PROMEDRICE
PROTECTING MEDITERRANEAN RICE-BASED AGRO-ECOSYSTEMS

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FACTSHEETS

LIMING IN RICE AGRO-ECOSYSTEMS

Why use liming?

Liming involves applying materials containing calcium and magnesium carbonates or oxides to the soil in order to correct acidity and improve its chemical and biological fertility. In the agricultural soils of the Po Valley in northern Italy, which are subject to acidification due to intensive cultivation and fertilizer use, liming represents an important method of maintaining soil fertility.

In rice cultivation, the flooding of the paddy fields has a significant impact on soil pH and redox dynamics, with consequences for nutrient availability and the mobility of potentially toxic elements. In this context, liming can help stabilize soil chemical conditions and improve nutrient-use efficiency within the cropping system.

Its application can provide several benefits, including:

- increased soil pH and correction of soil acidity;
- improved nutrient availability, phosphorus and nitrogen;
- reduced aluminium toxicity in acidic soils;
- promoted microbial activity and organic matter mineralization;
- reduced availability of some heavy metals, such as cadmium

A specific consideration concerns arsenic: the effect of liming on its mobility is more complex and strongly dependent on soil redox conditions.

How to apply lime?

Liming should be planned based on the soil's chemical and physical characteristics. In addition to soil pH, relevant factors include cation exchange capacity (CEC), base saturation, soil texture, organic matter content, and exchangeable calcium and magnesium concentrations. While soil pH describes the current acidity of the soil, it does not fully reflect its buffering capacity.

In rice-based cropping systems, the following is recommended:

- apply lime before sowing and flooding, in dry conditions (Figure 1), to promote uniform incorporation and allow it to react with soil acidity before reducing conditions develop;
- incorporate the product into the upper 10-20 cm of soil by harrowing or disc cultivation, as liming materials have limited mobility and surface-only application may result in a less uniform pH increase throughout the root zone.
- avoid application on saturated or waterlogged soil and immediately before heavy rainfall, to reduce the risk of uneven distribution, surface runoff, and soil compaction caused by machinery traffic;
- when using quicklime, specific safety precautions must be adopted due



Figure 1 - Liming application

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to its high reactivity and exothermic reaction with water;
- avoid direct contact with seeds and ammonium-based nitrogen fertilizers.

What did we observe in PROMEDRICE?

During the two experimental seasons, 2 t ha^{-1} of agricultural lime (Agrical; 92% CaO and 2% MgO) was applied before sowing each year.

Soil pH

Soil pH initially increased from 6.1 before the experiment to 6.7 in October 2024, demonstrating the initial alkalizing effect of the product.

However, it subsequently decreased to 5.8, suggesting a complex temporal response associated with flooding conditions, redox processes, and the agronomic management of the paddy system. These results suggest that the effects of liming in paddy soils may be transient and influenced by several environmental and management-related factors.

Arsenic and other grain parameters

- In **2024**, the limed plot had the lowest total arsenic concentration in rice grain (109 µg kg^{-1}), which was significantly lower than the concentrations recorded under the other treatments. In contrast, inorganic arsenic (69 µg kg^{-1}) did not differ significantly among treatments.
- In **2025**, total arsenic increased to 201 µg kg^{-1} but remained lower than under the other treatments, whereas inorganic arsenic reached the highest concentration among all treatments (152 µg kg^{-1}).
- Nickel and cadmium concentrations did not differ significantly between the two years and among the treatments.
- Milled-rice yield and head-rice yield were comparable to those obtained under the other treatments.

Grain yield

Liming did not substantially affect grain yield compared with the untreated control. In 2024, grain yield was 8.40 t ha^{-1}, compared with 8.35 t ha^{-1} in the untreated control, corresponding to an increase of 0.6%. In 2025, it was 7.40 t ha^{-1}, compared with 7.57 t ha^{-1} in the untreated control, corresponding to a 2.2% decrease. Overall, these findings suggest that liming had a neutral effect on crop productivity, with only minor variations observed between the two experimental years (Table 1).

Table 1 - Paddy rice production obtained from liming treatment compared to the untreated control

Year	Liming treatment (t ha^{-1})	Untreated (t ha^{-1})
2024	8.40	8.35
2025	7.40	7.57

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