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Enhancing crop yield through sustainable soil remediation with soil neutralisation and organic fertilisers versus using conventional acidic soils with inorganic fertilisers in St. Vincent and the Grenadines (SVG)

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Abbreviations

- CAIPA – Caribbean Association of Investment Promotion Agencies
- CARICOM – Caribbean Community and Common Market
- CEDEMA – The Caribbean Disaster Emergency Management Agency
- CIMH – Caribbean Institute for Meteorology and Hydrology
- CSEC – The Caribbean Secondary Education Certificate
- EU – European Union
- FAO – Food and Agriculture Organisation
- GCSE – General Certificate of Secondary Education
- FYM – Farmyard Manure
- IICA – Inter-American Institute for Cooperation on Agriculture
- NPK – Nitrogen, Phosphorus and Potassium
- SIDS – Small Island Developing States
- SVG – St. Vincent and the Grenadines
- UNCCD – United Nations Convention to Combat Desertification
- UNEP – United Nations Environment Programme
- UNOCHA – United Nations Office for the Coordination of Humanitarian Affairs

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Abstract

Healthy soil ensures food security, water regulation, and rural livelihoods, making it a foundation for resilient agriculture especially in small-island settings like St. Vincent and the Grenadines (SVG). Yet soil acidification is a critical constraint on agricultural productivity in SVG, where steep volcanic slopes and heavy rainfall accelerate nutrient leaching. Reliance on inorganic fertilisers has supported yields in the short term but has worsened long-term soil degradation. This study aimed to evaluate how soil neutralisation through liming, combined with organic fertiliser use, influences lettuce (Lactuca sativa) yield and quality in acidic soils, while also assessing whether presenting locally generated results could shift farmer attitudes toward adopting sustainable practices. A controlled pot trial compared four treatments: neutralised soil with organic fertiliser (N-ON), neutralised soil with inorganic fertiliser (N-ION), acidic soil with organic fertiliser (A-ON), and acidic soil with inorganic fertiliser (A-ION). Growth rate, leaf number, survival, and root mass were measured. Meanwhile, ten farmers participated in pre- and post-trial surveys and five semi-structured interviews, with data analysed using paired t-tests and thematic coding. Results showed that neutralised and organic treatments consistently produced healthier root systems and more resilient growth than acidic-inorganic soils. Survey responses revealed significant increases in willingness to test soil pH, and adopt liming, alongside a decline in confidence in the sole reliance on inorganic fertilisers. Interviews highlighted persistent barriers of labour, cost, and reduced governmental support, but confirmed that visible local evidence builds trust and strengthens intention to adopt. Overall, the study demonstrates that sustainable soil remediation is both agronomically beneficial and socially adoptable in SVG. While small in scale, this trial provides

a stepping stone for larger, demonstrations that could strengthen resilience and revitalise the agricultural sector.

Keywords: soil neutralisation, liming, organic fertiliser, sustainable agriculture, farmer adoption, St. Vincent and the Grenadines

1. Introduction

1.1 Background

Soil is foundational for critical ecosystem services such as water filtration, carbon storage, nutrient cycling, and agricultural yield, which in turn have a direct impact on food security, climate control, and biodiversity (Karlen et al., 2019). Traditionally, soil quality was assessed based on specific indicators like organic matter levels, texture, pH, and rates of erosion (Maurya et al., 2020). In the early 21st century, this piecemeal perspective evolved into the broader concept of soil health, which encompasses the physical, chemical, and biological functions to represent a soil's ability to support ecosystems and human well-being (Karlen et al., 2019).

The global acknowledgement of the significance of soil has also progressed. During the 20th century, local conservation initiatives concentrated on stopping erosion and preserving soil quality, yet ongoing land degradation led to the establishment of international governance frameworks. Initiatives like the FAO-led Global Soil Partnership and the UN Convention to Combat Desertification now create monitoring guidelines, set sustainability goals, and support various policy tools, both obligatory and voluntary, to manage soils on a global scale (Daedlow, Hansjürgens and Koellner, 2018).

