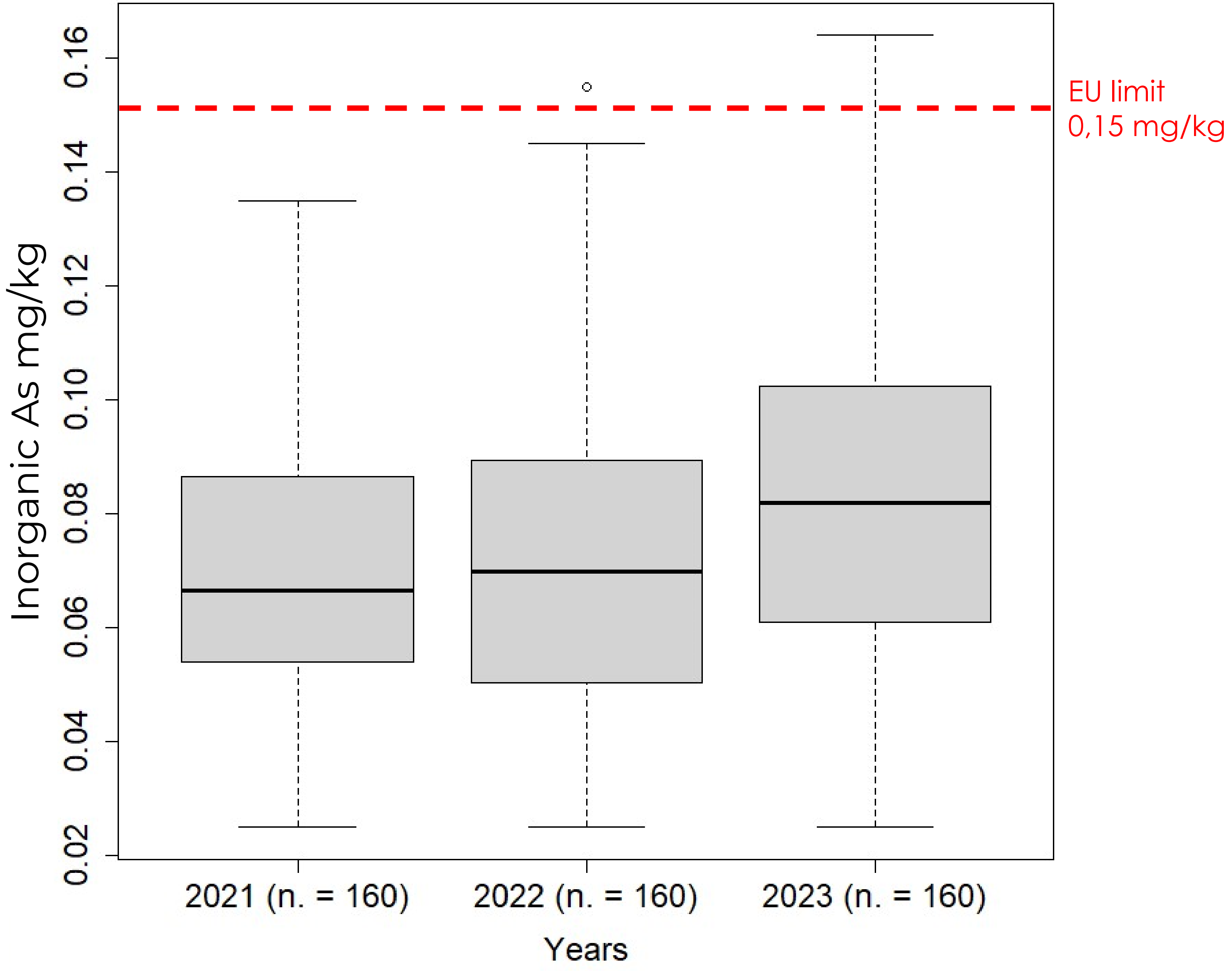


160 Rice samples collected every year

The distribution of sampling points was representative of the cultivated rice areas in each region.

