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Abstract

Agriculture in the Pacific is driven primarily by small-scale private farmers, many of whom do not have access to soil testing services or advice, nor the means to interpret analytical results into soil management and agronomic recommendations. Soil degradation through the process of acidification poses a significant risk to food and income security as it directly threatens crop productivity. The nutritional quality of food crops may also be affected through sub-optimal nutrient uptake by plants and nutrient imbalances. The dataset reported here provides a useful platform for the development of a decision-support tool (DST) that will assist Fiji farmers in understanding and managing soil pH and soil acidity. The DST will enable making informed decisions about liming to help correct soil pH. To support this development, historical soil pH data available from the Pacific Soils Portal were combined with updated analyses of agricultural soils from 17 locations in Viti Levu Island (Fiji) collected during a field campaign undertaken in August 2025. The soils were sampled at two depth intervals (0–15 and 15–30 cm) and analyzed for pH using a variety of methods. These methods included direct field measurements using a portable pH-meter as well as traditional laboratory determinations. Of the soils sampled, it was found that most soils exhibited pH levels below 7, which were observed for both depth intervals. Across all samples taken in 2025, it was found that 54.3% of them had soil pH < 5, 38.6% had soil pH between 5 and 6, and 7.1% had pH > 6 (based on soil $pH_{1:5}$ soil-to-water method). Depending upon specific land uses, climate and cropping intensity, it was recommended that routine liming be built into soil fertility management programs to help farmers overcome soil acidity-related constraints to production. Liming frequency, timing of application and application rate will need to be determined for specific soil and cropping situations; however, it was suggested that soil pH was not changed by more than 1 unit each time lime was applied. Such an approach should reduce the risk of soil organic matter loss through accelerated mineralization, which would be challenging to restore in that environment if soils remained under continuous cropping. The analytical information contained in this article expanded and updated the datasets available in the Pacific Soils Portal. Furthermore, this work provided an opportunity to build analytical expertise in aspects of soil chemistry at local organizations to support academic and extension activities as well as the ongoing development of the Pacific Soils Portal.

Keywords: cropping soils; liming recommendations; soil acidity; soil fertility

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1. Introduction

Fiji's agriculture sector contributes approximately 9% to the country's GDP, which is valued at FJ$764 million (FJ$1~US$0.45), and it is primarily driven by key crops such as sugarcane, roots and tubers, horticulture, and kava. This sector supports around 84,000 farmers who represent ~28% of the total workforce and cultivate ~195,000 ha of land across Fiji's main islands of Viti Levu and Vanua Levu. The majority of soils used for cropping in Fiji are prone to acidification [1] through natural processes (e.g., leaching), and it may be accelerated by farming practices due to insufficient replenishment of cations (importantly, calcium and magnesium) removed with each harvest [2,3]. Soil acidity has, for long, been a significant constraint to crop production in Fiji [4,5], which makes it challenging for farmers to appropriately manage crop nutrition [6,7]. Lack of awareness of this problem and knowledge of how to address it [8] has led to increased reliance on the use of synthetic fertilizers to correct perceived soil fertility issues with limited success and at the expense of reduced productivity. This approach has further compounded the problem, as commonly used fertilizers such as urea and di-ammonium phosphate (which have an acidic reaction) are reported to exacerbate longer-term soil acidity [9]. By contrast, correction of soil pH to near-neutral values is known to improve availability and uptake of essential plant nutrients, thus reducing the need for applied fertilizer (equally, improving fertilizer-use efficiency).

A cost-effective and technically feasible alternative to fertilizer is to promote the use of cheaper agricultural lime to correct soil acidity, as the first step to manage soil fertility, after which application of inorganic fertilizers or organic amendments, or a combination of both sources, can be used to improve soil fertility [10,11]. Soil pH can be used as an indicator of soil acidity; however, the determination of total acidity of soil (that is, exchangeable acidity plus residual acidity) is needed for the estimation of the lime application rate. Total acidity can be determined by titration of a soil suspension in a salt solution to a reference pH using a strong base or the incremental addition of lime [12]. Previous studies in Fiji have shown that the financial return from soil application of lime is likely to be positive and that it depends on the extent of soil acidity, the crop's susceptibility to low soil pH, and the lime application rate [13,14]. Maize, root, tuber, and vegetable crops, as well as sugarcane grown on acidic soils, are often responsive to upward adjustments in soil pH [15,16]. Generally, the use efficiency of applied nutrients increases when crops are grown in soils with near-neutral pH (crop response to fertilizer and its conversion to harvestable biomass improves as soil pH approaches neutrality) [17–19]. Therefore, the amount of fertilizer required for a target yield, and the associated fertilizer cost, may be proportionally reduced through correction of soil pH. Despite soil pH testing being relatively simple, the vast majority of farmers in Fiji do not routinely monitor it [20].

Previous work in Fiji has produced soil acidity maps (e.g., [21], Figures S1 and S2 in Supplementary Material File S1). These maps could be transformed into zoning to guide farmers as to whether lime application may be needed or justified, both from agronomic and economic perspectives. Lime application and technical advice may be promoted by government and private sector entities, such as input retailers and importers. However, the information available on soil pH may be outdated as systematic soil surveys in Fiji were conducted more than 30 years ago (e.g., [4,21]), and therefore, the data may not reflect the current state of soil acidity. Furthermore, some of the data used to produce soil pH maps are not readily available (with the exception of data that can be retrieved from the Pacific Soils Portal). Therefore, there is a need to verify existing datasets through physical measurement of soil properties (soil pH and total acidity of soil). A good agreement between previously published soil pH datasets (which demonstrated widespread soil acidity across agriculturally important regions of Fiji) and soil pH measurements (this work) will provide the confidence needed to develop a decision-support tool (DST). Ideally, farmers would obtain and know how to interpret soil test results, but soil testing services are not readily available, and farmers often lack the technical knowledge required to interpret and apply analytical results to aid decision-making on their farms.

1.1. Objectives and Scope

The objectives of this work were twofold: (1) to measure soil pH and soil acidity at 17 locations (36 sampling points) in Fiji to assess the current status of soils used for cropping, and (2) to use the data collected to support the development of a decision support tool (DST) that will provide farmers with a usable soil pH indication for their location, and agronomic recommendation for correction of soil pH and soil acidity. This work also provided the opportunity to train technical officers from the Fiji National University and the Fiji Ministry of Agriculture and Waterways in the measurement of soil pH and soil acidity. Such activity contributed to technical capacity building in the country, which is a key objective of the Australian Government in the Pacific region.

1.2. Terminology and Definitions

Soil acidity can be described in several forms:

(i) *Active acidity* refers to the concentration of hydrogen ions (H^+) present in the soil solution and is measured directly as soil pH. Active acidity represents only a small fraction of the total acidity. *Soil pH* is a measure of the hydrogen ion concentration in soil. The pH is measured over a range between 0 and 14, and agricultural soils often have pH values between 3.5 and 10 [22]. Soils can be classified according to their pH (in water) value as follows:

- Alkaline: pH > 7.5,
- Neutral: pH between 6.5 and 7.5,
- Acidic: pH < 6.5,
- Strongly acidic: pH $\leq$ 5.5.

(ii) *Exchangeable acidity* includes hydrogen and aluminum ions that are weakly adsorbed on the soil's cation exchange sites and can be displaced by neutral salt solutions (e.g., KCl or $CaCl_2$). Beyond this, soils also contain reserve acidity, which is associated with strongly bound hydrogen and aluminum on clay colloid surfaces and organic matter structures; this reservoir can replenish active acidity over time. Together, exchangeable and reserve acidity contribute to the soil's buffering capacity.

(iii) *Titratable actual acidity* provides a more comprehensive measure by quantifying all forms of acidity that react with a neutralizing base, and it is usually determined by titrating with a standardized alkali solution. Because these acidity pools interact, even when active acidity is corrected (e.g., by liming), exchangeable and reserve sources may continue to release acidity, making it necessary to apply lime based on buffer pH or titration methods rather than just water pH alone. Understanding these different components of soil acidity is therefore essential for effective soil management and long-term crop productivity. Titratable actual acidity will be referred to as TAA.

Soil pH and soil acidity are key chemical properties that influence soil fertility, availability of soil nutrients for plant uptake, and therefore plant growth, microbial activity, and important biogeochemical processes that affect carbon and nutrient cycling. Soil pH directly affects the soil concentration of major nutrients and the forms of microelements available for plant uptake, and it can result in deficiencies or toxicities. Nitrogen is most available in slightly acidic to neutral soil (pH 6.0–7.5), while phosphorus availability is optimal between pH 6.5 and 7.5, and it decreases in very acidic or alkaline conditions. Potassium is generally available over a wide range of soil pH, but it is highest at or above a soil pH of 6. Despite this, soil pH may be kept below 7.0–7.5 to avoid co-limitation of other nutrients (e.g., P) induced by pH [23].