Globally, healthy soils underpin food production, carbon storage and water regulation. Yet more than one-third of the world's soils are now degraded in sub-Saharan Africa, South and East Asia, and the Mediterranean Basin (FAO, 2015; UNEP, 2020). This degradation is driven by erosion, nutrient depletion, acidification and salinisation, undermining soils' ability to support crops and ecosystems (FAO, 2015). Degraded soils limit yield potential, compel farmers to apply ever-greater quantities of fertiliser, and drive the clearing of new land for agriculture (UNEP, 2020). As a pillar of economic development and food security, agriculture employs roughly 40 per cent of the global workforce and sustains over two billion farmers, signifying its importance (World Bank, 2025).

In response, sustainable agriculture approaches such as conservation tillage, agroforestry and integrated nutrient management have delivered yield improvements of 20 to 30 per cent while restoring soil organic matter Kassam, 2023). Brazil's no tillage revolution, which began in the 1970s, transformed its degraded soils by boosting grain yields and halving erosion rates within five years (Kassam, 2023). What triggered this was extreme soil erosion and collapsing yields in Brazil. By contrast, large-scale monocropping of rice and palm oil in parts of Southeast Asia has accelerated soil losses of tens of tonnes per hectare each year, exacerbating land degradation (Anschell, 2023). The rapid deterioration was caused by the clearing of steep hillsides for rice and oil palm monocultures. While farmers observed a decrease in yields, they only implemented erosion control measures after government initiatives for cover crops and contour bunding were introduced (Anschell, 2023).

Although these global examples demonstrate both the promise and the pitfalls of sustainable soil management, the picture shifts when we view the challenge through the lens of Small Island Developing States. Small-island developing states (SIDS) face acute vulnerabilities arising from their small land areas, steep slopes, intense tropical rainfall and heavy dependence on food imports (Ewing-Chow, 2024). For example, Hurricane Fiona's torrential rains in

2022 caused severe erosion across Puerto Rico's plantain and banana plantations, highlighting how extreme precipitation can strip fertile topsoil in a matter of hours (McGinley, 2022). Soil health is even more precious where arable land is scarce. For instance, in the Maldives, rising sea levels have led to increased soil salinity, reducing agricultural productivity and forcing greater dependence on imported food (FAO, 2020). In Jamaica, unprotected hillsides can lose up to 100 tonnes of soil per hectare each year, undermining future crop production and food security (Morgan, 2005). In comparison, continental croplands such as those in Kenya lose around 26 tonnes per hectare annually to erosion, illustrating the amplified vulnerability of island topographies (Warui, 2025)

Some SIDS, such as Barbados, have embraced composting initiatives to restore degraded soils, reduce reliance on synthetic fertilisers, and improve water retention (Desai, 2024). These are key steps toward sustainable agriculture in small-island contexts. Although these cases show both the negatives and positives of sustainable soil management, the challenge takes on new dimensions when viewed through the lens of St Vincent and the Grenadines (SVG).

St. Vincent's landscape is defined by its volcanic origins, most recently underscored by the volcanic eruption of La Soufrière in 2021 (see Figure 1), which deposited fresh ash layers prone to rapid weathering and acidification (Phillips et al., 2024).

Figure 1. News Photo showing the La Soufriere Volcanic eruption in 2021 (Cooke and Lopez, 2021)

The island's steep slopes and annual rainfall of 2,000–3,000 mm accelerate leaching, then calcium and magnesium are washed from the root zone, creating pronounced acidic horizons (Mosaic, 2024; SVG Ministry of Tourism, 2025). See figures 2 & 3 for the average rainfall and landslide inventory in SVG. Such processes drive soil pH well below the optimal 6.0–7.0 range, locking up phosphorus and increasing aluminium toxicity (Shaaban, 2024).