Rice surface 2023
210.239 ha

Inorganic arsenic in white rice

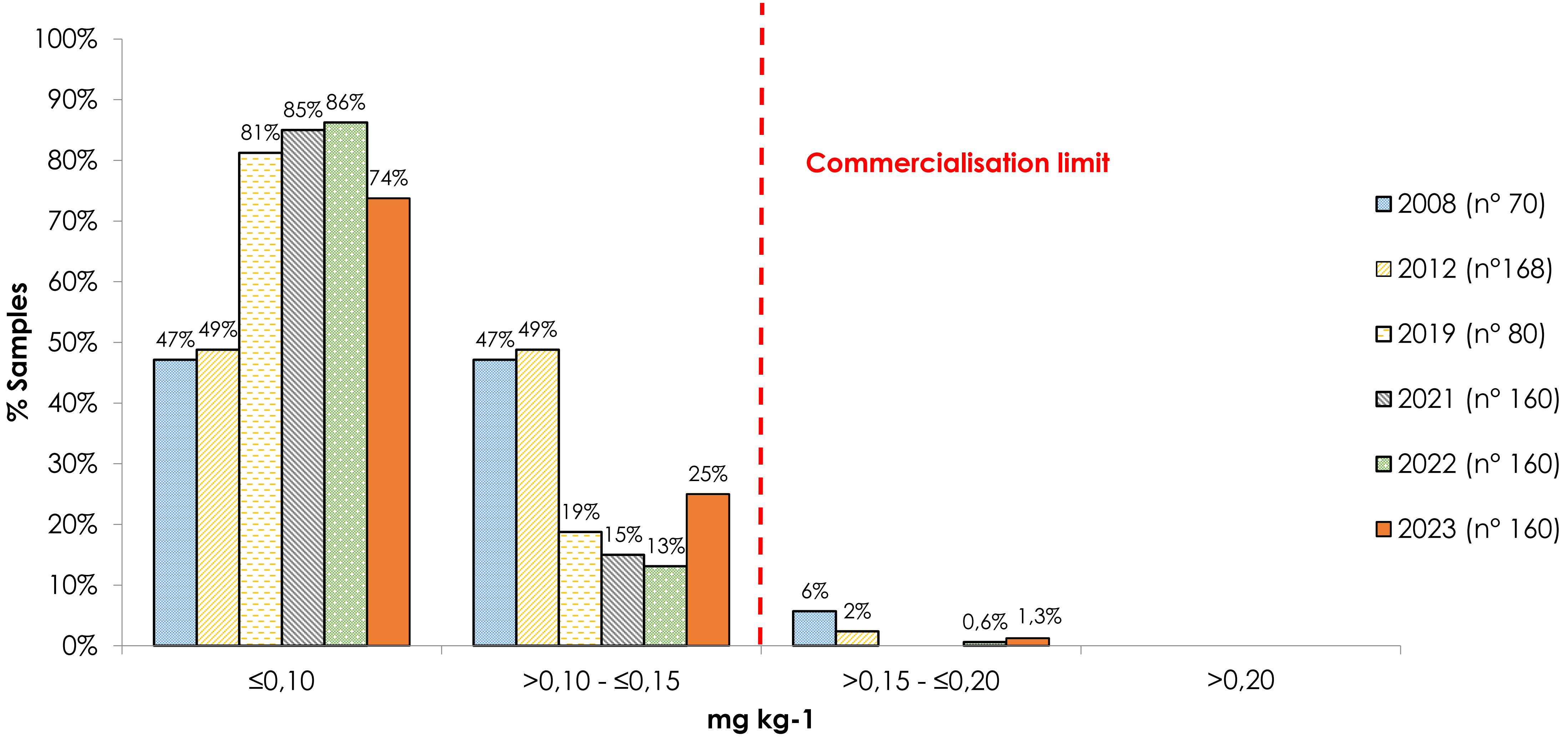


Inorganic ARSENIC

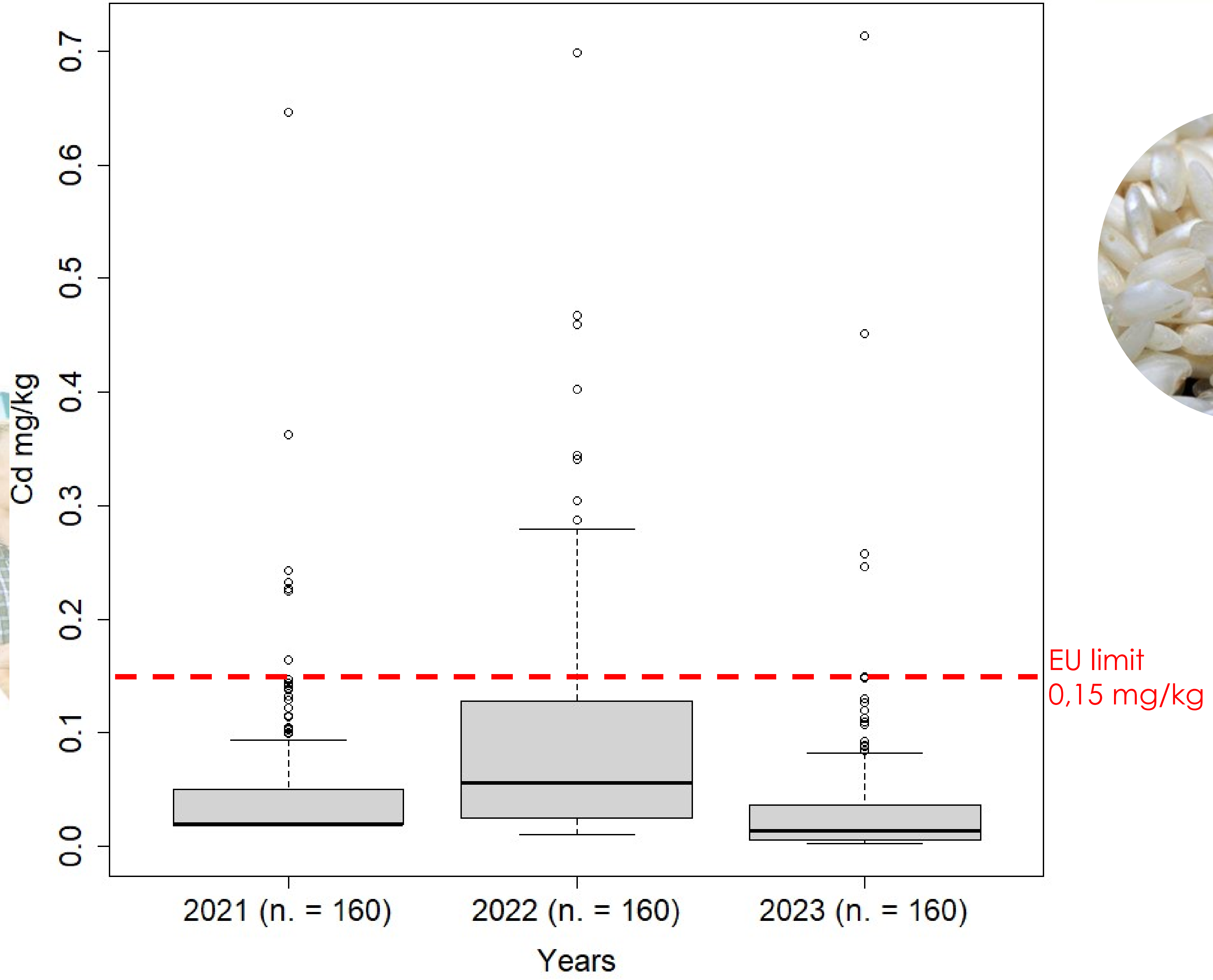
	2021	2022	2023
Mean	0,07	0,07	0,08
Min	0,03	0,03	0,03
1st quartile	0,05	0,05	0,06
Median	0,07	0,07	0,08
3rd quartile	0,09	0,09	0,10
Max	0,14	0,16	0,16

Inorganic arsenic in white rice(mg/kg)

ENR monitoring



Cadmium in white rice

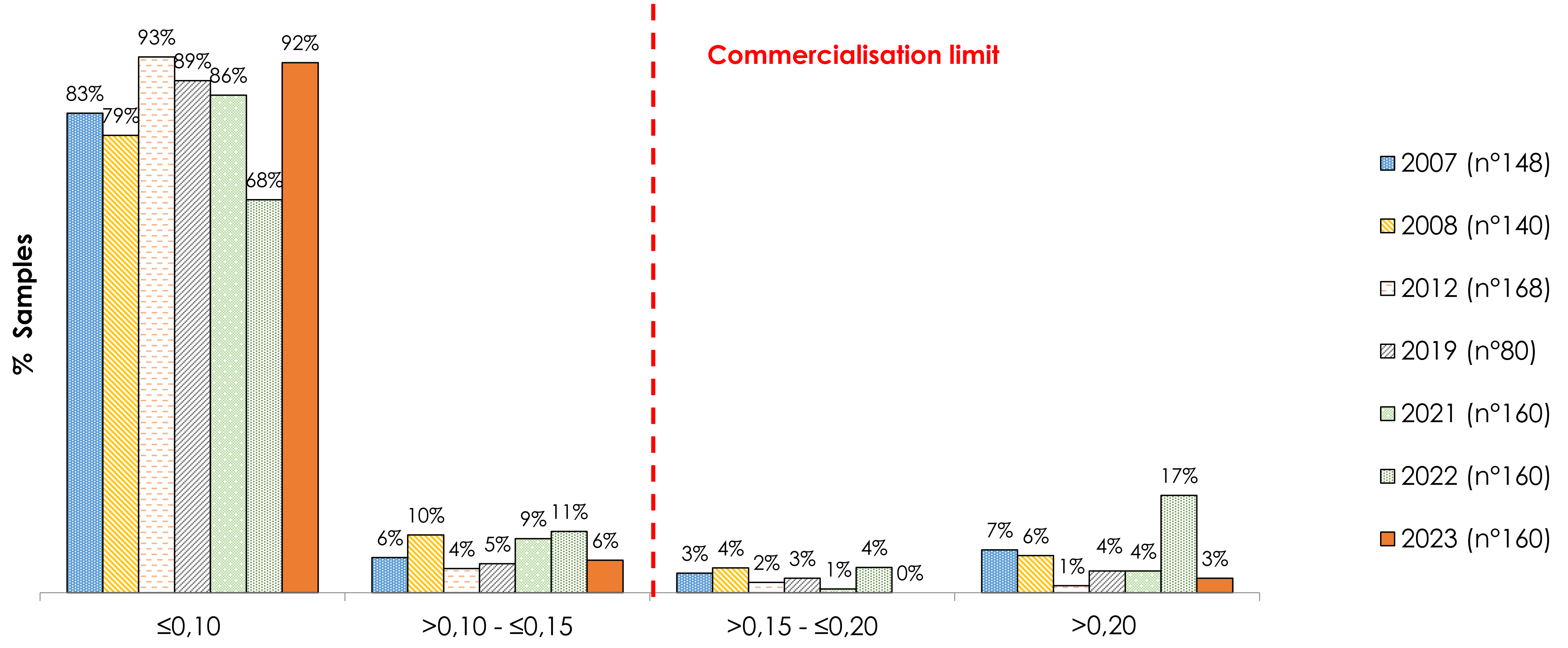


CADMIUM

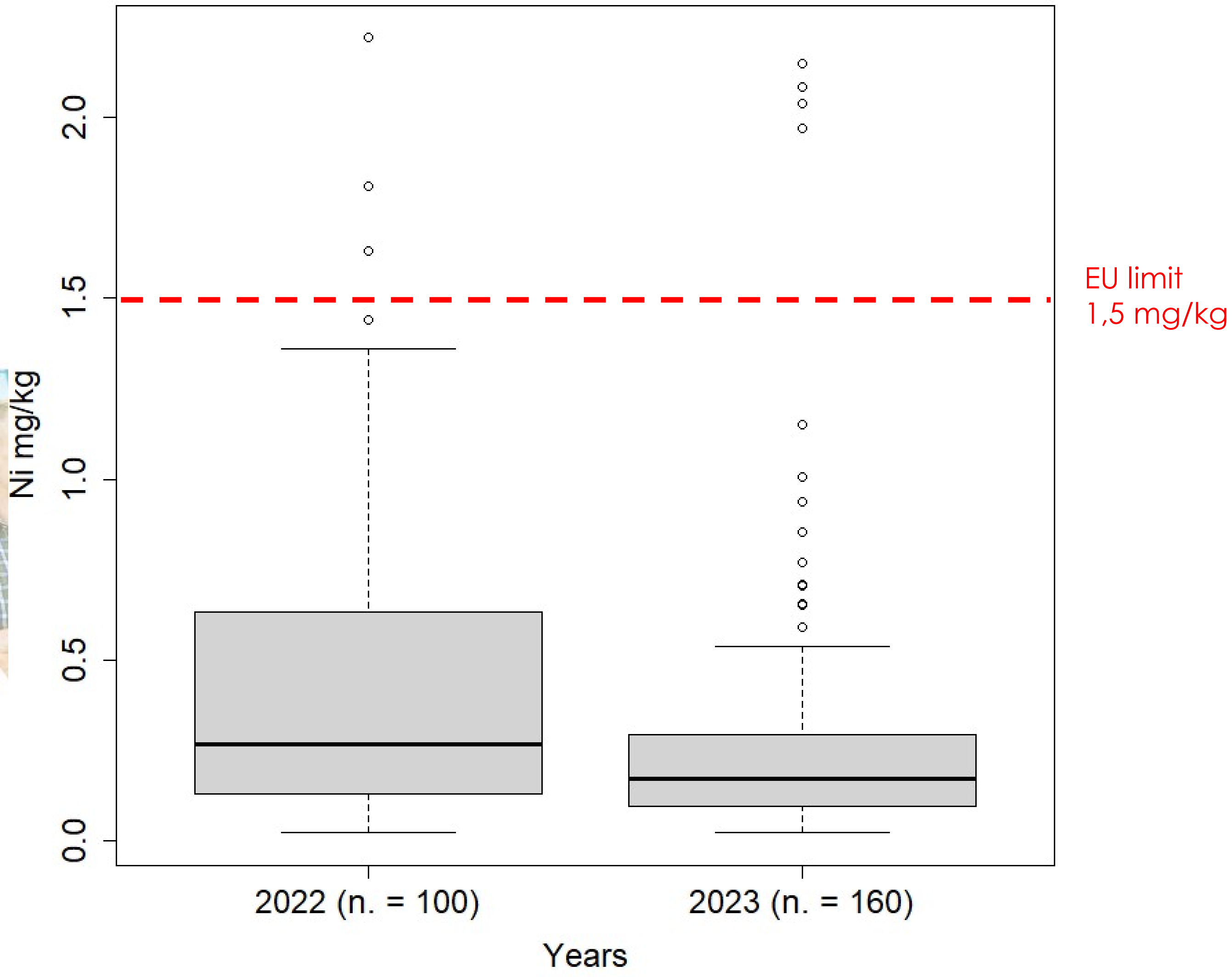
	2021	2022	2023
Mean	0,05	0,10	0,04
Min	0,02	0,01	0,00
1st quartile	0,02	0,03	0,01
Median	0,02	0,06	0,01
3rd quartile	0,05	0,13	0,04
Max	0,65	0,70	0,71