2. Materials and Methods

2.1. Historical Data and Selection of Sites Sampled in 2025

Pacific Islands have had a long history of soil surveys, mainly under New Zealand's leadership (e.g., [24,25]). Recent work commissioned to Manaaki Whenua Landcare Research et al. [26] consolidated much of this soil information, which is now available from The Pacific Soil Portal (https://psp.landcareresearch.co.nz/, accessed 12 February 2026) and included Fiji (https://fiji-psp.landcareresearch.co.nz/, accessed 12 February 2026). The Portal is a project of the Pacific Soil Partnership [27], which is part of the Global Soil Partnership [28]. Manaaki Whenua Landcare Research (MWLR, renamed the New Zealand Bioeconomy Science Institute in 2025, https://www.bioeconomyscience.co.nz/, accessed 30 January 2026) has led the development of the Portal with technical and operational support from CSIRO (https://www.csiro.au/en/, accessed 30 January 2026) and funding from ACIAR (https://www.aciar.gov.au/, accessed 30 January 2026). Working in collaboration with MWLR, it was possible to undertake this work with legacy soil pH and soil acidity data for Fiji. The legacy data retrieved from the Portal were obtained using a variety of methods across soil mapping projects conducted in Fiji since the 1980s (Appendix A, Table A1).

Sampling locations for this work were chosen based on available historical data, ease of access, and current land-use (cropping) and included both government-owned and private land. In the south of Viti Levu Island, sites were located on private farmland. The Legalega, Sigatoka, Lautoka, and Koronivia sites were located on private land or on agricultural research stations of the Fiji Ministry of Agriculture and Waterways and the Sugar Research Institute of Fiji. MWLR provided historical soil pH data in the Koronivia, Davuilevu, Legalega, Sigatoka, Naduruloulou, and Nawaicoba areas of Viti Levu. However, due to land-use changes, many of the historical sampling locations were inaccessible, which made re-sampling impractical or no longer relevant (e.g., conversion to forest or urban land-use). In some locations, it was not possible to gain permission for some historical sites within project timelines. To supplement, additional sampling locations were included around the historical sites, and Figure 1 shows both the locations sampled in August 2025 ("+" symbols) and available historical data ("o" symbols). The figure shows that historical data were clustered in specific areas at or near research stations and villages (e.g., Legalega Research Station, Nawaicoba, Sigatoka Research Station, Naduruloulou, and Koronivia Research Station near Davuilevu). Samples taken in 2025 from Nawaka, Yako, Nawau, Bila, Loma, Narewa, Korovisilou, Vakabalea, Naboro, Davuilevu, Navuso and Lomaivanu were collected on an ad hoc basis between historical sampling sites. Table 1 lists the actual sites sampled in August 2025.

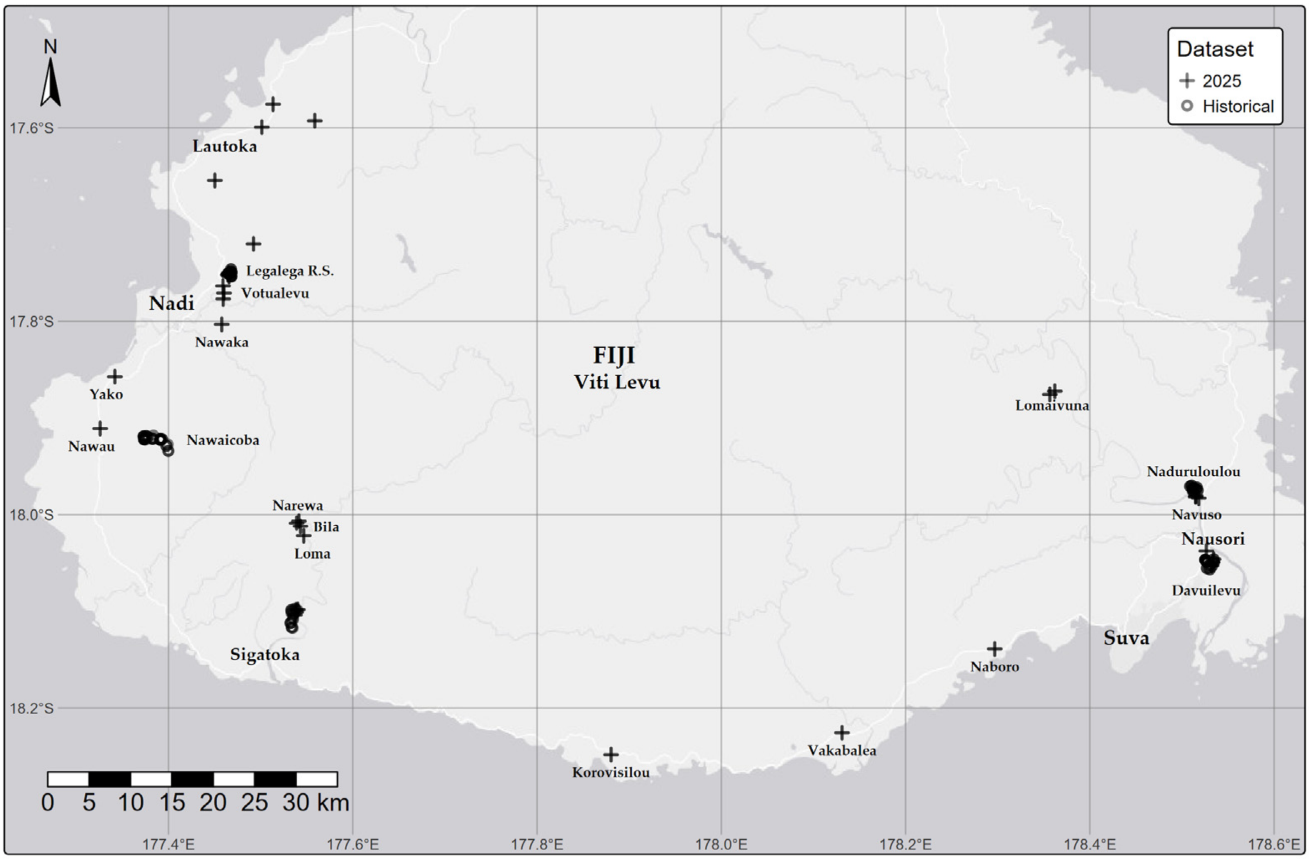

Figure 1. Map of Viti Levu Island (Fiji) showing the locations where soil samples for pH analysis in 2025, as well as historical sample sites.

Table 1. Sites sampled in August 2025, including nearest village, site ID and GPS coordinates. KRS: Koronivia Research Station, LRS: Legalega Research Station, SRS: Sigatoka Research Station. The research stations are part of the Fiji Ministry of Agriculture and Waterways (Fiji Government). Elevation is given in m (above-sea-level).

Location	Soil Textural Class	Latitude	Longitude	Elevation
Davuilevu	Silty clay loam/clay loam	−18.0381	178.5264	10.68
Korovisilou	Sandy clay loam	−18.2480	177.8804	30.12
KRS	Silty clay loam	−18.0464	178.5343	20.60
KRS	Silty clay loam/clay loam	−18.0531	178.5321	12.33
KRS	Sandy clay loam	−18.0497	178.5332	12.38
Bila	Clay loam/silt loam	−18.0125	177.5432	23.65
Lomaivuna	Clay loam/clay	−17.8727	178.3620	111.87
Lomaivuna	Clay loam/clay	−17.8760	178.3565	130.73
Loma	Clay loam/silt loam	−18.0223	177.5468	21.82
LRS	Sandy clay loam	−17.7505	177.4653	20.03
LRS	Sandy loam	−17.7522	177.4644	18.41
LRS	Humic clay	−17.7539	177.4657	13.44
LRS	Sandy clay loam	−17.7523	177.4659	21.82