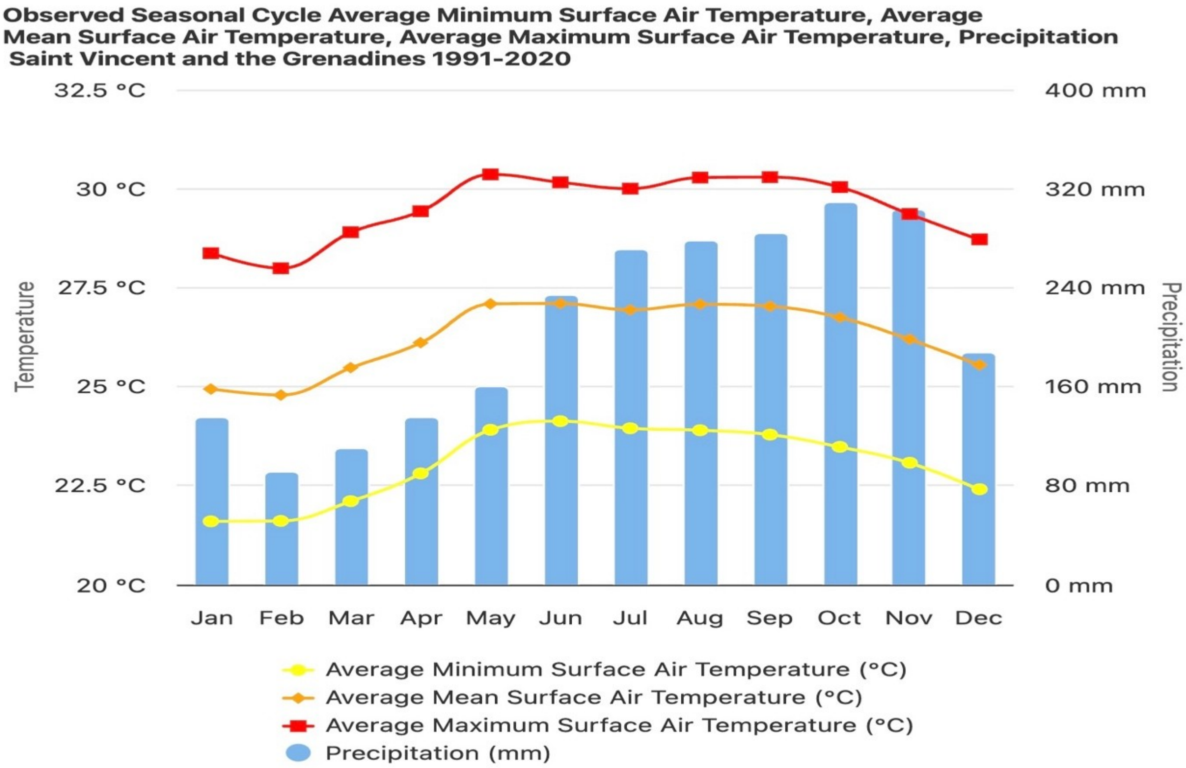

Figure 2. Graph showing the average annual temperature and precipitation in SVG (Climate Change Knowledge Portal, 2025)

Figure 3. Map showing the Landslide inventory, which provided a contour view of SVG (CDEMA, 2019)

Agriculture in SVG directly supports food security, supplying about 20 per cent of national caloric needs, and sustains rural livelihoods by employing roughly 25 per cent of the workforce. It accounted for nearly 45 per cent of household income in farming communities in 2016 (CARICOM, 2016). Agriculture has long been a cornerstone of SVG's economy and diet, but meeting demand on limited, steep terrain has concentrated production on fragile soils. During the colonial period, SVG's estates focused on arrowroot and sugar cane monocultures, applying inorganic fertilisers coupled with minimal soil testing practices (Díaz-Guadarrama et al., 2024; Fraser, 2025). In the mid-20th century, preferential EU access to European markets sparked a thriving banana planting industry in SVG, prompting plantations to intensify the use of inorganic NPK fertilisers for short-term yields (Mlachila, 2010). After the 2009 loss of European Union banana preferences, national policy shifted towards diversified root crops, fruits and high-value vegetables on farmer plots averaging under one hectare (Fridell, 2011). Current soil management practices today include farmers still relying on imported inorganic NPK blends, which are easy to apply, and neglecting to remediate the soil by restoring its properties (University of California, 2019). Due to excessive inorganic fertiliser use and natural volcanic properties, soils have become acidic in SVG, which can lead to a 20–50 per cent reduction in vegetable yields (Zingore et al., 2023). A study done in Africa synthesised results from over 120 field trials on acidic soils across sub-Saharan Africa, comparing yields on unlimed plots (pH 4.8–5.5) versus limed controls (pH 6.0–6.5) and found vegetable yields were 20–50 per cent lower on the acidic soils due to aluminium toxicity and phosphorus fixation. SVG having a similar soil pH range suggests that farmers could face similar yield shortages without acidity management. This can significantly impact stakeholders' income, especially in a nation where agriculture is a cornerstone of rural livelihoods (Shaaban, 2024). This can be seen where over 200 cases of soil degradation across Africa, Asia and Latin America have been reviewed, and they found that as soils lose structure and fertility, crop yields fall by 20-40 per cent, translating almost directly into income losses for smallholder farmers and eroding their resilience to climatic and market shocks (Bayata, 2024).