Cadmium in white rice (*mg/kg*)

ENR monitoring



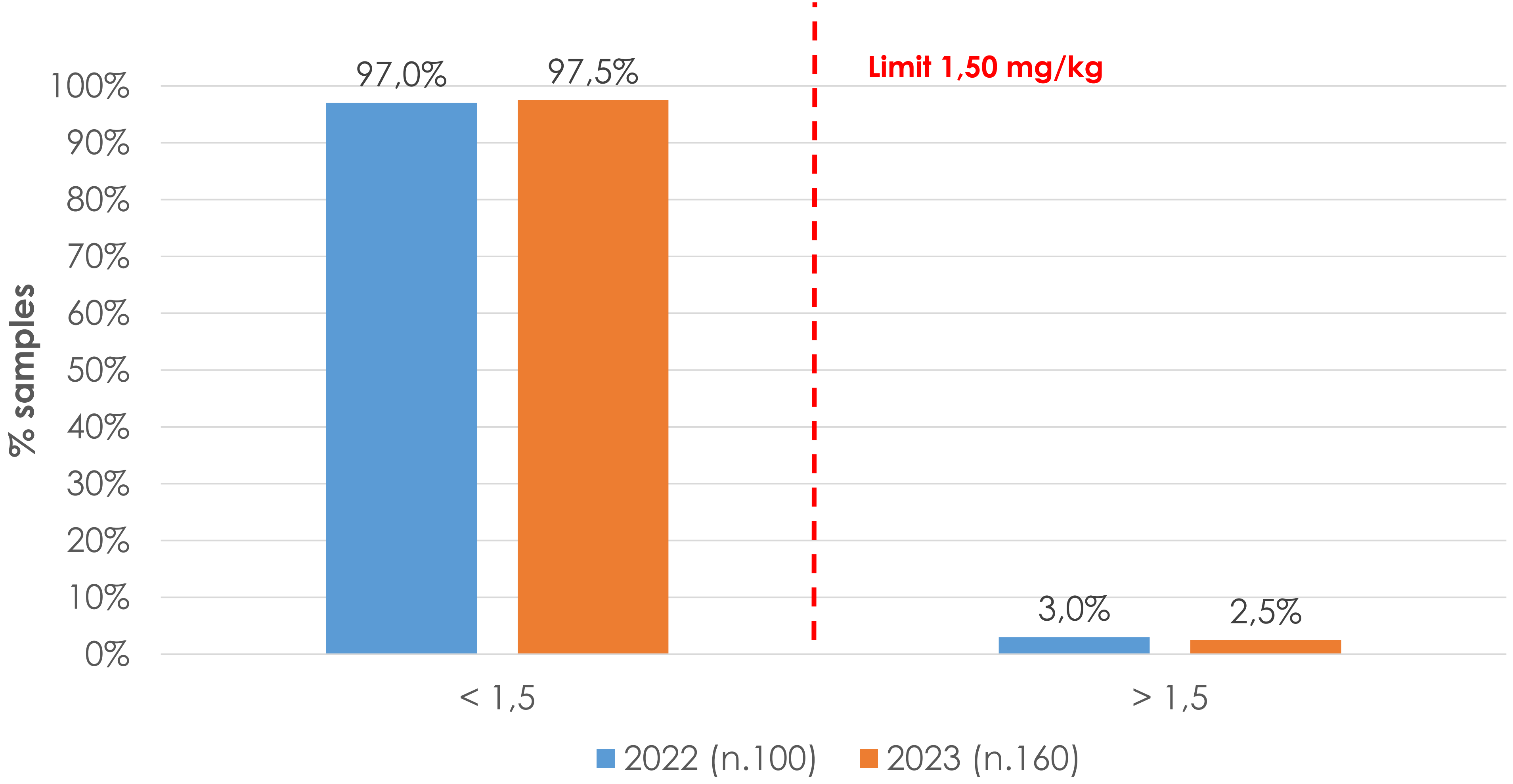
Nickel in white rice



NICKEL

	2022	2023
Mean	0,46	0,27
Min	0,02	0,02
1st quartile	0,13	0,10
Median	0,27	0,17
3rd quartile	0,63	0,29
Max	2,22	2,15

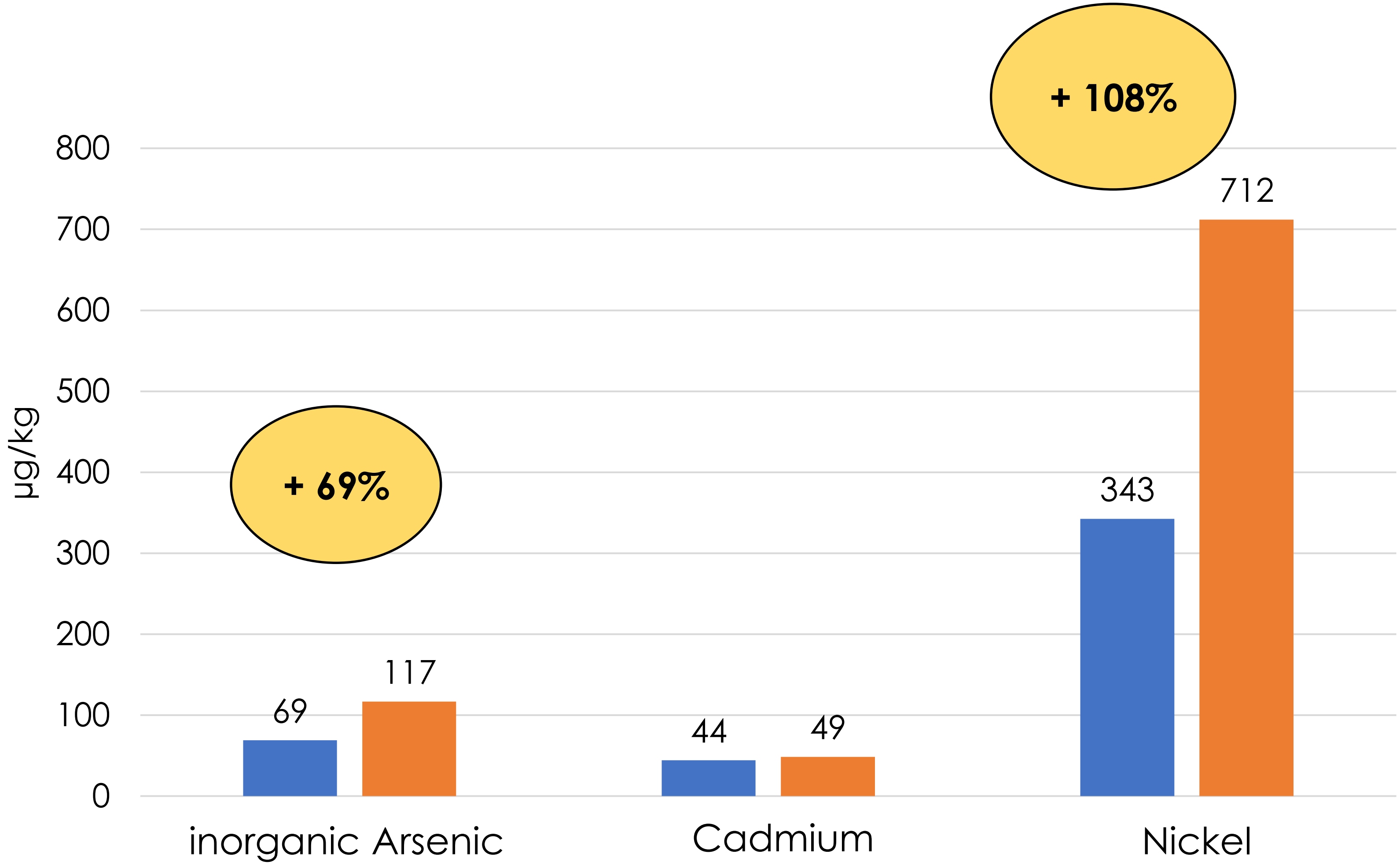
Nickel in white rice(mg/kg)
ENR monitoring