Table 1. *Cont.*

Location	Soil Textural Class	Latitude	Longitude	Elevation
LRS	Sandy clay loam	−17.7511	177.4652	18.31
Lautoka	Clay loam/gritty clay	−17.5927	177.5588	20.97
Lautoka	Clay/gritty clay	−17.5994	177.5013	16.03
Lautoka	Gritty clay loam/stony clay loam	−17.6550	177.4503	69.14
Lautoka	Stony clay loam	−17.7204	177.4923	32.39
Lautoka	Clay	−17.5757	177.5135	7.72
Naboro Prison Complex	Silt loam/silty clay loam	−18.1388	178.2968	8.74
Nawau	Clay loam/clay	−17.9113	177.3258	52.81
Narewa	Clay loam/silt loam	−18.0068	177.5415	22.23
Narewa	Clay loam/silt loam	−18.0090	177.5390	22.88
Navuso	Silty clay loam	−17.9818	178.5148	12.99
Navuso	Silty clay loam	−17.9809	178.5149	10.39
Navuso	Silty clay loam	−17.9832	178.5182	9.18
Nawaka	Clay	−17.8033	177.4578	17.20
SRS	Clay loam/silt loam	−18.1039	177.5372	20.03
SRS	Clay loam/silt loam	−18.0983	177.5404	19.43
SRS	Clay loam/silt loam	−18.1010	177.5385	15.07
SRS	Clay/clay loam	−18.0987	177.5385	13.63
Vakabalea	Silty clay loam	−18.2255	178.1310	11.85
Votualevu	Stony clay loam	−17.7637	177.4592	19.76
Votualevu	Clay	−17.7709	177.4603	19.49
Votualevu	Clay	−17.7770	177.4594	21.38
Yako	Stony clay loam	−17.8577	177.3418	15.73
Naduruloulou	Fibric peat/clay loam	−17.9730	178.5124	13.00

2.2. Measurement of Soil pH

There are several methods available for measuring soil pH, and those commonly used in Pacific Island countries are listed in Table 2 (after Rayment and Lyons [29]). Of the historical sites provided by MWLR, the KRS, LRS, Naduruloulou, and Nawaicoba sites had soil pH measured using the 1:2.5 soil–water ratio method and included 92 samples taken at multiple depth intervals (from the soil surface down to a maximum depth of 75 cm). Other analytical methods (e.g., pH in NaF and KCl) were also used on historical samples (and data included in this article), but these methods were not common across sites, which therefore did not allow for comparisons with contemporary data. Hence, comparisons between historical and contemporary data were only possible for pH measured in a 1:2.5 soil–water ratio. For the samples collected in 2025 (this work), a total of seven different methods were used for determining soil pH and soil acidity, as described below. Soil samples were collected by hand augering at two depth intervals: 0–15 and 15–30 cm, respectively. Following collection, the soil samples were taken to Koronivia Research Station (Ministry of Agriculture and Waterways, Fiji Government), where they were dried at 40 °C and ground to pass 2 mm prior to measuring soil pH and soil acidity. The analyses were subsequently conducted at the Soil Science Laboratory at The Fiji National University at Koronivia Campus.

Table 2. Soil pH methods and suitability for use in laboratories in Pacific Island countries. The codes correspond with those listed in Rayment and Lyons [29].

Code	Method	Notes	Suitability for Use in Pacific Countries
With the use of glass-calomel electrodes and a millivolt meter.			
4A1	$pH_{1:5}$ soil:water suspension.	Reliable and quick laboratory method, but results can be influenced by the presence of soluble salts.	Yes
4A3	$pH_{1:2.5}$ soil:water suspension.	Variant of 4A1.	Comparison with historical data required.
4B1	$pH_{1:5}$ soil/0.01 M $CaCl_2$ extract–direct (without stirring during measurement).	Reliable and quick laboratory method. Results are largely unaffected by the presence of soluble salts.	Yes, but 4B2 is recommended as it requires less soil.
4B2	$pH_{1:5}$ soil/0.01 M $CaCl_2$ extract—following method 4A1 (without stirring during measurement).		Yes, if the amount of soil available for the analysis is limited.
4C1	$pH_{1:5}$ soil/1 M KCl extract—direct (without stirring during measurement).		Yes, when there is sufficient soil available for the analysis. More suitable when the number of samples is large as it requires shorter preparation time.
4C2	$pH_{1:5}$ soil/1 M KCl extract—following method 4A1 (without stirring during measurement).		Yes, if the amount of soil available for the analysis is limited. More suitable when the number of samples is small as it requires longer preparation time.

2.2.1. Soil pH in H_2O 1:5 Ratio

Five grams of soil were mixed with 25 mL of deionized water, and the mixture was placed in a mechanical shaker for one hour. The soil was then left to settle for 20–30 min. The same soil–water mixture was used as the basis for the $CaCl_2$ and KCl $pH_{1:5}$ analyses, as described below. Soil pH was measured while stirring the mixture and holding the electrodes of a TPS Ranger pH sensor (City of Moreton Bay, Australia) in the suspension until the reading was steady.

2.2.2. Soil pH in H_2O 1:2.5 Ratio

Ten grams of soil were mixed with 25 mL of deionized water, stirred vigorously and left to settle overnight (~12 h). Soil pH was measured by holding the electrodes of the TPS Ranger pH sensor in the upper supernatant without stirring.

2.2.3. Soil pH in $CaCl_2$ 1:5 Ratio

Following the determination of pH in H_2O 1:5 ratio, 1.25 mL of 0.21 M $CaCl_2$ solution was pipetted to the 1:5 soil suspension to obtain a 0.01 M $CaCl_2$ solution. This mixture was then manually shaken to equilibrate the solution and allowed to settle for 20–30 min. Soil pH was measured by holding the electrodes of the TPS Ranger pH sensor in the upper supernatant without stirring, and the pH value was recorded once the reading was steady.

2.2.4. Soil pH in KCl 1:5 Ratio

Five grams of soil were mixed with 25 mL of 1 M KCl solution and the mixture was placed in a mechanical shaker for one hour. The soil solution was then left to settle for 20–30 min. Soil pH was measured by holding the electrodes of the TPS Ranger pH sensor in the suspension until the reading was steady.

2.2.5. Soil pH in KCl 1:5 Ratio Following Method 4A1 (Table 2)

Following the determination of pH in H_2O 1:5 ratio, a weighed quantity of KCl was added to develop the soil suspension required to match 1 M KCl (e.g., 1.865 g/25 mL). The solution was then placed in a mechanical shaker for 1 h. The soil solution was then left to settle for 20–30 min. Soil pH was measured by holding the electrodes of a TPS Ranger pH sensor in the suspension until the reading was steady.

2.2.6. Field Measurement of Soil pH

In situ measurements of soil pH were performed with a low-cost portable instrument called 'Soil Tester S1' manufactured by RoHS (China). Values were compared with traditional laboratory methods for measuring soil pH to determine the suitability of this device for 'quick assessments of soil pH in-field conditions.

2.3. Measurement of Soil Acidity

One gram of finely ground soil, made to pass through a 0.5 mm sieve, was mixed with 40 mL of 1 M KCl solution. A separate "control" tube without soil added and with 40 mL of 1 M KCl solution was kept to the side. All soil-KCl mixtures were placed in a mechanical shaker for four hours and left to settle overnight (~12 h). After that time, the soil-KCl mixtures were manually shaken to re-suspend the soil in solution, and the content transferred to a titration beaker with a small volume of deionized water. The pH of the solution was measured while stirring the suspension with the TPS Ranger pH-meter (calibrated using the control solution) to determine pH, which is referred to as the Australian Acid Sulphate Soil Standard ($pH_{KCl\text{-}ASS}$). The $pH_{KCl\text{-}ASS}$ was used for NaOH usage to determine the titratable actual acidity (TAA). The TAA was determined by titrating the suspension to pH 6.5 with a standardized 0.05 NaOH solution and the titer volume (mL) was recorded. For soils whose $pH_{KCl\text{-}ASS}$ were greater than 6.5, TAA was recorded as 0. The calculations are shown below:

$$TAA = [(V_1 - V_2) \times C_1 \times (1000/M_1)] \tag{1}$$

where

- TAA = Titratable actual acidity (mol H^+ Mg^{-1} soil),
- V_1 = Volume of NaOH titrant (mL),
- V_2 = Volume of the blank,
- C_1 = Concentration of NaOH (0.05 mol L^{-1}),
- M_1 = Mass of soil sample (g), and
- 1000 = Conversion to Mg (mega-grams).

2.4. Statistical Analyses

Statistical analyses for soil pH and soil acidity data used GenStat Release 22nd Edition [30] and involved ANOVA. The least significant differences (LSD) were used to compare means with a probability level of 5% ($p < 0.05$). Statistical analyses were graphically assessed by means of residual plots, and normalization of data was not required. A linear regression analysis was applied to examine the relationship between $\log_{10}$-converted TAA data and soil $pH_{KCl\text{-}ASS}$. A nonlinear relationship between a theoretical lime ($CaCO_3$) application rate (expressed in kg per ha of pure material) and the $\log_{10}$-converted total acidity of soil (TAA) was established. Analytical values were reported as the mean ± standard deviation (SD). The historical dataset included 4 locations and multiple depth intervals, but these were not consistent across locations. Hence, comparisons between locations were performed by clustering measured soil depths into two groups, namely: shallow (0–20 cm) and deep (below a depth of 20 cm). The 2025 dataset included 17 locations with 36 sampling points sampled at 2 depth intervals (0–15 and 15–30 cm).