Addressing soil acidity in SVG demands more than technical recommendations; farmers must trust the benefits, witness results first-hand, and receive consistent extension support. These are determinants that Rogers' Diffusion of Innovations model identifies as relative advantage, trialability, and observability. Figure 4 provides a brief explanation of the model (Rogers, 2003). For example, Trinidad's Ministry of Agriculture and the Inter-American Institute for Cooperation on Agriculture (IICA) established liming demonstration plots in three pilot communities from 2018 to 2020. Within two growing seasons, the proportion of participating farmers applying lime rose from 15 per cent to 55 per cent after they observed clear yield improvements and measurable changes in soil condition (Roop and St. Martin, 2020). This blend of agronomic trial and social engagement directly informs the purpose of this study.

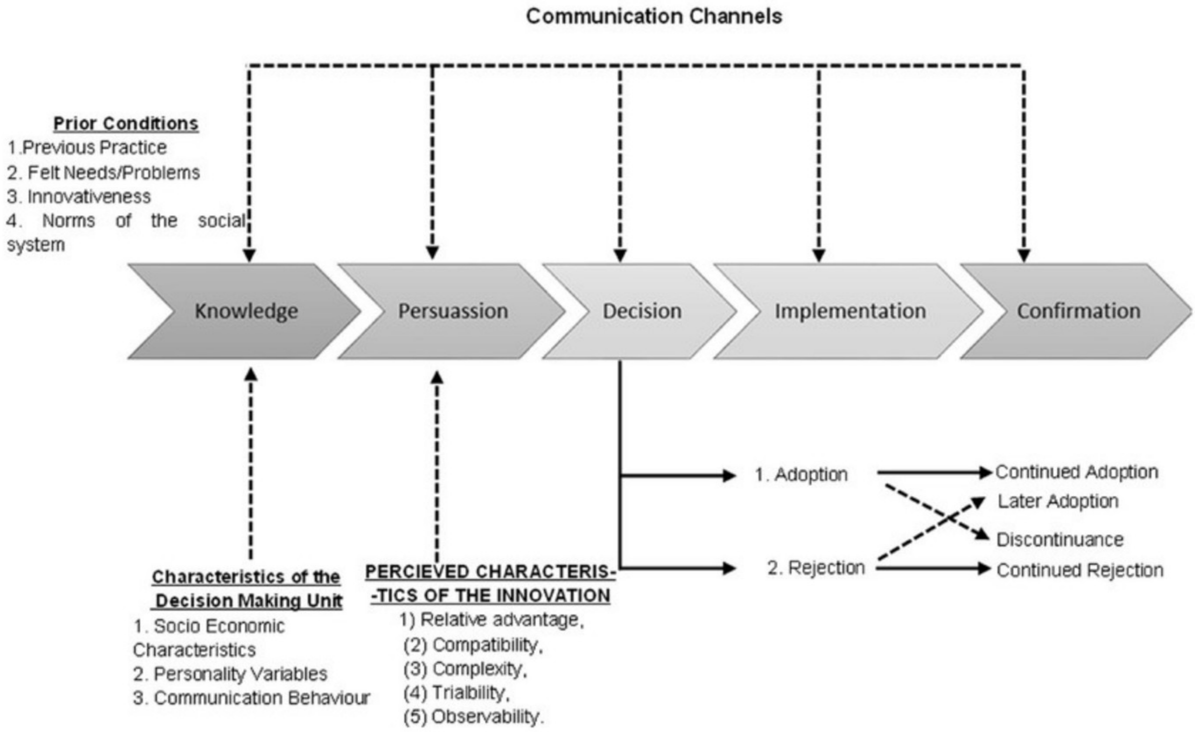

Figure 4. Image of the communication channels within the Rogers' Diffusion of Innovations model (Jensen, 2021)

1.2 Purpose of the Research

1.2.1 Rationale & Significance:

Farming practices matter at every scale because agriculture sits at the nexus of food security, environmental health and rural livelihoods. Today's conventional methods, such as increasing fertiliser usage, have improved production but have also increased soil acidity, forcing farmers to apply ever higher rates of fertiliser (FAO, 2015). For example, Pahalvi et al. (2021) showed that sole reliance on chemical fertilisers in intensive cereal and vegetable systems not only depleted soil organic matter but also caused persistent acidification. This created a feedback loop where lower pH limited nutrient availability, which in turn prompted higher fertiliser applications to maintain production levels.