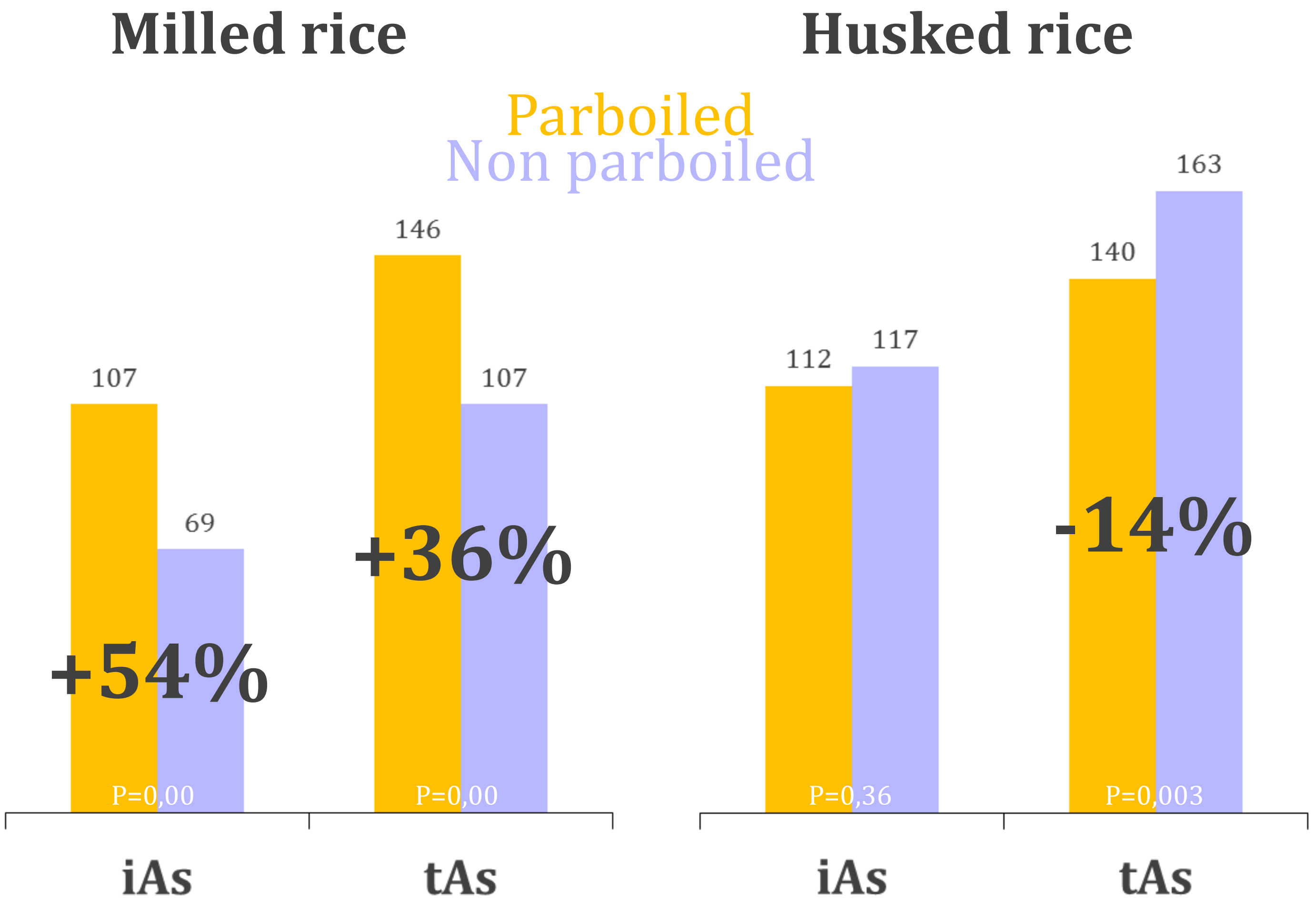
Effect of rice milling (µg/kg)

White rice

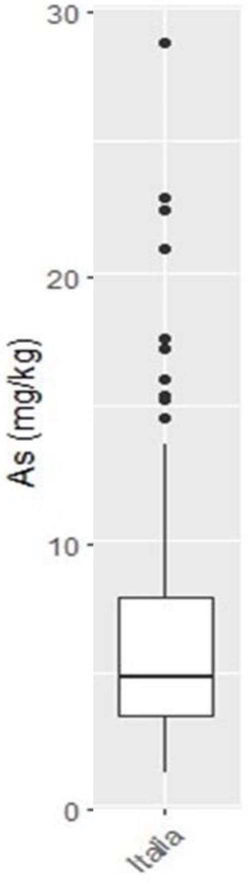
Husked rice

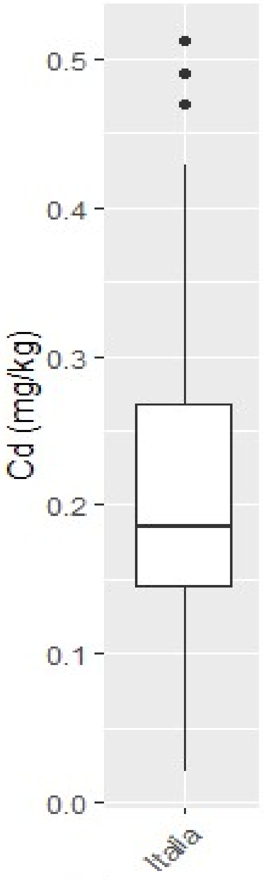


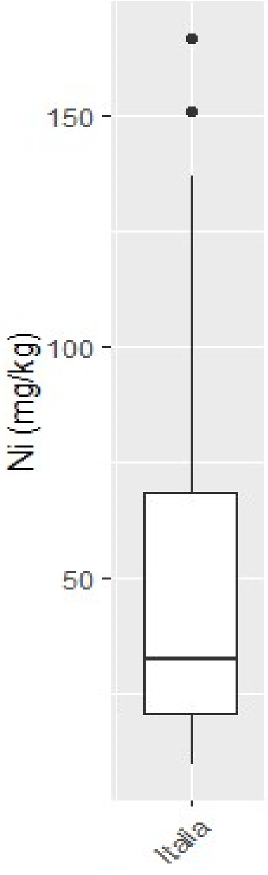
Effect of parboiling process (µg/kg)



Contaminants in soils – ENR monitoring 2023







Values in mg/kg

	N° of samples	Mean	Minimum	Median	Maximum
Arsenic	160	**6,22**	**1,24**	**4,81**	**28,71**
Cadmium	160	**0,21**	**0,02**	**0,19**	**0,51**
Nickel	160	**46,91**	**9,57**	**32,20**	**166,79**

ARSENIC

8 mg/kg
South Europe average concentration
(Tarvainen et al 2013)

CADMIUM

0,36 mg/kg world average concentration
0,20 mg/kg European average concentration (Kubier et al, 2019)

NICKEL

14 mg/kg european median (EU RAR, 2008)
Most of European agricultural soils <48 mg/kg with high variability
(Albanese et al. 2015)

Contaminants in water – Piedmont and Lombardy Regions

Data ARPA Lombardia and ARPA Piemonte
expressed in µg/l

Water course	Cd		As		Ni	
	AA	MCA	AA	MCA	AA	MCA
Agogna	**<0,05**	**<0,05**	**<2**	**<3**	**< 4**	**<34**
Agogna	**0,185** (2019) **0,313** (2020) **0,185** (2021)	**0,33** (2019) **1,00** (2020) **0,40** (2021)	"	"	"	"
Po	**<0,05**	**<0,05**	"	"	"	"
Po	"	"	"	"	"	"
Ticino	"	"	"	"	"	"
Lambro Meridionale	"	"	**3,4** (2019) **2,9** (2020) **3,1** (2021)	**8,1** (2019) **3,6** (2020) **5,2** (2021)	**5,9** (2019) **5,5** (2020) **5,3** (2021)	"
Sesia	"	"	**<2**	**<3**	**< 4**	"
Cervo	"	"	"	"	"	"
Dora Baltea	"	"	"	"	"	"