3. Results and Discussion

3.1. Soil pH

A comparison of soil pH values by analytical method, including both historical and current datasets, is shown in Figure 2 (the solid horizontal line denotes pH = 7). The historical data showed a grand mean soil $pH_{1:2.5}$ of 5.417 ± 0.524 (across all locations and sampling depths available). There were significant differences in soil $pH_{1:2.5}$ depending on the location ($p < 0.001$). Mean soil $pH_{1:2.5}$ values for all locations were below 6 and they ranged between 5.16 and 5.93. There were no statistical differences in soil $pH_{1:2.5}$ between the two soil depth interval groups (shallow at 0–20 cm, and deep > 20 cm) ($p = 0.168$). Mean soil $pH_{1:2.5}$ values were 5.36 ± 0.424 (0–20 cm) and 5.48 ± 0.607 (below 20 cm).

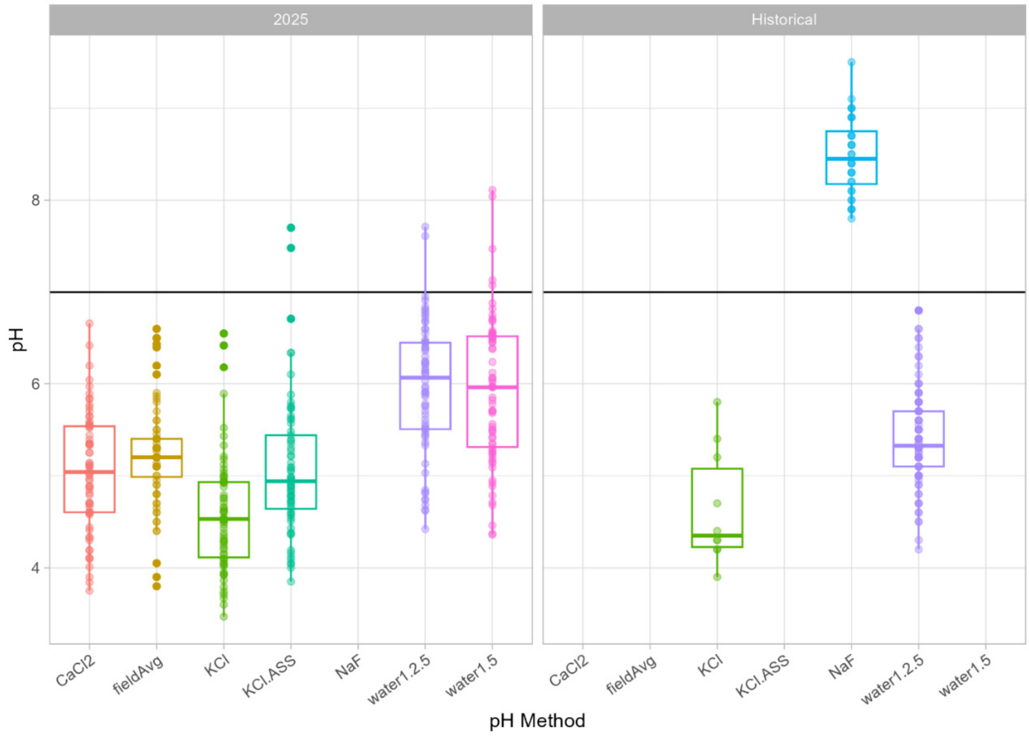

Figure 2. Soil pH determined on samples collected in 2025 (**left**) compared with historical data (**right**), by analytical method. Soil pH methods are as described in Section 2.2. The box spans the interquartile range of values in the variate (Q_3–Q_1), with the middle line indicating the median (Q_2). Whiskers extend to the most extreme data values.

The samples collected in 2025 reported a grand mean soil pH (across locations, sampling depths and analytical methods) of 5.304 ± 0.842. As expected, there were significant differences in soil pH depending on the analytical method used ($p < 0.001$); the average soil pH by method increased in the order: KCl < $CaCl_2$ < KCl-ASS < portable field pH-meter < Water (1:5) < Water (1:2.5). Overall, across all analytical methods, there were significant differences in soil pH depending on location ($p < 0.001$) and all locations reported average soil pH values below 7. Three locations reported average soil pH values between 6 and 7: Naboro (6.07 ± 1.004), Nawau (6.00 ± 0.769), and Yako (6.84 ± 1.071). Three locations reported average soil pH values below 5: Lautoka (4.92 ± 0.832), Lomaivuna (4.66 ± 0.570), and Vakabalea (4.56 ± 0.568). The remaining eleven locations sampled in 2025 reported average soil pH values between 5 and 6. Soil $pH_{1:2.5}$ results from the samples collected in 2025 are summarized in Figure 3 and additional information is shown in Figure A1 (Appendix B). Overall, across all analytical methods, there were no statistical differences in soil pH between the two soil depth intervals ($p = 0.639$), which reported average soil pH values of 5.29 ± 0.830 (0–15 cm) and 5.32 ± 0.855 (15–30 cm).

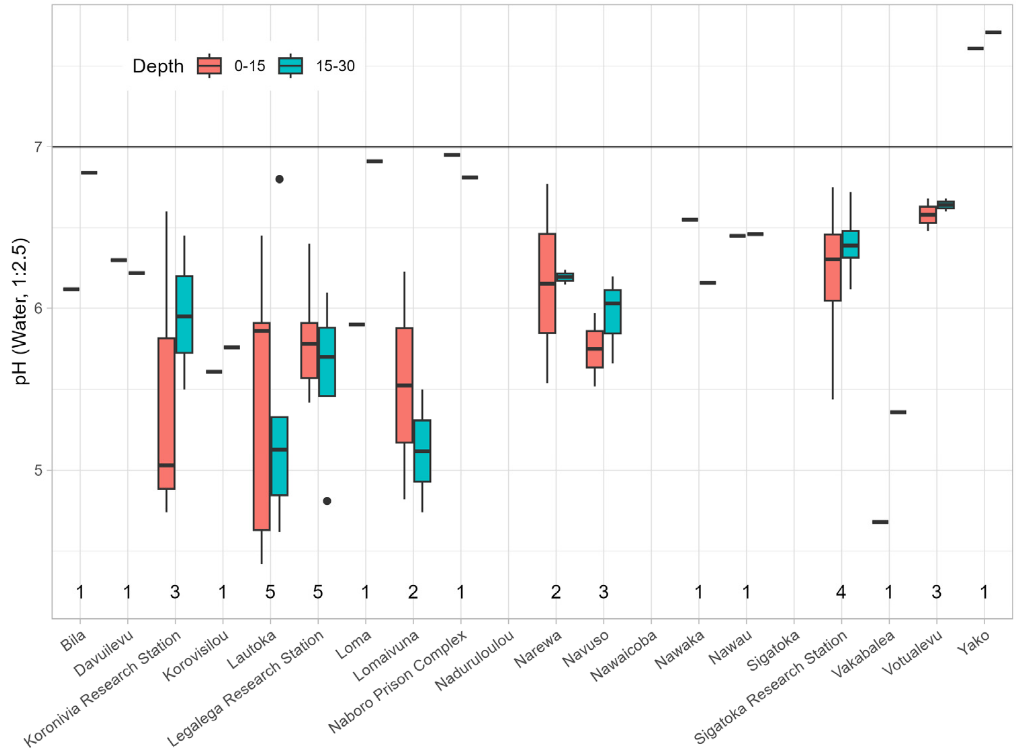

Figure 3. Soil pH 1:2.5 determined on samples collected in 2025 by soil depth interval (0–15 and 15–30 cm) and location. Locations are as described in Table 1. The box spans the interquartile range of values in the variate (Q_3–Q_1), with the middle line indicating the median (Q_2). Whiskers extend to the most extreme data values.

