

Plant-available phosphorus in young volcanic soils developed on pyroclasts from the 1991 eruption of Mt. Pinatubo, Philippines

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Introduction

- ❖ Phosphorus (P) is an essential nutrient for crop growth but its availability in soils is often limited due to precipitation in secondary minerals, adsorption to clays, or fixation/immobilization with organic matter.
- ❖ Plant available P (P_{avail}) in young volcanic soils may be high due to rapid weathering of primary minerals.
- ❖ This study assesses the content of plant-available P in agricultural and non-agricultural soils after 26 years of pyroclastic (ash and lahar) deposition from 1991 Mt. Pinatubo eruption.



1991 Mt. Pinatubo eruption

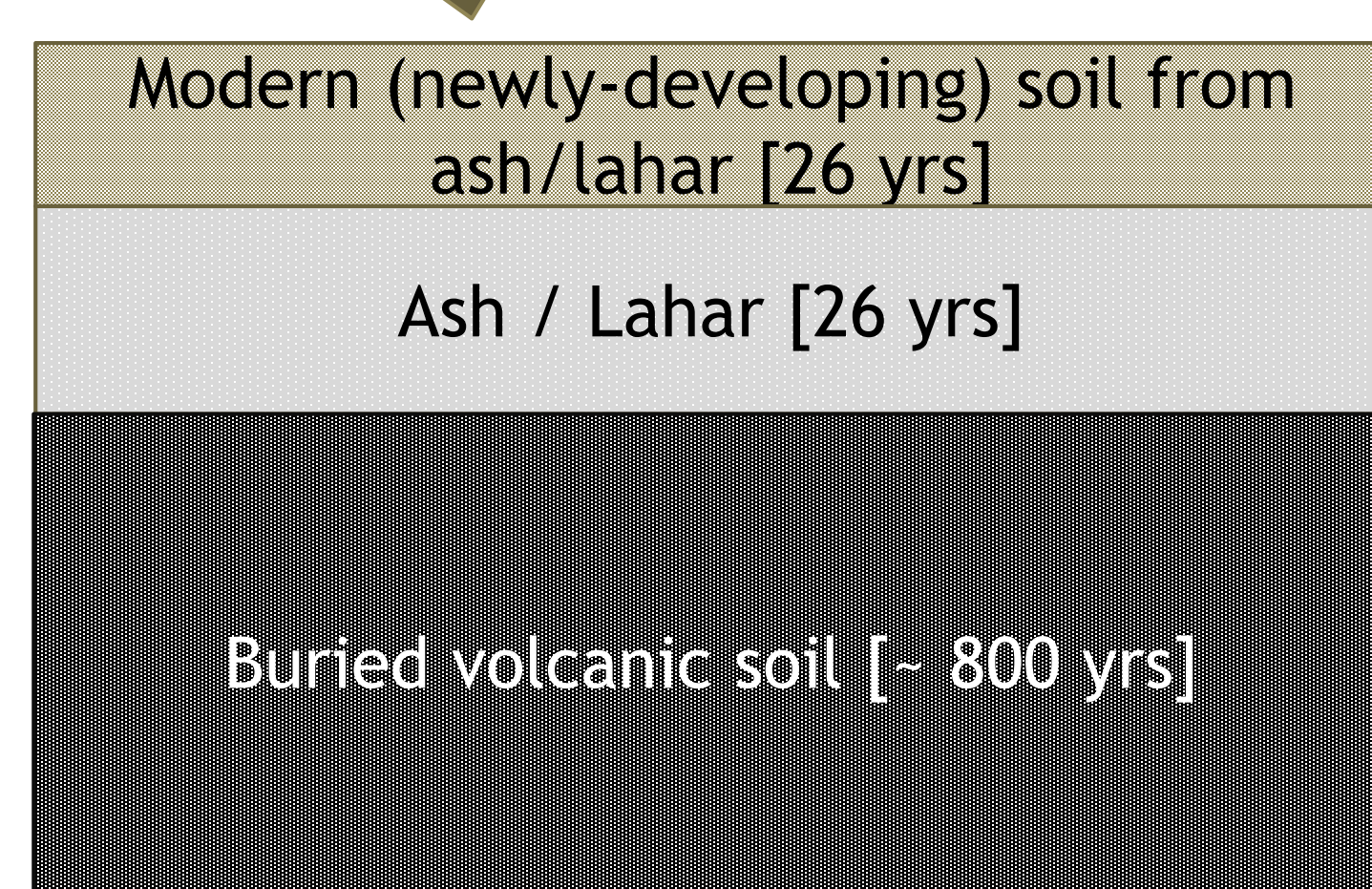


Figure 1. Soil profile of a young volcanic soil 26 years after 1991 Pinatubo eruption

Methods

Soil Sampling

Modern and buried soil samples were collected from 5 sampling sites (2 profile pits / site) varying in land-use types and altitudes (Fig. 2).