Water used for the irrigation of paddy fields is not contaminated

2019

2020

2021

DIRECTIVE 2008/105/EC of 16 December 2008

Cd µl/l	**As** µl/l	**Ni** µl/l	**Field of application**
5	10	20	Drinking water
<0,08-0,25	10	4	Annual average value (EQS-AA) surface water
<0,45-1,50		34	Maximum concentration (EQS-MCA) surface water

Cd and As dynamics in paddy soils

Anoxic | **Oxic**

CADMIUM

Anoxic

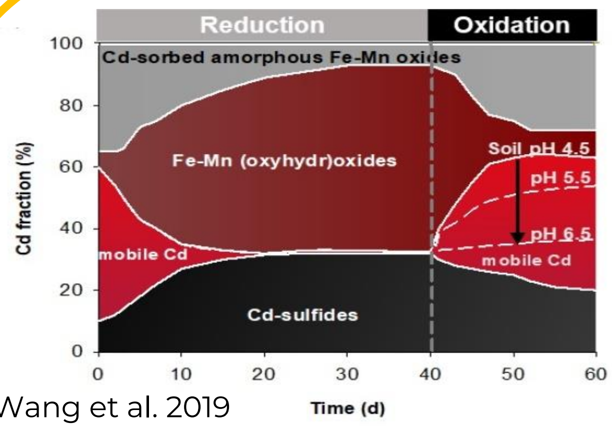
pH

Stable forms:
$CdCO_3$; $Cd(OH)_2$

Sorbed Cd to the
Fe–Mn (oxyhydro)oxides

CdS

Oxic

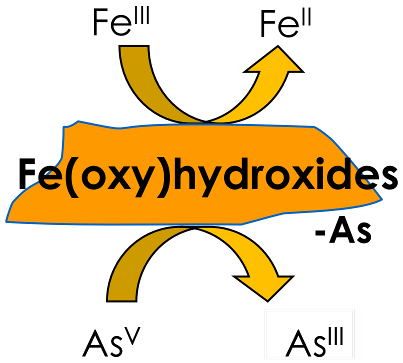


Wang et al. 2019

Cd mobilization from the **Fe–Mn (oxyhydro)oxides**

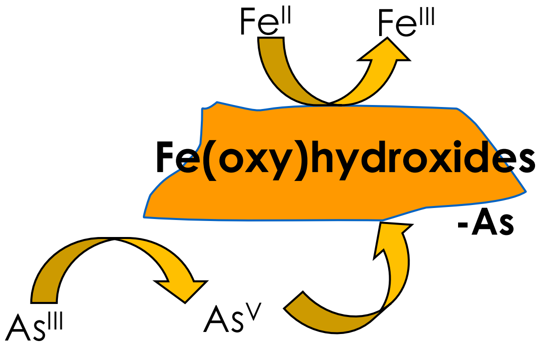
ARSENIC

Anoxic



Dissolution of Fe(oxy)hydroxides and release of As in soil solution

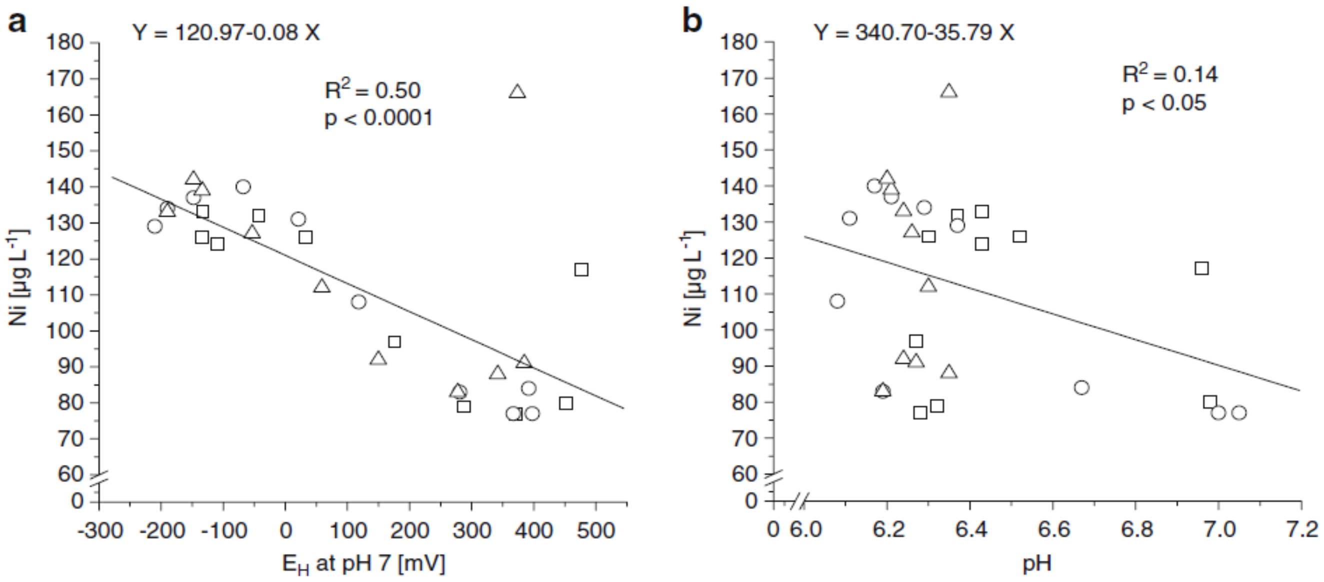
Oxic



Immobilization

Ni dynamics in paddy soils

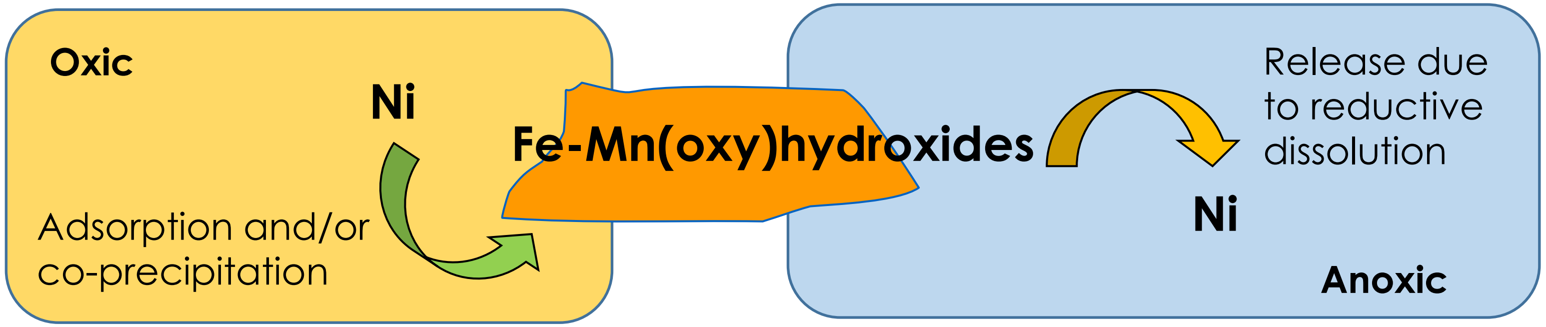
Influence of Redox potential and pH
on Ni in soil solution