A comparison between historical samples and samples taken in 2025 could only be performed with data derived from the analysis of soil $pH_{1:2.5}$ (1:2.5 soil–water ratio). The grand mean soil $pH_{1:2.5}$ (for both historical and 2025 data) was 5.56 ± 0.667, $n = 164$ (shallow depth: pH of 5.52 and deeper soil: pH of 5.61). There were statistical differences in soil $pH_{1:2.5}$ between historical (5.42 ± 0.525) and 2025 (5.75 ± 0.728) data, $p < 0.001$ (LSD 5% level: 0.173). There were no statistical differences between sampling depths across both historical and contemporary samples ($p = 0.295$). The relatively higher soil $pH_{1:2.5}$ values encountered on average in 2025 (5.75 vs. 5.42) were attributed to:

- Inclusion of soils from Sigatoka in 2025 (not available in the historical dataset), which are irrigated and may be showing an effect of salinity (the water used for irrigation in this catchment is sourced from the Sigatoka River, which experiences sea water ingression during high tide). The average soil $pH_{1:2.5}$ at the Sigatoka sites was 6.30 ± 0.409.
- Inclusion of soil samples from a site in Yako (not available in the historical dataset), which reported an average soil $pH_{1:2.5}$ of 7.66 ± 0.071.
- Inclusion of these sites may explain marginally higher soil pH values in 2025; however, despite being significant, differences were small and of no practical consequence as soils sampled in 2025 were (on average) below a desirable soil pH range of ~6 (or slightly higher) and 7 [31,32].

3.2. Soil Acidity

Total acidity (TAA) determined in soil samples collected in 2025 showed significant differences between locations ($p = 0.021$). Overall, differences between depth intervals were not significant ($p = 0.556$). The grand TAA mean (across all locations and depth intervals) was 30.40 ± 29.18 mol H^+ Mg^{-1} soil, and individual TAA values ranged from ~1 at Loma to 148 mol H^+ Mg^{-1} soil at Lautoka. Total acidity data are summarized in Figure 4 (by location) and Figure 5 (by depth interval).

There was a linear relationship between the $\log_{10}$-converted total acidity and soil $pH_{KCl\text{-}ASS}$, as shown in Figure 6. This relationship may be used to determine soil acidity if the value of $pH_{KCl\text{-}ASS}$ is known. Whilst this relationship was significant for the linear model fitted to the data, care should be exercised given that the number of datapoints (i.e., soil samples) available to develop the model was limited (n = 62) and the R^2 obtained was low (~50%). However, it may still be used to provide 'quick' estimates of soil acidity based on soil pH. Similar relationships may be established using soil pH data derived from other analytical methods (e.g., $pH_{1:2.5}$ soil–water ratio), which are available in this article (Appendix A, Table A2). Such relationships will allow for 'quick' estimations of soil acidity based on alternative soil pH data. A further relationship was established between the $\log_{10}$-converted total acidity and the lime application rate, expressed in kg of pure $CaCO_3$ per ha (Figure 7). This relationship assumed that the soil bulk density was 1.30 Mg m^{-3} and that the soil depth interval to be corrected was 0–15 cm. Since agricultural lime does not have 100% purity, the theoretical rate derived from Figure 7's equation needs to be corrected to an actual rate. This correction is done by dividing the theoretical rate by the purity of the material (e.g., if the theoretical rate was 1200 kg pure lime per ha, and the purity was 90%, then the actual rate would be 1200/0.9 = 1333 kg ha^{-1} of $CaCO_3$). With these two relationships, it is possible to derive an approximate lime application rate. However, whenever possible, it is recommended that TAA be measured to ensure that the lime application rate can be more accurately determined. The rate and timing of lime application should be aligned with the overall farming system design and economic considerations. In practice, managing soil pH through liming is a long-term strategy, often implemented by applying smaller lime doses over several years to maintain optimal soil conditions and support sustained productivity.

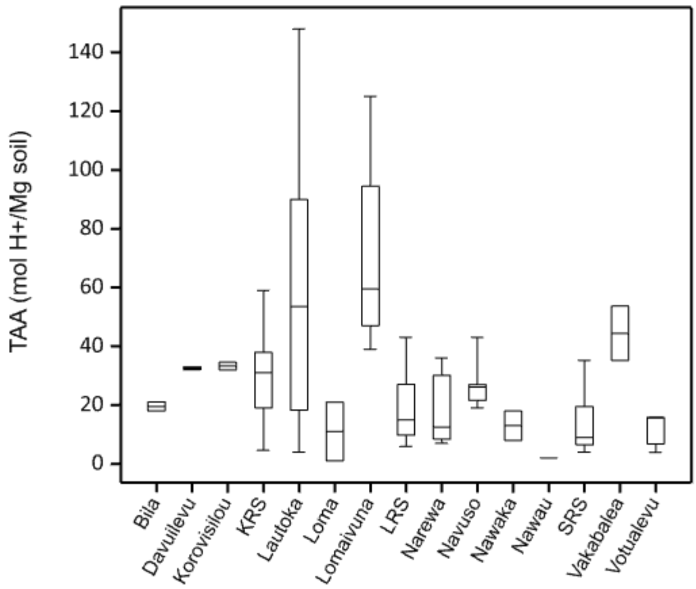

Figure 4. Titratable actual acidity (TAA) as determined on samples collected in 2025 by location. "TAA" denotes the total acidity of soil. The box spans the interquartile range of values in the variate (Q_3–Q_1), with the middle line indicating the median (Q_2). Whiskers extend to the most extreme data values.

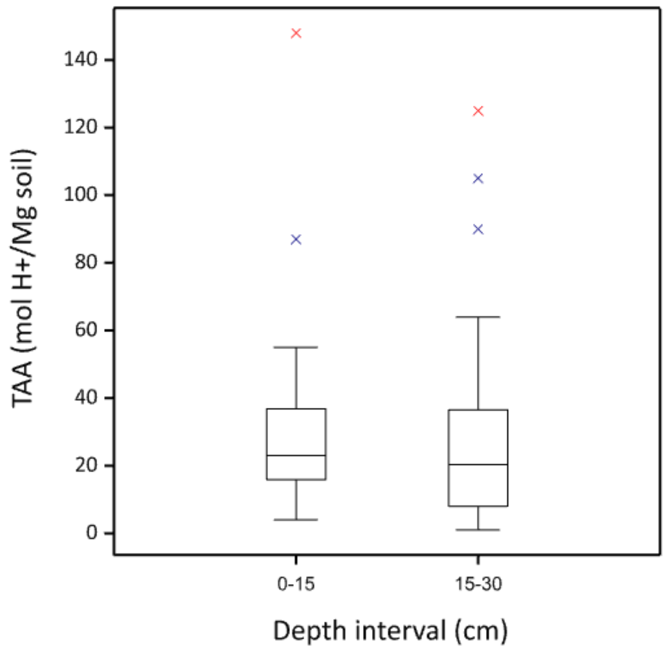

Figure 5. Titratable actual acidity (TAA) as determined on samples collected in 2025 by depth interval. "TAA" denotes the total acidity of soil. The box spans the interquartile range of the values in the variate (Q_3–Q_1), with the middle line indicating the median (Q_2). Whiskers extend to the most extreme data values within the inner 'fences', which are at a distance of 1.5 times the interquartile range beyond the quartiles (or the maximum value if that is smaller). Individual outliers are identified with a blue cross and 'far' outliers (beyond the outer 'fences') are at a distance of three times the interquartile range beyond the quartiles.

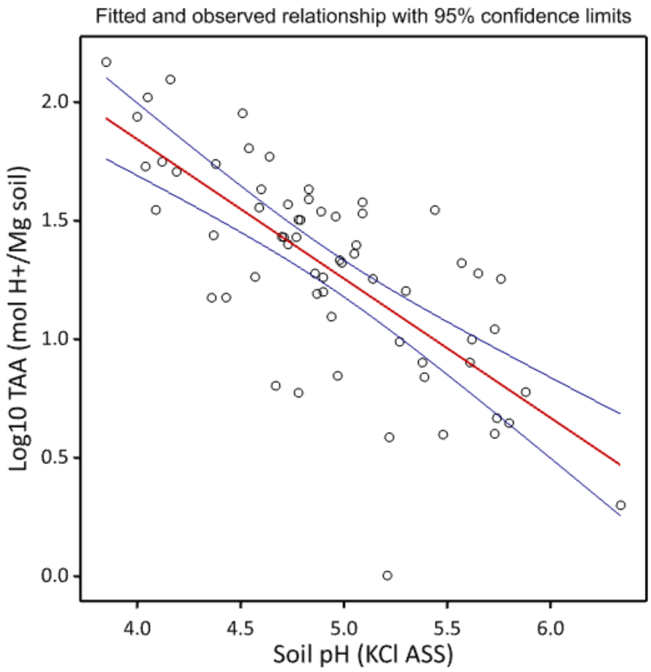

Figure 6. Titratable actual acidity (TAA), expressed as $\log_{10}$ of mol H^+ per Mg of soil, as a function of soil pH determined by the KCl-ASS method. Fitted model: $Y = 4.193 - 0.5873x$, $p < 0.001$, SE: 0.303, R^2: 0.52, n = 62. The two blue lines on either side of the fitted linear model (red line) show the 95% confidence interval. "TAA" denotes the total acidity of soil.