These challenges are even more acute in small island developing states, where slopes and heavy rainfall leave soils particularly fragile (see section 1.1). In SVG, volcanic parent material combined with intense precipitation drives leaching and soil acidification, which can cause unamended fields to yield 20 to 50 per cent below their potential, undermining rural incomes and national food security (Shaaban 2024). As a result, many farmers rely on familiar but unsustainable inorganic fertiliser schemes because they lack access to education on better options, and there is little effective promotion of sustainable farming practices (RSPB, 2024). There are no document cases specific to SVG, hence the use of credible and comparable case studies and references.

This project embodies the core principles of environmental management and sustainability by integrating ecosystem health, resource efficiency and stakeholder engagement. It applies adaptive management approaches to restore a critical natural resource.

1.2.2 Purpose:

The purpose of this study is to evaluate whether targeted education using a simple, local field demonstration alongside relatable external case studies and farmer interviews and surveys can measurably shift farms in SVG knowledge, attitudes, and adoption intentions toward soil-acidity management (e.g., liming) and more sustainable fertilisation practices. Thereby reducing reliance on inorganic inputs. Beyond the field trial, the research evaluates whether sharing these locally generated results with farmers can shift attitudes and encourage adoption of soil-neutralisation practices. By linking clear, context-specific evidence, the study aims to demonstrate that sustainable soil remediation is both practical and advantageous for small-scale farmers.

1.2.3 Aim:

To assess the effect of soil neutralisation and organic fertiliser on crop yield and quality using lettuce (*Lactuca sativa*). By comparing four treatments, neutralised (limed) soils with inorganic fertiliser and organic fertiliser versus (the current fertilisation method) unmodified acidic soils with inorganic and organic fertiliser, in SVG. Then, to evaluate whether presenting these findings influences local farmers' views on adopting soil neutralisation and the use of organic fertiliser as a sustainable practice.

1.2.4 Objectives:

- Conduct controlled experiments to compare the impact on crop yield and quality between four treatments: (a) soils neutralised (limed) before cultivation with inorganic fertiliser, (b) neutralised soil before cultivating with organic fertiliser, (c) unmodified acidic soils with inorganic fertiliser, and (d) unmodified acidic soils with organic fertiliser
- Quantitatively evaluate key agronomic indicators, such as growth rate, overall yield, and visual and physical characteristics (such as colour and firmness) across the four treatments to assess how liming (i.e., soil neutralisation) and the use of organic fertiliser influence plant growth and soil health.
- Conduct qualitative interviews with 5 local farmers to document their current practices, levels of awareness, and attitudes toward sustainable soil remediation. Additionally, a quantitative survey will be administered before presenting the research findings, and a follow-up survey will be conducted afterwards to measure any changes in their willingness to adopt soil neutralisation and the use of organic fertilisers.

1.2.5 Scope:

This research involves a controlled one-season pot experiment on lettuce, designed to test the effects of soil neutralisation using lime. Four fertiliser treatments will be evaluated: limed versus unmodified acidic soils under both inorganic and homemade organic fertilisers. In parallel, the study includes pre- and post-intervention farmer interviews and short surveys to assess changes in awareness, attitudes and potential adoption following the communication of results.

Structure of Dissertation:

This dissertation is organised into five chapters. Chapter one introduces the research context, outlines the problem, and presents the study's aims and objectives. Chapter two reviews relevant literature on soil degradation, sustainable remediation practices and identifies gaps within the literature. Chapter three details the methodology, including the experimental design and data collection tools. Chapter four presents the results of the pot trials and farmer surveys and discusses these findings about existing research and local implications. Finally, chapter five concludes the study and offers recommendations for policy, practice and future research.