Antić-Mladenović et al. 2010

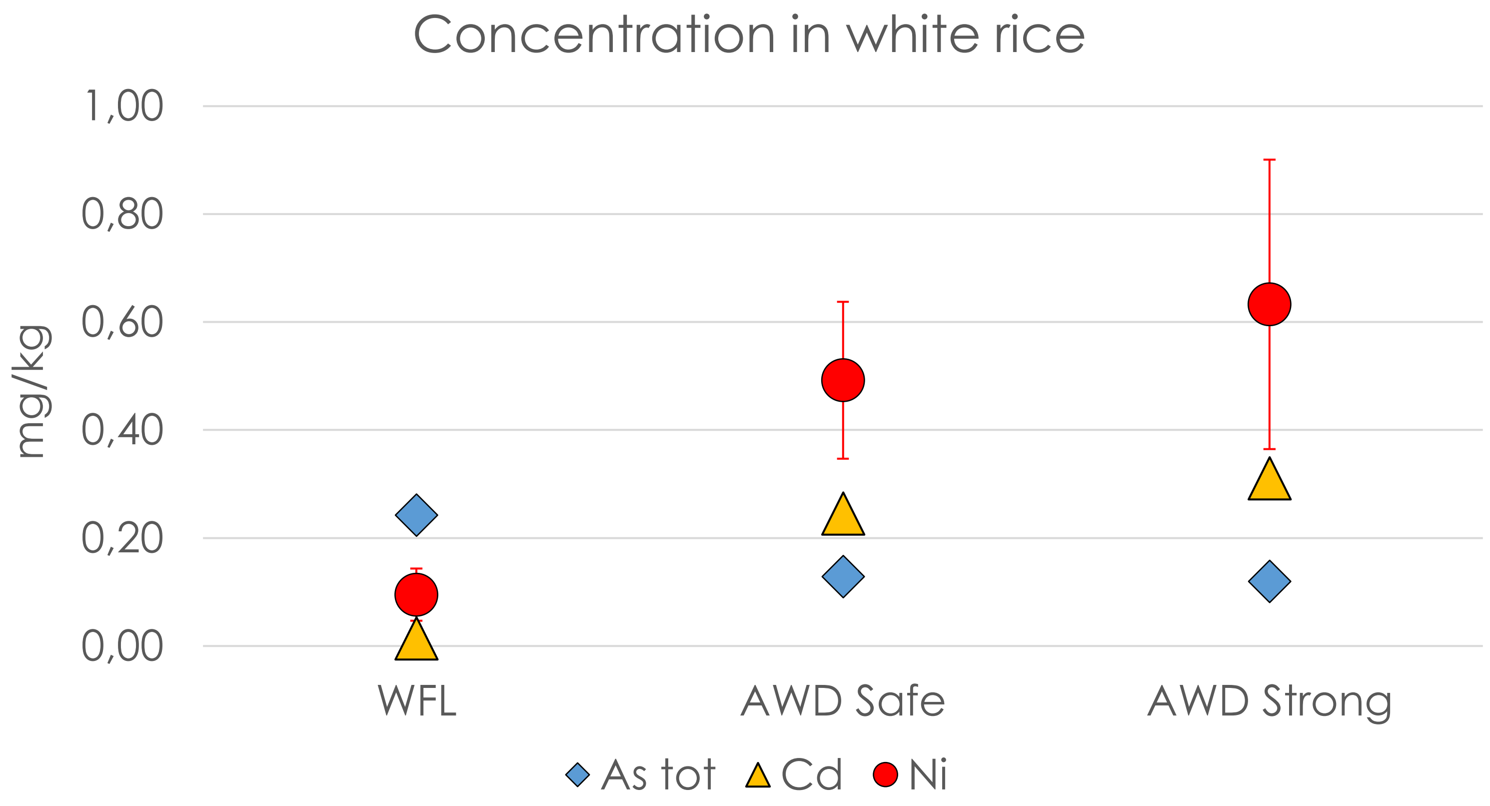
NICKEL

Nickel is associated with
Fe−Mn (oxyhydro)oxides



Water management effect

Project RISWAGEST 2022 – field trial



Contaminant concentration in **white rice** mg/kg

	As tot	Cd	Ni
WFL	0.24 a	0.01 b	0.09 b
AWD Safe	0.13 b	0.25 a	0.49 a
AWD Strong	0.12 b	0.31 a	0.63 a

Contaminant concentration in **soil** mg/kg

	Cd	As tot	Ni
Test soil	0.16	13.00	31.29

WFL – continuous flooding

AWD safe – Alternate wetting and "safe" drying

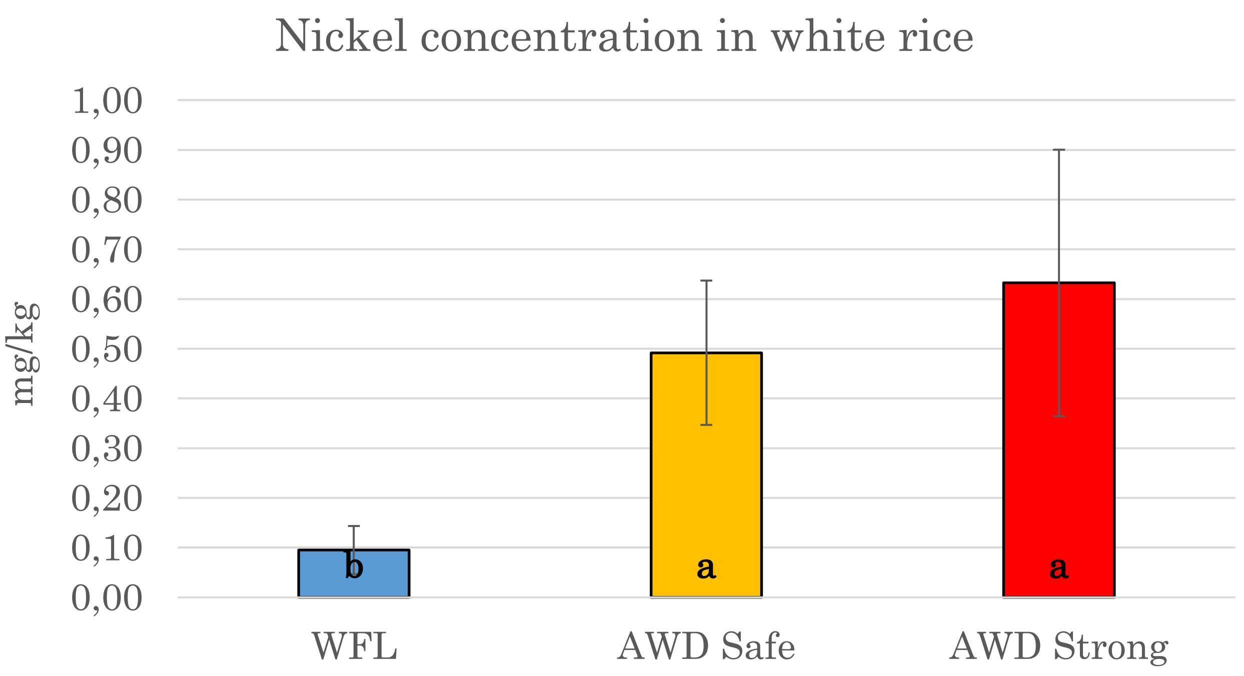
AWD strong – Alternate wetting and "strong" drying

Soil characteristics

	Sand %	Silt %	Clay %	pH	S.O. %	CSC meq/100g
Test soil	28.8	56.9	14.4	5.8	1.82	11.9

Nickel - water management effect

Project RISWAGEST 2022 – field trial



WFL – continuous flooding

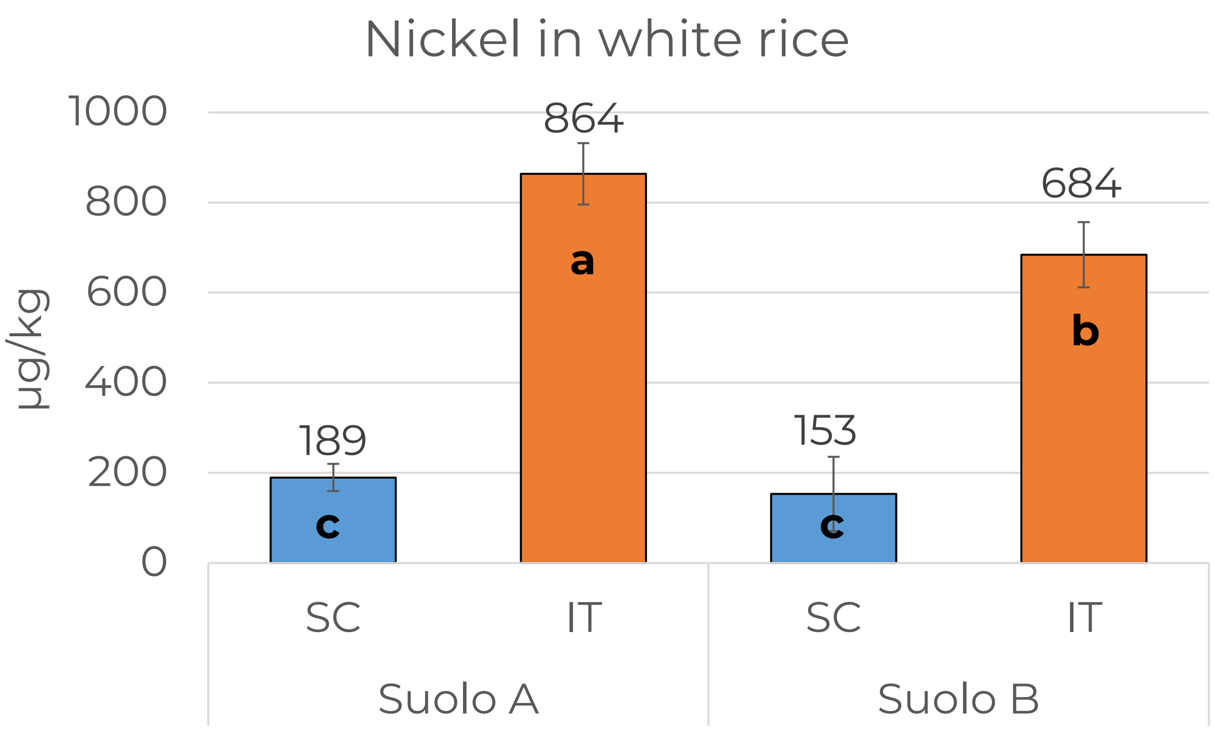
AWD safe – Alternate wetting and "safe" drying

AWD strong – Alternate wetting and "strong" drying

Average concentration in soil:

31.29 mg/kg

Water management effect
Contaminants Project – mesocosm trial



SC – water seeding and continuous flooding

IT – Aerobic rice, drill seeded

Contaminant concentration in **soil**
mg/kg

	Cd	**As**	**Ni**
Soil A	0.22	9.53	139.0
Soil B	0.31	3.62	33.9

Soil characteristics

	Sand %	**Silt** %	**Clay** %	**pH**	**S.O.** %	**CSC** meq/100g
Soil A	31.7	57.7	10.6	8.1	1.22	8
Soil B	71.65	21.55	6.8	6.3	1.45	10.8

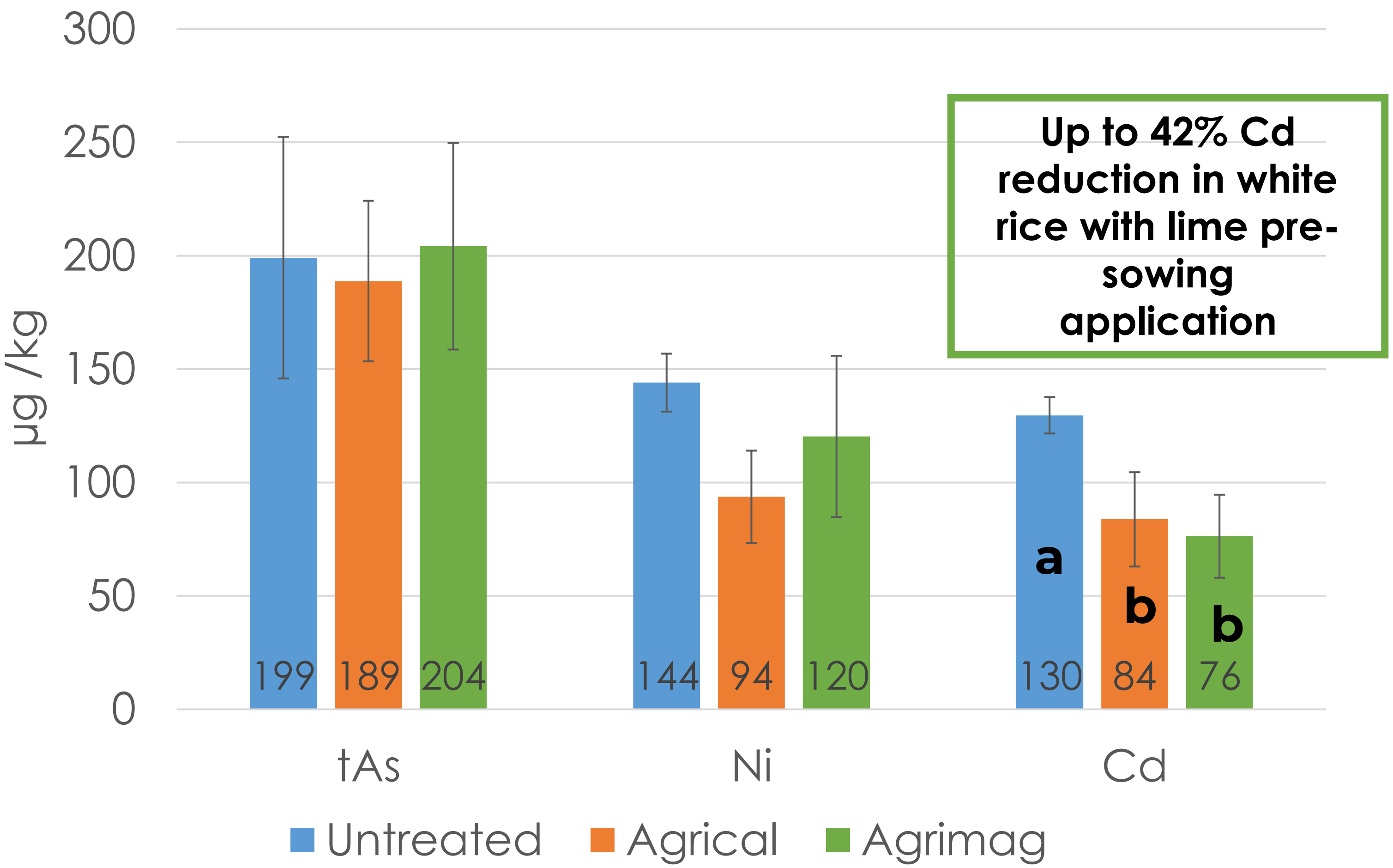
Effect of lime application

Agrical

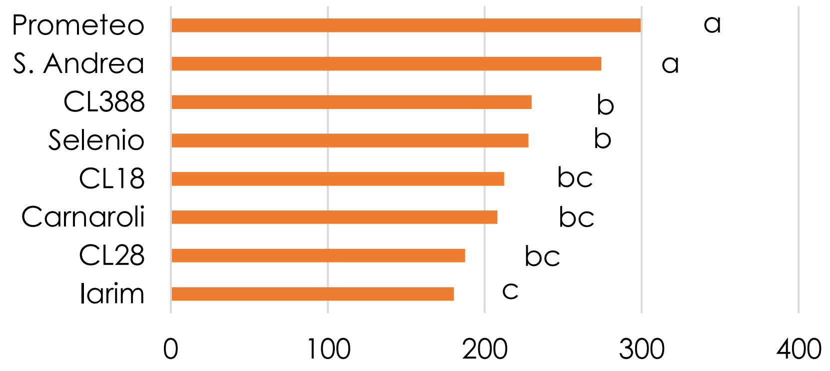
CaO+MgO %	92+2
Rate kg/ha Pre-sowing	2000

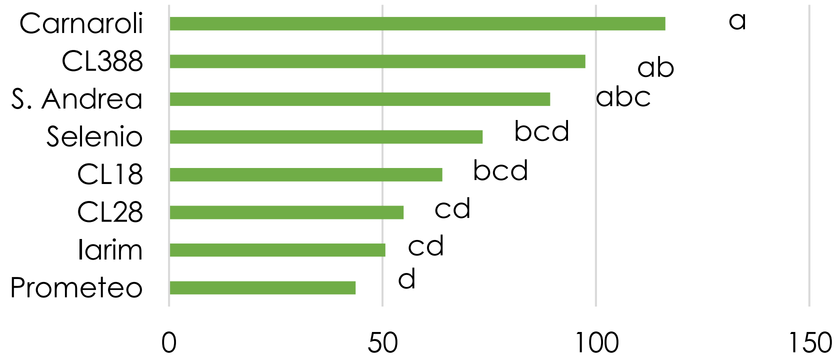
Agrimag

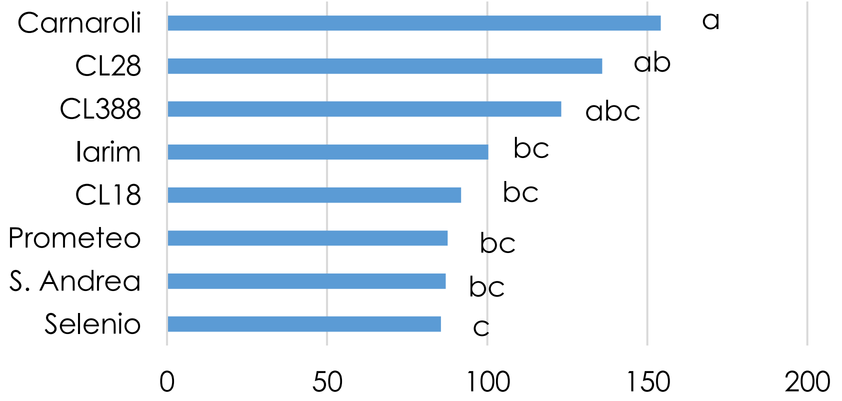
CaO+MgO %	80+15
Rate kg/ha Pre-sowing	2000