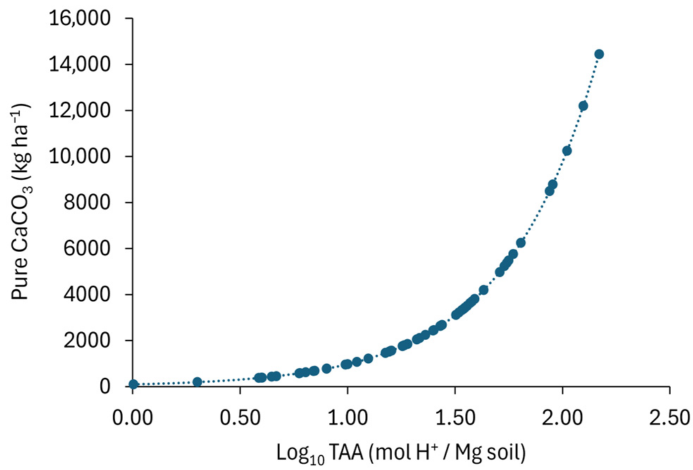

Figure 7. Lime ($CaCO_3$) rate expressed in kg per ha of pure material as a function of the $\log_{10}$-converted titratable actual acidity (TAA). $Y = 97.588e^{2.3026x}$, $p < 0.05$, R^2: 1, $n = 62$. The number e is a mathematical constant, approximately equal to 2.71828. "TAA" denotes the total acidity of soil.

4. Conclusions

Soil pH and soil acidity were measured in 2025 at 17 locations in Fiji to assess the usefulness and relevance of historical soil information (which dates back to the 1980s) required to develop a decision support tool (DST) that will assist farmers in managing soil acidity and other related agronomic constraints to production. Results showed that historical soil information is still relevant and therefore may be used with confidence to inform the development of the DST. Whilst differences between legacy soil pH data (5.42 ± 0.525) and data derived from samples collected in 2025 (5.75 ± 0.728) were significant ($p < 0.001$, LSD 5% level: 0.173), such differences were small, and potentially of any practical consequence. It was suggested that future work should consider site-specific sampling for analysis of soil pH to further verify historical data and determine the need for analysis of soil acidity, which will better inform liming decisions derived from the DST.

Based on the data collected as part of this work, and the historical soil information available on the Pacific Soils Portal, it was confirmed that soils used for cropping in Fiji are generally acidic and that crop productivity may be constrained by low pH. Therefore, soil liming should be incorporated into routine soil fertility management programs. 'Quick' estimates of liming rates may be derived from the relationships provided in Figures 6 and 7. However, more accurate determination of liming rates and the frequency of lime application to soil will need to be decided based upon specific situations. This will require targeted and repeated soil analyses, and knowledge of soil type, crop rotation and expected yield (which will help to inform annual nutrient offtakes, including calcium [Ca^{2+}] and magnesium [Mg^{2+}]). Care should be exercised not to increase soil pH by more than one pH unit each time lime is applied to reduce the risk of soil organic matter loss (through rapid mineralization), which under the Fiji environmental and cropping conditions will be difficult to restore.

The soil assessment conducted as part of this work supports the development of the proposed DST. It is recommended that routine soil analyses conducted by The Fiji Ministry of Agriculture and Waterways (MOAW) and The Sugar Research Institute of Fiji (SRIF) record the GPS coordinates of the sampling locations such that analytical information can be used to further update the Fiji's section of the Pacific Soils Portal, which will allow for improvements of the DST (such functionality may need to be built into the back-end of the DST). Implementation of this recommendation will require an agreement between landholders, service providers (Fiji MOAW, SRIF) and the Pacific Soils Portal holder. This work provided a valuable opportunity to upskill local technical officers (from Fiji National

University, Fiji MOAW) in the measurement of soil pH and soil acidity by titration, thus contributing to the effort of ACIAR, DFAT and other international agencies to technical capacity building in the Pacific region.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/data11040090/s1: Supplementary Material File S1, which contains Figure S1 (A map of soil acidity for Viti Levu Island, Fiji) and Figure S2 (A map of soil acidity for Vanua Levu Island, Fiji); Supplementary Material File S2, which contains a Microsoft Excel file with the historical soil pH dataset for Fiji and the dataset derived from the 2025 soil surveys.

Author Contributions: Conceptualization, D.L.A., T.P.S., B.C.T.M. and M.N.; methodology, D.L.A., J.C.J.V. and X.Z.; validation, D.L.A., X.Z. and J.C.J.V.; formal analysis, D.L.A., X.Z., J.C.J.V., J.R.F.B. and T.C.; investigation, D.L.A. and B.C.T.M.; resources, J.R.F.B. and T.C.; data curation, J.C.J.V., P.Z. and X.Z.; writing—original draft preparation, D.L.A. and P.Z.; writing—review and editing, D.L.A., T.P.S., M.N. and B.C.T.M.; supervision, D.L.A.; project administration: D.L.A.; funding acquisition, D.L.A. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare that T.P.S. and M.N. (MDF, https://marketdevelopmentfacility.org/; accessed 10 December 2025) reviewed the manuscript prior to this submission; however, they had no role associated with the interpretation of the data reported herein or the design of the study, the collection and analysis of data, or the decision to publish the results. The review of the manuscript by T.S. and M.N. was part of a standard CSIRO procedure prior to the submission of the manuscript.

Abbreviations

The following abbreviations are used in this manuscript:

ACIAR	Australian Centre for International Agricultural Research, Australian Government
DFAT	Department of Foreign Affairs and Trade, Australian Government
DST	Decision Support Tool
FNU	Fiji National University, Koronivia, Fiji
MDF	Market Development Facility
MOAW	Fiji Ministry of Agriculture and Waterways, Fiji Government
SRIF	Sugar Research Institute of Fiji, Fiji Government

Appendix A. Historical Soil pH Data for Fiji

Table A1. Soil $pH_{1:2.5}$ (soil–water ratio), pH_{KCl} (potassium chloride), pH_{NaF} (sodium fluoride). KRS: Koronivia Research Station, LRS: Legalega Research Station (Retrieved from https://fiji-psp.landcareresearch.co.nz/, accessed 8 September 2025). The sites listed in this table are at Agricultural Research Stations of the Fiji Ministry of Agriculture and Waterways (Fiji Government), which had detailed soil mapping, and the corresponding soil textural classes were drawn from actual descriptions of sampled profiles. Where no textural class or other soil profile information was available (sites marked with *), the soil texture provided is a representative profile texture of the soil series for the site. These may not exactly match the texture of the actual textural class of the sample, and therefore, site-specific particle size analysis may be needed. Detailed soil mapping and associated analytical data for some of the historical sites quoted in this report, and a description of the timeframe over which such data were collected, are available from Laffan [33], Laffan and Leslie [34], Leslie [35–37], Leslie [38], Leslie and Laffan [39], Rijkse [40], and Rijkse and McLeod [41].