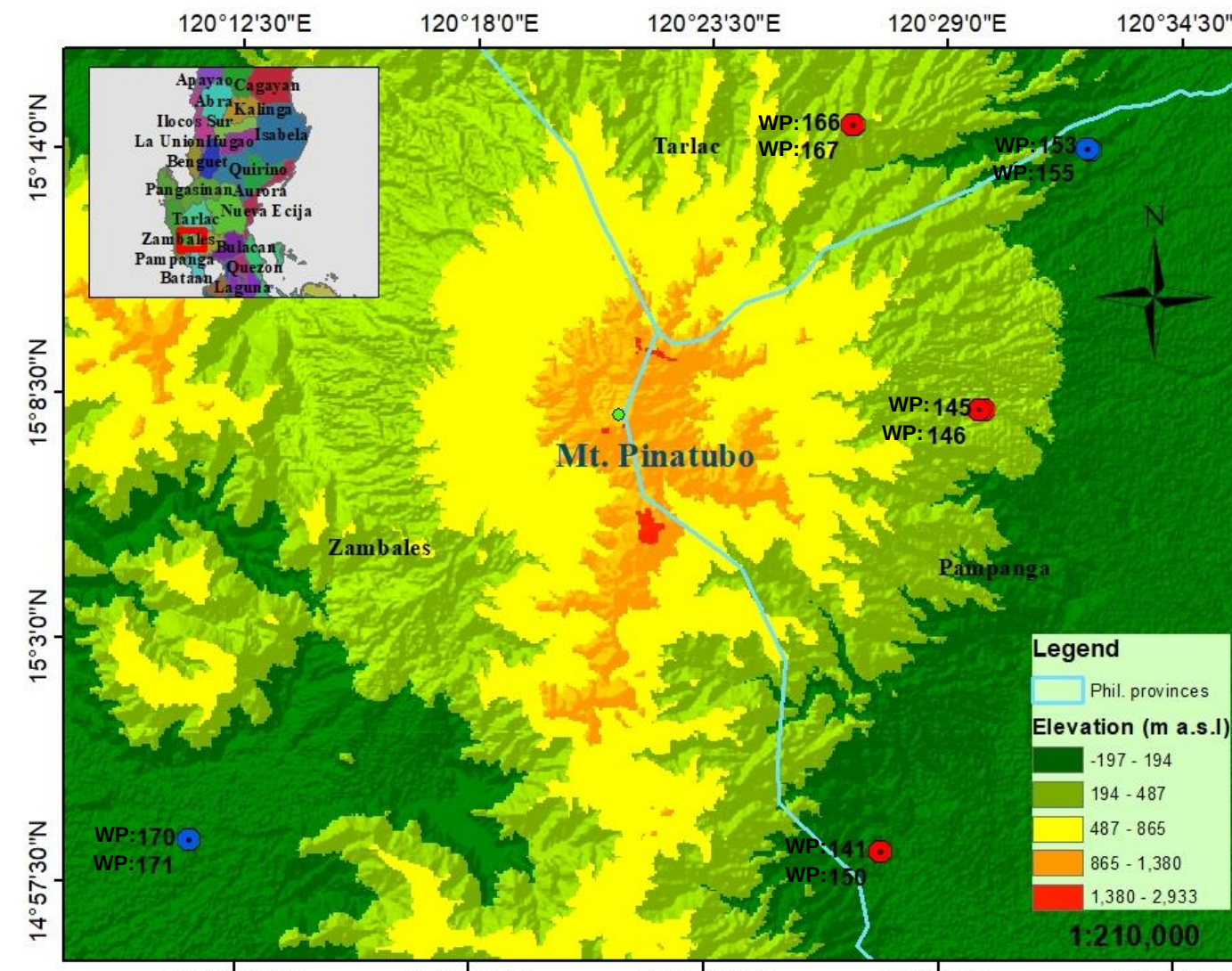


Figure 2. Digital elevation map of Philippines showing the study sites

Chemical Analysis

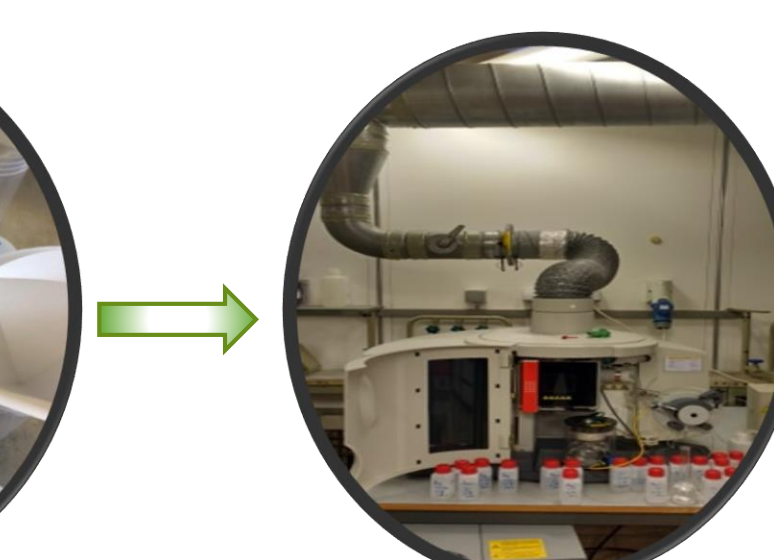
- ❖ Available P
- ❖ Total Elemental Analysis [Total P (as P_2O_5), Ca, Na, K, Mg]