2. Literature Review

2.1 Introduction

In preparing the literature review, a wide range of secondary sources was consulted to ensure a comprehensive understanding of both the agronomic and social dimensions of soil remediation in small-island contexts. Key academic databases such as Science Direct, Research Gate and Google Scholar were used for peer-reviewed studies on soil acidification, liming and organic fertilisers in tropical or volcanic soils. This was complemented by industry and agency reports from FAO, UNEP, IICA and local government publications (SVG Ministry of Agriculture, CAIPA), as well as relevant theses and conference proceedings.

The searches combined key terms to pinpoint studies that relate to soil chemistry, agronomy and farmer behaviour. For example, queries such as "acidic tropical soils and liming," "organic fertiliser and crop yield and small-island developing states," and behaviour-change frameworks including Ajzen's Theory of Planned Behaviour and Rogers' Diffusion of Innovations. This was done to ensure that findings reflected current practice. Inclusion was limited to peer-reviewed articles, official agency reports and government documents presenting empirical data on soil pH, crop performance or adoption behaviour. These sources were prioritised because they undergo rigorous evaluation for validity and reliability, making them reliable sources (Drost, 2011).

This section reviews literature on soil remediation techniques such as soil neutralisation and the use of organic fertilisers. It will address how farmers adopt new techniques in small-island developing states, with a focus on St Vincent and the Grenadines. It has four main goals, including:

- To summarise research on liming and organic fertilisers as remediation methods.
- To identify the approaches used to measure crop yield and quality, and to explore behaviour-change models that explain farmer uptake of these practices.
- To discuss various areas of this research. As well as the inclusion of studies from tropical or island contexts that engage in sustainable farming practices.

The chapter is organised into six sections, which include:

- 2.2 An evaluation of global soil degradation and agriculture, which defines soil degradation and reviews major trends (erosion, nutrient loss, acidification).
- 2.3 An examination of Small-island developing states (SIDS) vulnerabilities. Which describes geographic limits (steep terrain, scarce arable land) and import dependence.
- 2.4 Identifying liming and organic fertilisers as remediation techniques, which aid in nutrient release and structural benefits for soil and plants.
- 2.5 Examine farmer perceptions and behaviour change and identify barriers such as trust gaps, weak training services and entrenched habits within farmers in SVG.

- 2.6 Identify gaps and relevance to SVG, noting the absence of peer-reviewed soil neutralisation and home-made organic fertiliser trials in Caribbean Island soils.

- 2.7 Provides a Conclusion of the review.

2.2 Global Soil Degradation and Agriculture

Soil degradation is the decline in soil's physical, chemical or biological functions caused by natural processes or human activity (United Nations Office for Disaster Risk Reduction, UNDRR, 2023). It manifests as erosion, which is the loss of topsoil by water and wind, and nutrient depletion (exhaustion of nitrogen, phosphorus and organic matter). Acidification, where the soil pH falls below optimal levels for plant growth, is a factor of degradation (FAO, 2015). Worldwide, roughly one-third of all soils are degraded, as noted in section 1.1, with erosion alone carrying away an estimated 75 billion tonnes of fertile topsoil every year, and acidification affecting large swathes of Asia and Europe (Warui, 2024). In England, for example, climate-driven increases in heavy rainfall have been projected to raise soil erosion by up to 20 per cent by 2050, jeopardising both crop production and water quality (Committee on Climate Change, CCC, 2019). Hotspots in sub-Saharan Africa and South Asia experience persistent, high erosion and nutrient loss, while Europe and North America have seen stabilised or improving soil health thanks to conservation measures (Navarro, 2024). Acidification is accelerating rapidly in parts of Asia, showing that degradation trajectories are far from uniform (Hicks et al., 2025).