Site ID	Site, Soil Type	Depth Interval, cm	Latitude	Longitude	$pH_{1:2.5}$	pH_{KCl}	pH_{NaF}
KN8	KRS, silt loam	0–20	−18.04906657	178.5348935	5.7	-	-
KN8	KRS, silty clay loam	20–33	−18.04906657	178.5348935	5.8	-	-
KN9	KRS, silty clay loam	0–18	−18.04963882	178.5331499	5.4	-	-
KN9	KRS, clay loam	17–37	−18.04963882	178.5331499	5.7	-	-
KN5	KRS, silty clay loam	0–18	−18.04638103	178.5343783	5.6	-	-
KN5	KRS, silty clay loam	16–28	−18.04638103	178.5343783	5.7	-	-
KN11	KRS, silty clay loam	0–16	−18.05364443	178.5323685	5.1	-	-
KN11	KRS, silty clay loam	16–28	−18.05364443	178.5323685	5.2	-	-
KN30	KRS, silt loam	0–18	−18.05278247	178.5292561	5.4	-	-
KN30	KRS, silt loam	18–41	−18.05278247	178.5292561	5.6	-	-
KN22	* KRS, clay loam	0–9	−18.04930519	178.5271003	5.1	-	7.9
KN22	* KRS, clay loam	9–26	−18.04930519	178.5271003	5.0	-	8.4
KN23	KRS, clay loam	0–18	−18.04911691	178.5270932	5.3	-	8.1
KN23	KRS, clay loam	18–38	−18.04911691	178.5270932	5.3	-	8.5
KN24	* KRS, silty clay loam	0–10	−18.04893131	178.5270629	5.3	-	8.4
KN24	* KRS, silty clay loam	10–20	−18.04893131	178.5270629	5.4	-	8.6
KN20	KRS, silty clay loam	0–13	−18.04688438	178.5252105	5.5	-	8.2
KN20	KRS, silty clay loam	13–32	−18.04688438	178.5252105	6.0	-	8.3
KN19	KRS, clay loam	0–18	−18.04704857	178.5252854	5.6	-	8.3
KN19	KRS, clay loam	18–31	−18.04704857	178.5252854	5.9	-	8.6
KN18	KRS, clay loam	0–11	−18.04715207	178.5252979	5.2	-	8.4
KN18	KRS, clay loam	11–21	−18.04715207	178.5252979	5.3	-	8.7
KN17	KRS, silty clay loam	0–6	−18.04729484	178.5253479	5.5	-	8.0
KN17	KRS, silty clay loam	6–19	−18.04729484	178.5253479	5.2	-	8.2
KN14	KRS, peaty loam	0–20	−18.05691006	178.5301637	4.5	-	-
KN14	KRS, peat	20–77	−18.05691006	178.5301637	4.3	-	-
KN16	KRS, silty clay loam	0–14	−18.05574903	178.5269821	5.5	-	-
KN16	KRS, clay loam	14–31	−18.05574903	178.5269821	5.7	-	-
LL34	LRS, gravelly sandy loam	0–30	−17.74958600	177.468430	6.6	-	-
LL34	LRS, gravelly sandy loam	30–60	−17.74958600	177.468430	5.6	-	-

Table A1. *Cont.*

Site ID	Site, Soil Type	Depth Interval, cm	Latitude	Longitude	$pH_{1:2.5}$	pH_{KCl}	pH_{NaF}
LL33	* LRS, sandy clay loam	0–22	−17.74994300	177.468312	5.0	-	-
LL33	* LRS, sandy clay loam	22–52	−17.74994300	177.468312	5.3	-	-
LL80	LRS, clay	0–18	−17.74895600	177.468162	4.6	-	-
LL80	LRS, clay	18–60	−17.74895600	177.468162	4.5	-	-
LL53	* LRS, clay loam	0–30	−17.75403500	177.46826	5.2	-	-
LL53	* LRS, clay loam	30–48	−17.75403500	177.46826	5.0	-	-
LL69	LRS, fine sandy clay loam	0–25	−17.75365300	177.468018	5.0	-	-
LL69	LRS, clay loam	25–75	−17.75365300	177.468018	4.95	-	-
LL74	LRS, loamy sand	0–25	−17.74638800	177.467841	5.6	-	-
LL74	LRS, clay loam	25–38	−17.74638800	177.467841	5.5	-	-
LL01	LRS, sandy clay loam	0–28	−17.75148500	177.466069	5.3	4.7	8.7
LL01	LRS, sandy clay loam	28–54	−17.75148500	177.466069	5.4	5.8	9.0
LL09	* LRS, sandy clay loam	0–27	−17.75086600	177.465151	4.9	4.4	8.5
LL09	* LRS, sandy clay loam	27–67	−17.75086600	177.465151	5.3	5.2	9.0
LL29	LRS, sandy loam	0–24	−17.75115500	177.465448	5.2	4.2	8.7
LL29	LRS, clay loam	24–69	−17.75115500	177.465448	5.4	5.4	9.1
LL65	LRS, fine sandy loam	-	−17.75077700	177.464444	-	-	-
LL30	LRS, loamy sand	0–30	−17.75053900	177.464811	5.0	4.2	8.6
LL30	LRS, clay	30–68	−17.75053900	177.464811	4.7	3.9	9.5
Nd101	Naduruloulou, sandy clay loam	0–22	−17.97569300	178.511761	6.0	-	-
Nd101	Naduruloulou, sandy clay loam	22–52	−17.97569300	178.511761	6.4	-	-
Nd105	Naduruloulou, clay loam	0–11	−17.97429800	178.511741	5.2	-	-
Nd105	Naduruloulou, clay	11–30	−17.97429800	178.511741	5.2	-	-
Nd60	Naduruloulou, clay	0–8	−17.97501500	178.517082	5.3	-	-
Nd60	Naduruloulou, silty loam	8–25	−17.97501500	178.517082	5.7	-	-
Nd54	Naduruloulou, silty clay loam	0–19	−17.97376400	178.515313	5.2	-	-
Nd54	Naduruloulou, silty clay loam	19–53	−17.97376400	178.515313	5.2	-	-
Nd35	Naduruloulou, clay	0–20	−17.97326700	178.511582	4.7	-	-
Nd35	Naduruloulou, silty clay loam	20–30	−17.97326700	178.511582	4.7	-	-
Nd80	Naduruloulou, silty clay loam	0–13	−17.97243400	178.511702	4.8	-	-
Nd80	Naduruloulou, clay loam	13–22	−17.97243400	178.511702	4.9	-	-
Nd78	Naduruloulou, clay loam	0–15	−17.97300400	178.512389	5.2	-	-
Nd78	Naduruloulou, clay loam	15–53	−17.97300400	178.512389	5.2	-	-
Nd3	Naduruloulou, clay	0–11	−17.97286800	178.513249	5.1	-	-
Nd3	Naduruloulou, silty clay loam	11–29	−17.97286800	178.513249	5.0	-	-
Nd87	Naduruloulou, silty clay loam	0–21	−17.97193400	178.516055	5.5	-	-
Nd87	Naduruloulou, clay	21–57	−17.97193400	178.516055	5.8	-	-
Nd12	Naduruloulou, fibric peat	0–20	−17.97083500	178.50879	4.6	-	-
Nd12	Naduruloulou, fibric peat	20–50	−17.97083500	178.50879	4.2	-	-

https://doi.org/10.3390/data11040090

Table A1. *Cont.*

Site ID	Site, Soil Type	Depth Interval, cm	Latitude	Longitude	$pH_{1:2.5}$	pH_{KCl}	pH_{NaF}
Nd7	Naduruloulou, fibric peat	0–25	−17.97007100	178.510457	4.8	-	-
Nd7	Naduruloulou, clay loam	25–45	−17.97007100	178.510457	5.2	-	-
NW24	Nawaicoba, clay loam	0–18	−17.91929000	177.372851	5.8	-	-
NW24	Nawaicoba, clay loam	18–38	−17.91929000	177.372851	6.1	-	-
NW163	Nawaicoba, clay loam	0–22	−17.92213300	177.373538	5.7	-	-
NW163	Nawaicoba, clay loam	22–48	−17.92213300	177.373538	5.8	-	-
NW8	Nawaicoba, silty loam	0–10	−17.92190100	177.382675	6.2	-	-
NW8	Nawaicoba, coarse sandy loam	10–18	−17.92190100	177.382675	6.5	-	-
NW162	Nawaicoba, clay loam	0–9	−17.91981200	177.377637	5.2	-	-
NW162	Nawaicoba, clay loam	9–29	−17.91981200	177.377637	5.1	-	-
NW20	Nawaicoba, clay loam	0–12	−17.91901900	177.375836	5.4	-	-
NW20	Nawaicoba, clay loam	12–60	−17.91901900	177.375836	5.3	-	-
NW36	Nawaicoba, silty clay loam	0–10	−17.92242700	177.373415	5.4	-	-
NW36	Nawaicoba, silty clay loam	10–20	−17.92242700	177.373415	5.4	-	-
NW91	Nawaicoba, clay loam	0–20	−17.92193100	177.391203	6.3	-	8.1
NW91	Nawaicoba, clay loam	20–45	−17.92193100	177.391203	6.8	-	8.9
NW87	Nawaicoba, clay loam	0–14	−17.92204600	177.391134	5.8	-	7.8
NW87	Nawaicoba, clay loam	14–39	−17.92204600	177.391134	6.6	-	8.9
NW88	Nawaicoba, silty clay loam	0–17	−17.92232100	177.391079	5.9	-	7.9
NW88	Nawaicoba, silty clay loam	17–44	−17.92232100	177.391079	6.6	-	9.0
NW89	* Nawaicoba, silty clay loam	0–11	−17.92264200	177.391046	5.9	4.3	8.0
NW89	* Nawaicoba, silty clay loam	11–31	−17.92264200	177.391046	6.5	4.3	8.9
NW90	Nawaicoba, silty clay loam	0–9	−17.92298400	177.39109	5.9	-	7.9
NW90	Nawaicoba, stony sandy loam	9–31	−17.92298400	177.39109	6.3	-	8.3