Soil preparation

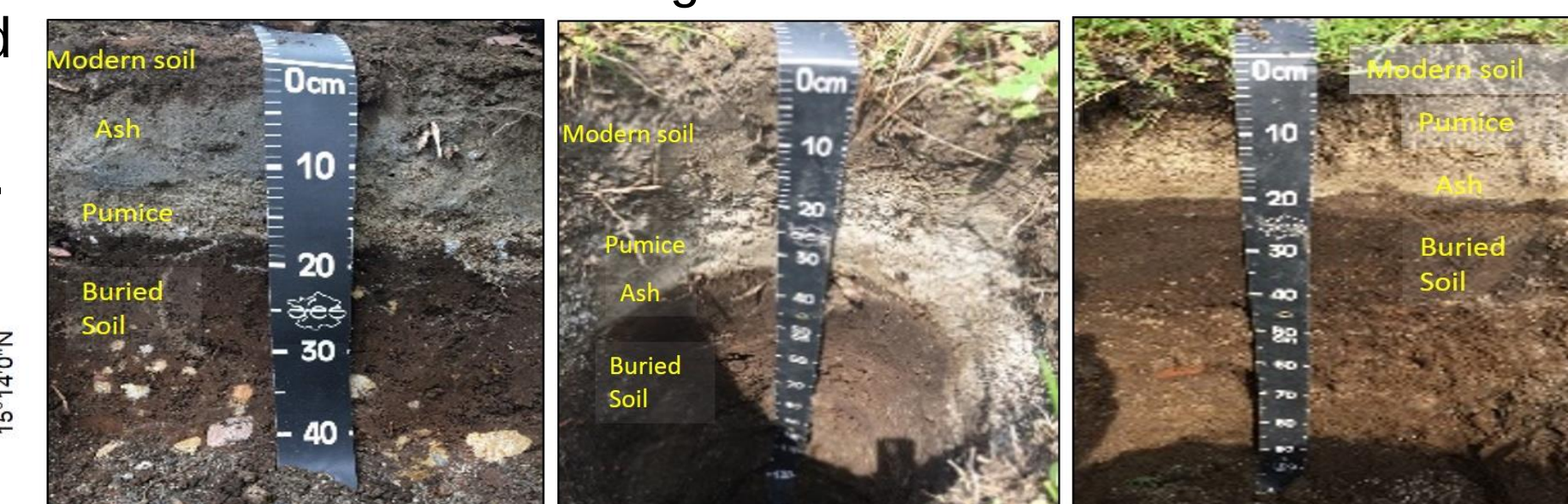


Extraction of elements

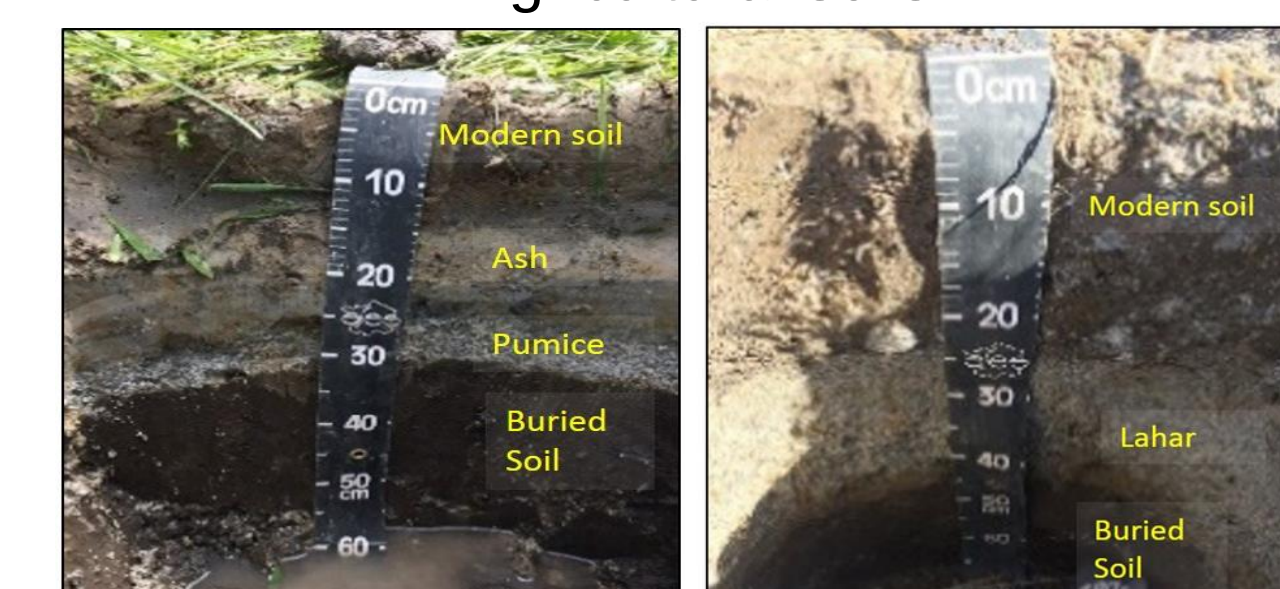


Quantitative analysis using ICP-AES

Non-agricultural soils



Agricultural soils



Results and Discussion

Plant-available P is not limiting in the modern volcanic ash soils

- ❖ High P_{avail} concentration in modern soils ranging from 56-152 mg/kg across different land-use types (Fig. 3).
- ❖ The total P of fresh ash decreased by ~ 50 % from 1700 mg/kg (in 1991) to 352-763 mg/kg in modern soils.
- ❖ P_{avail} /Total P of fresh ash increased from 4 % (in 1991) to 11-22 % in the modern soils of different profiles.
- ❖ This suggests that P is being released from the primary minerals in pyroclastic deposits.
- ❖ Higher P_{avail} /Total P of 20-22 % was observed from high altitude forest and grassland compared to 11-16 % in the low-lying grassland and irrigated rice soils (Fig. 3).