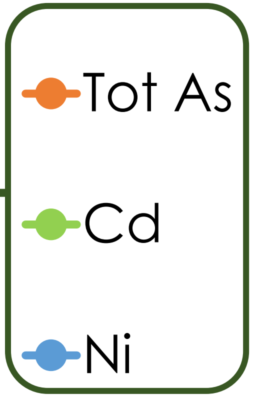
Varietal effect

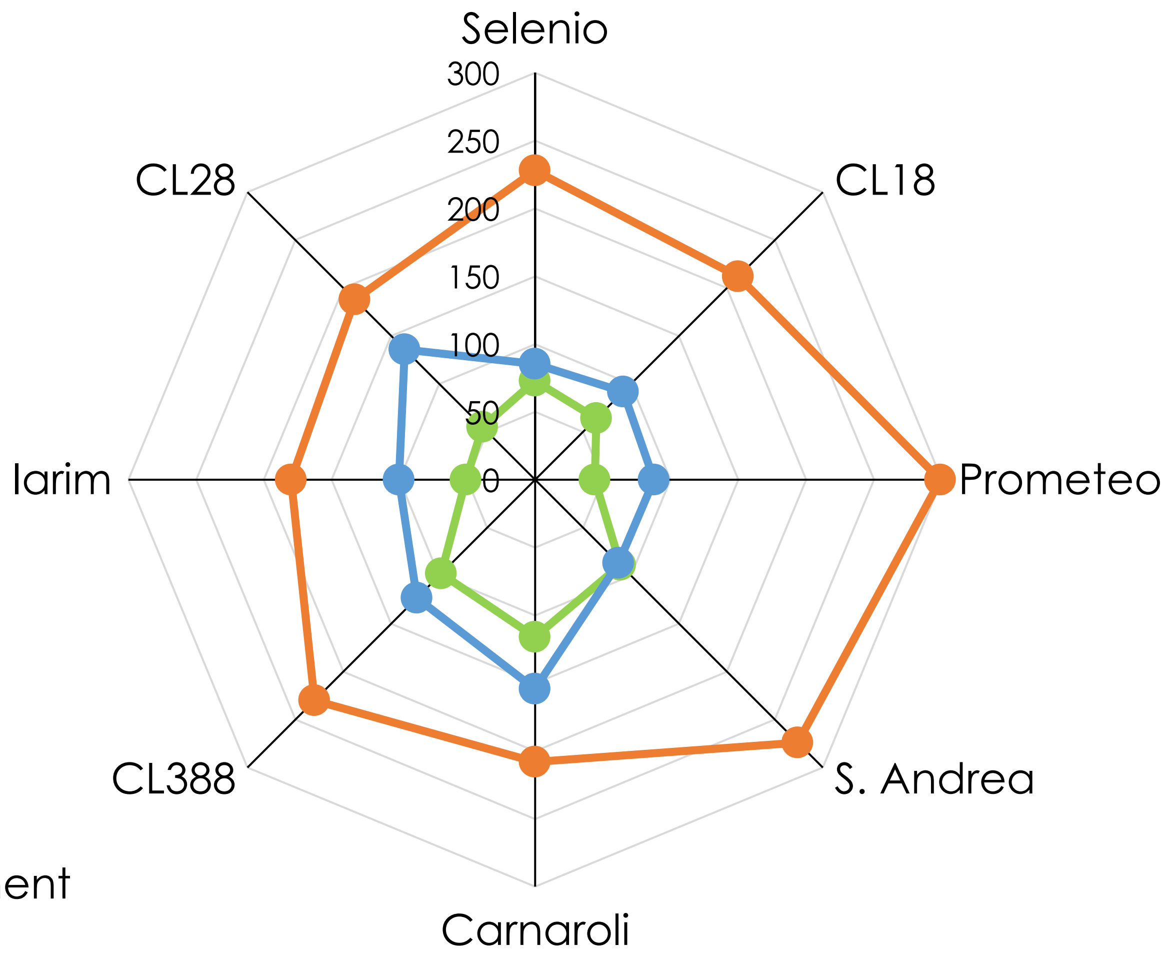






The varieties have been cultivated in the same field.
4 replication

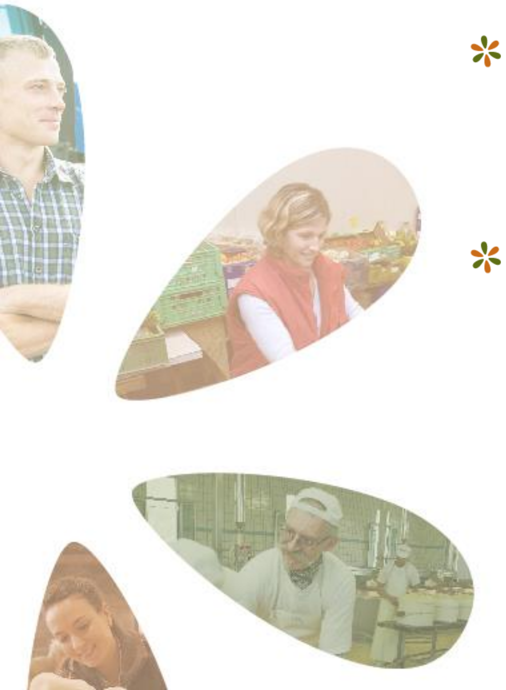




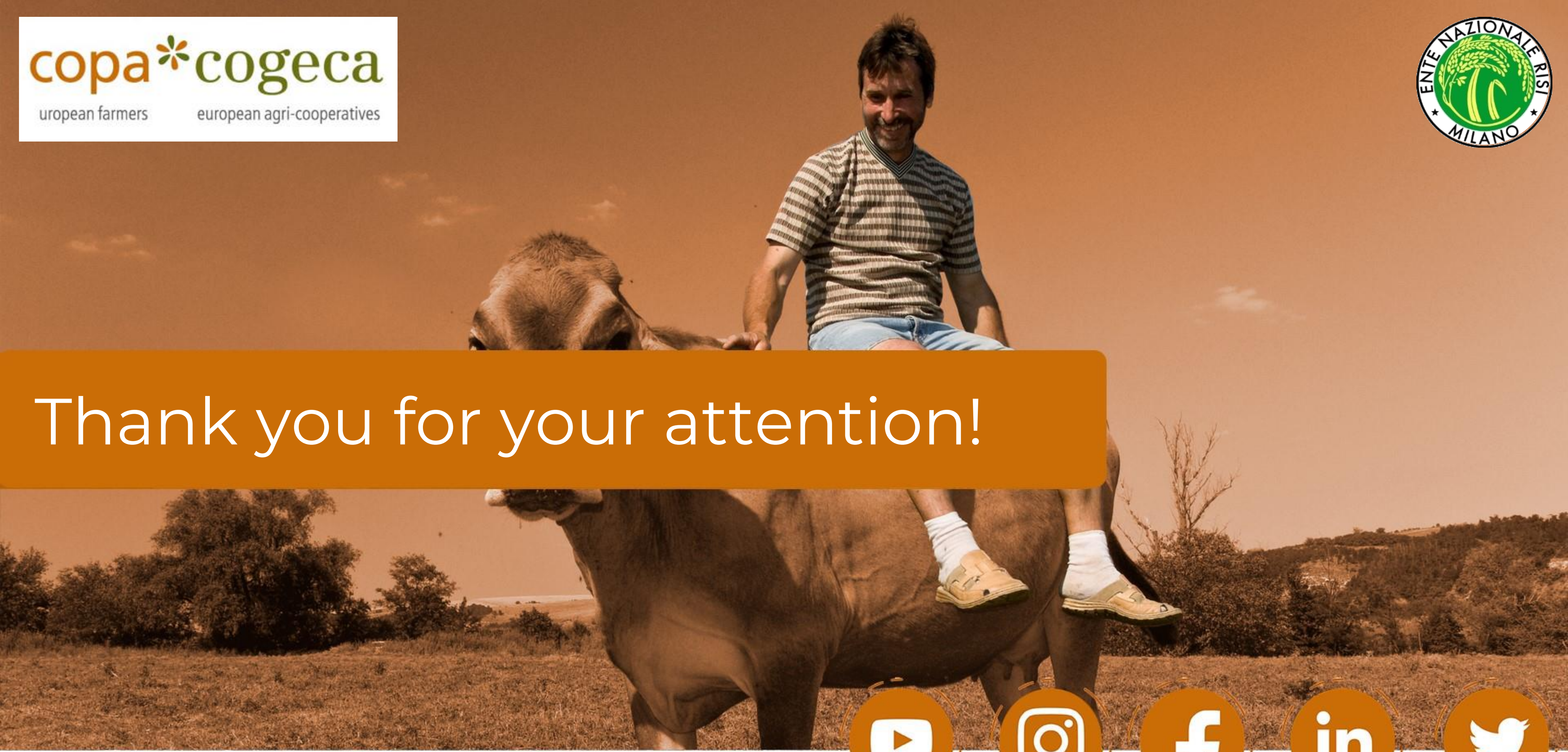
Dry seeding
AWD water management

	Cd mg/kg	As mg/kg	Ni mg/kg	Sand %	Silt %	Clay %	pH	O.M. %	CEC meq/100g
Soil	0,25	16,8	21,4	30,0	56,4	13,6	5,8	3,4	9,3

Conclusions



- Inorganic contaminants are starting to worry the cereals, food and catering sectors in general.
- The EU rice sector is proactively working towards more sustainable practices, but…
- The delicate balance between different inorganic contaminants (e.g. nickel, cadmium and arsenic) with respect to water management needs to be taken into account…
- Indeed, over the years, increasingly different extreme climatic conditions have had an impact on production but also on the residues of inorganic contaminants→ **sometimes with opposite behaviour according to water management practices!**
- **Therefore, a careful analysis is needed before applying too strict limits, even for a single inorganic containant, which would result in the loss of flexibility in paddy water management operations that is necessary to achieve an overall more sustainable production process and that would have a negative impact on EU rice production.**



Thank you for your attention!

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