Table A2. Logarithmic mean of soil pH and (standard deviation) by analytical method and Titratable Actual Acidity (TAA, expressed as mol H+ Mg^{-1} soil) of soil samples collected by CSIRO in 2025. ^{A} $H_2O_{1:2.5}$ (1:2.5 soil-to-water ratio; Section 2.2.2); ^{B} $H_2O_{1:5}$ (1:5 soil-to-water ratio; Section 2.2.1); ^{C} $CaCl_2$ (1:5 soil-to-calcium chloride solution ratio; Section 2.2.3); ^{D} KCl (1:5 soil-to-potassium chloride solution ratio; Section 2.2.4); ^{E} NaF (soil-to-sodium fluoride solution ratio, historical method [42]); ^{F} KCl-ASS (potassium chloride on acid sulphate soils; Section 2.3); ^{G} Field (field measurement taken in situ using a handheld pH probe; Section 2.2.6). 'N=' is the number of observations. KRS: Koronivia Research Station, LRS: Legalega Research Station, SRS: Sigatoka Research Station. Soil textural classes are as defined in Table 1 (for samples collected in 2025) and Table A1 (Appendix A, for historical samples).

Location	Dataset	n=	^{A} $H_2O_{1:2.5}$	^{B} $H_2O_{1:5}$	^{C} $CaCl_2$	^{D} KCl	^{E} NaF	^{F} KCl ASS	^{G} Field	TAA
Bila	2025	2	6.345 (0.509)	6.455 (0.007)	5.532 (0.148)	4.485 (0.021)	-	5.059 (0.106)	5.369 (0.106)	19.526 (2.159)
Davuilevu	2025	2	6.258 (0.057)	5.861 (0.127)	4.791 (0.127)	4.405 (0.134)	-	4.861 (0.127)	4.080 (0.919)	32.5 (0.707)
KRS	2025	6	5.267 (0.754)	5.590 (0.708)	4.887 (0.449)	4.371 (0.910)	-	4.983 (0.457)	4.730 (0.313)	30.455 (18.666)
	Historical	28	5.390 (0.374)	-	-	-	-	-	-	-
Korovisilou	2025	2	5.679 (0.106)	5.811 (0.184)	5.072 (0.078)	4.327 (0.071)	-	4.837 (0.071)	4.294 (0.601)	33.288 (1.905)
Lautoka	2025	10	4.939 (0.822)	4.845 (0.883)	4.220 (0.675)	3.898 (0.671)	-	4.278 (0.681)	5.283 (0.368)	59.786 (47.304)

Table A2. *Cont.*

Location	Dataset	n=	^{A} H_2O $_{1:2.5}$	^{B} H_2O $_{1:5}$	^{C} $CaCl_2$	^{D} KCl	^{E} NaF	^{F} KCl ASS	^{G} Field	TAA
LRS	2025	10	5.484 (0.432)	5.138 (0.548)	4.441 (0.494)	4.227 (0.302)	-	4.619 (0.434)	5.838 (0.475)	17.915 (11.605)
	Historical	23	5.027 (0.359)	-	-	4.393 (0.673)	8.797 (0.327)	-	-	-
Loma	2025	2	6.161 (0.714)	6.855 (0.258)	5.720 (0.028)	4.837 (0.120)	-	5.354 (0.255)	5.247 (0.071)	11.005 (14.135)
Lomaivuna	2025	4	5.033 (0.694)	4.884 (0.380)	4.203 (0.481)	3.991 (0.232)	-	4.413 (0.282)	4.765 (0.225)	70.750 (37.615)
Naboro Prison Complex	2025	2	6.874 (0.099)	6.742 (0.417)	6.139 (0.318)	5.735 (0.467)	-	6.487 (0.262)	4.082 (0.354)	−2.000 (1.414)
Naduruloulou	Historical	22	4.949 (0.493)	-	-	-	-	-	-	-
Narewa	2025	4	5.965 (0.504)	5.88 (0.519)	5.062 (0.324)	4.506 (0.292)	-	4.797 (0.211)	5.373 (0.469)	15.625 (13.825)
Navuso	2025	6	5.795 (0.255)	5.704 (0.187)	5.027 (0.295)	4.215 (0.232)	-	4.804 (0.100)	4.765 (0.320)	27.133 (8.393)
Nawaicoba	Historical	37	5.685 (0.500)	-	-	4.3 (0)	8.163 (0.497)	-	-	-
Nawaka	2025	2	6.313 (0.276)	6.433 (0.064)	5.535 (0.021)	4.965 (0.021)	-	5.679 (0.106)	5.147 (0.071)	13 (7.071)
Nawau	2025	2	6.455 (0.007)	6.916 (0.559)	5.977 (0.262)	5.214 (0.255)	-	6.204 (0.170)	4.955 (0.283)	0 (2.828)
SRS	2025	8	6.085 (0.409)	6.069 (0.392)	5.199 (0.347)	4.851 (0.191)	-	5.406 (0.262)	5.358 (0.181)	13.632 (10.667)
Vakabalea	2025	2	4.899 (0.481)	5.186 (0.046)	4.351 (0.297)	3.788 (0.198)	-	4.064 (0.035)	4.855 (0.283)	44.426 (13.085)
Votualevu	2025	6	6.602 (0.095)	6.203 (0.313)	5.161 (0.343)	4.65 (0.150)	-	5.039 (0.237)	5.307 (0.175)	9.075 (7.770)
Yako	2025	2	7.657 (0.071)	8.074 (0.049)	6.248 (0.438)	6.105 (0.467)	-	7.576 (0.156)	5.189 (0.141)	−3.000 (0)

Appendix B. Soil pH Data Distribution for Samples Collected in 2025

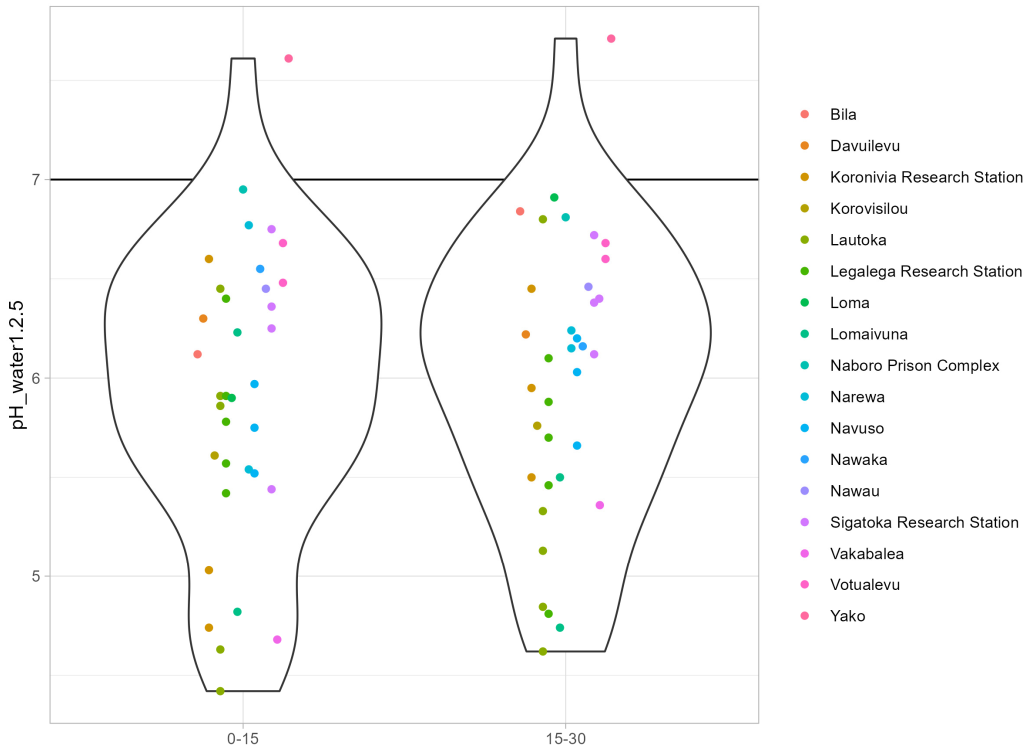

Figure A1. Distribution of soil $pH_{1:2.5}$ data from samples collected in 2025 by depth interval (0–15 and 15–30 cm) and location.

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