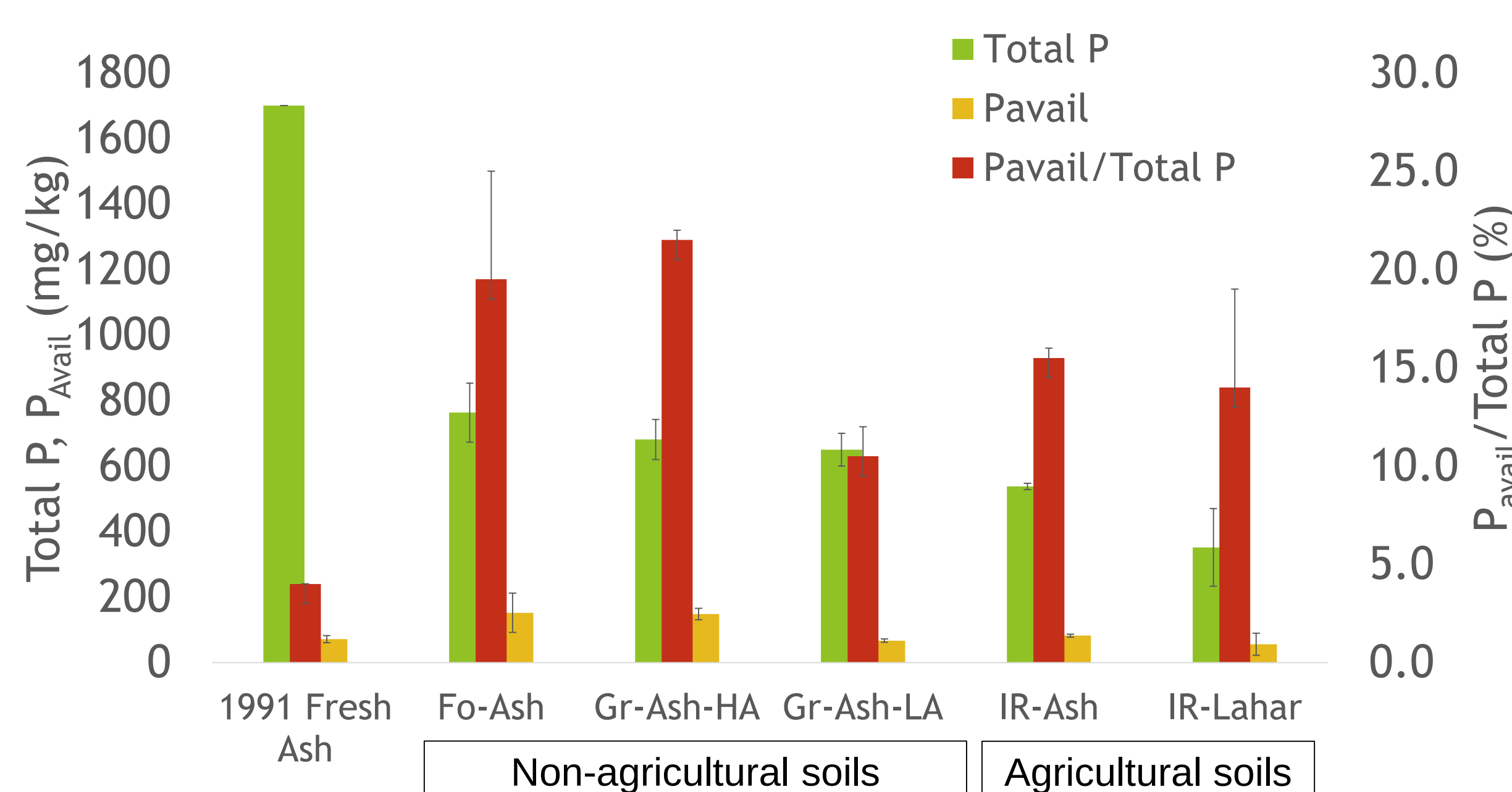


Figure 3. Total P, P_{avail} , and P_{avail} /Total P in the modern soils of different land-use types

Weathering does not influence Total P concentration in the modern and buried soils

- ❖ Total reserve in bases (TRB), a weathering index, does not correlate with total P in the modern and buried soils which suggests that P dissolution and output flux in these horizons are not influenced by the removal of easily weatherable minerals.

P availability in buried soils may be influenced by different land-use types

- ❖ P_{avail} concentrations of modern soils (56-152 mg/kg) under different land-use types did not differ significantly (Fig. 4).
- ❖ Buried soils from high altitude forest and grassland have deficient P_{avail} concentration at 5 and 2 mg/kg, respectively.
- ❖ Buried soil of IR-Lahar has significantly higher P_{avail} (136 mg/kg) even with minimal inorganic fertilizer application compared to IR-Ash (24 mg/kg) applied with 18-27 kg P/ha/yr (as per comm. with farm owners).

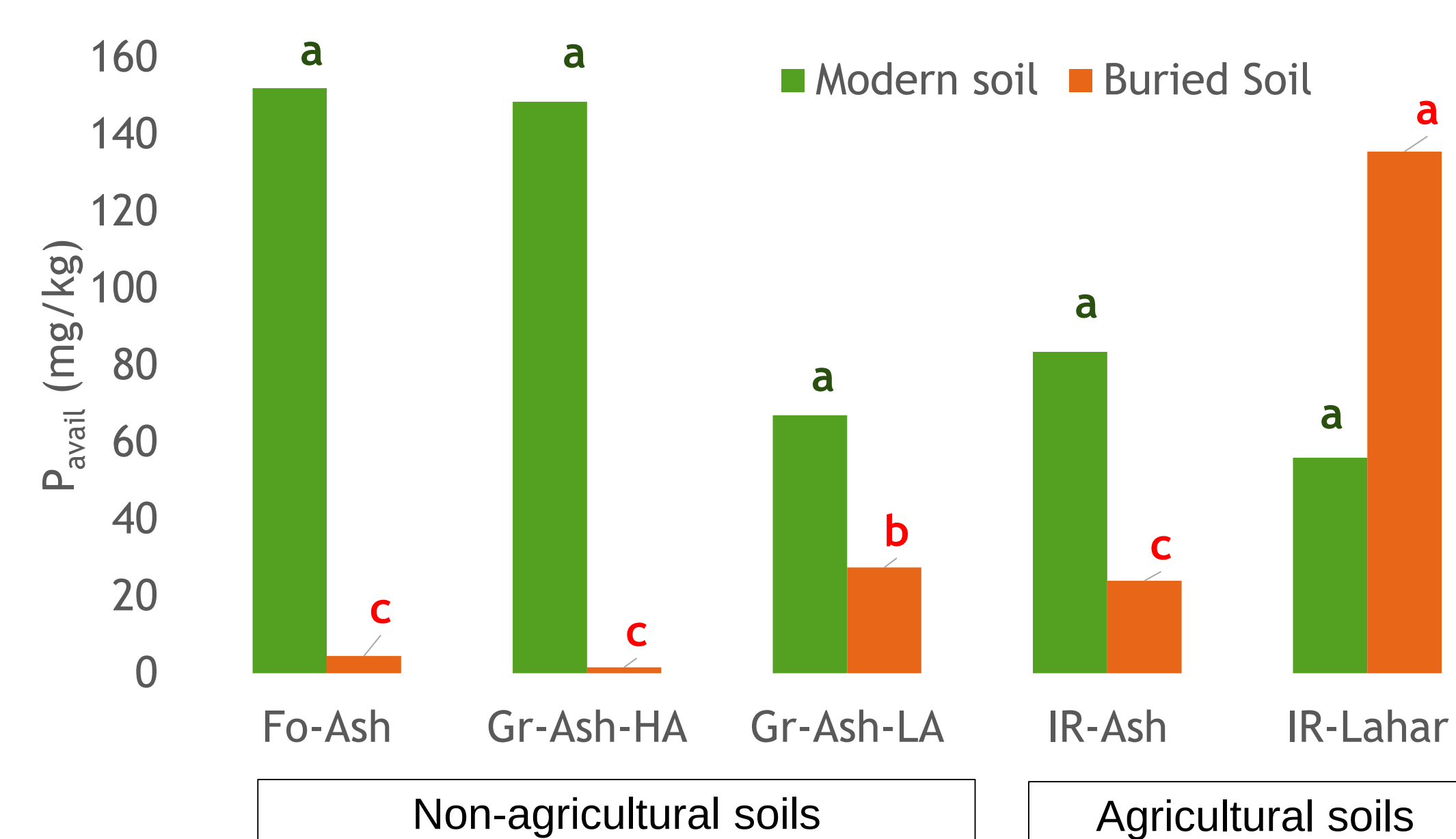


Figure 4. Comparison of P_{avail} concentrations between modern and buried soils affected with different land-use types

Conclusions

- ❖ Plant-available P in young volcanic soils with ~ 26 yr pyroclastic deposits are sufficient to support the P requirement of agricultural crops such as irrigated rice.
- ❖ There is still a good reserve of P from primary minerals contributing to high levels of P_{avail} in the modern (newly-developing) volcanic soils.
- ❖ Buried soil of grassland located in higher altitude have deficient P_{avail} compared to grassland in lower altitude while ash-buried rice soil have lower P_{avail} than the lahar-buried rice soil. This necessitates further research to determine the factors influencing P availability in these young volcanic soils.