Historically, farming tended to operate within local ecological limits; however, the agricultural revolution and later industrialisation transformed production into commercial, large-scale and mechanised systems (Johns Hopkins University, 2023). Coupled with rapid population growth and expanding global trade, these forces intensified land use and input dependence, moving agriculture beyond many of its former natural constraints (Johns Hopkins University, 2023). Agricultural practices have long accelerated soil decline. Intensive tillage and monocropping break down soil structure, reduce organic matter and expose bare earth to erosive forces (Ferreira et al., 2022). Overuse of synthetic fertilisers can lead to nutrient imbalances and acidification, while heavy machinery compacts soil and impedes water infiltration (Basics Growing Professionally, 2025). In the North China Plain, repeated ploughing and high nitrogen rates have cut wheat yields by around 15 per cent over a decade due to compaction and declining soil organic carbon (Narasimha, 2020). Similarly, large-scale cotton monocultures in Uzbekistan resulted in severe salinisation and a 40 per cent drop in cotton productivity between 1990 and 2010 (Nodir Djanibekov et al., 2010).

Effective crop nutrition management, which guarantees appropriate fertilisation tailored to local circumstances, is fundamental to all sound agricultural practices (Yara, 2020). In the US Midwest, for instance, adopting no-tillage with winter rye cover crops increased corn and soybean yields by 10 per cent over five years while reducing soil loss to under 2 tonnes per hectare annually (Yara, 2020). Effectively controlling weeds, minimising soil erosion, enhancing soil health, and capturing surplus nitrogen, which makes these techniques favoured options for both gardeners and farmers (Chandler, 2023). Complementing these approaches, farmer-produced organic fertiliser can restore fertility and buffer acidification as seen in a farmer-led network trial across 12 rice fields in Nueva Ecija Philippines (Skivington, 2025). Skivington (2025) found that integrating organic and inorganic fertilisation increased yields by 20% within two seasons. The compost, approximately 60% rice straw, 25% cattle manure, and 15% legume biomass, was matured for 90 days and applied at 5 t ha^{-1}.

Healthy soils underpin sustainable agriculture by delivering essential ecosystem services, retaining water, cycling nutrients, and sustaining biodiversity. For example, conventional ploughing significantly reduces earthworm abundance and biomass compared with no-tillage and conservation tillage, whereas reduced tillage and cover-cropping have been shown to increase both earthworm population density and functional diversity (Bertoncelj, Anže Rovanšek and Leskovšek, 2025). Well-aggregated soils buffer extreme weather by absorbing heavy rainfall and releasing moisture during dry spells, thus stabilising yields in the face of climate variability (Skivington, 2025), which is important for tropical islands that are affected by extreme weather conditions. Soils capture atmospheric carbon, helping mitigate greenhouse gas emissions. They store roughly 1,500 Pg (petagrams) of organic carbon, more than twice the amount in the atmosphere (FAO, 2015). Without these functions, agriculture cannot meet food demand without heavy reliance on external inputs.

When best practice is ignored, food security is threatened. Yield declines force farmers to apply more fertiliser and water, driving up costs and eroding profit margins. In East Africa, over 40 per cent of soils are degraded through erosion, nutrient loss and salinisation, leaving farmers unable to grow enough food for their families and increasing the region’s reliance on imports (Gatwiri, 2025). Kenya’s croplands lose an average of 26 tonnes of soil per hectare each year, contributing to repeated crop failures and rising food prices (Warui, 2024). Kenya’s croplands have been losing roughly 26 t/ha/yr for decades, with erosion rates climbing steadily after the shift in the 1970s from traditional fallow and woodland systems (shift cultivation) to continuous, intensively tilled croplands (Warui, 2024). Beyond physical loss, long-term use of ammonium-based nitrogen fertilisers has driven measurable soil acidification. For example, nationwide surveys in China show significant declines in cropland soil pH from the 1980s to the 2000s, with acidity loads from nitrogen cycling far exceeding acid deposition (Guo et al., 2010). Consistent with this mechanism, field evidence from western Kenya indicates that correcting acidity through liming on soils with initial pH 4.0–5.7 reliably increases maize yields with or without added fertiliser, underscoring the importance of pH management alongside erosion control (Hijbeek et al., 2021). This highlights the urgent need for sustainable soil management practices to mitigate these challenges and ensure long-term agricultural productivity.

While these global trends highlight the widespread drivers and consequences of soil degradation, the challenges intensify in small-island developing states (SIDS) such as SVG the focus of this study, where limited land area, fragile volcanic soils and high exposure to extreme weather make agricultural systems even more vulnerable

2.3 Small-Island Developing States (SIDS): Environmental and Agricultural Vulnerabilities

Some SIDS, such as SVG, are located in the southern part of the Caribbean Sea. This group of islands is a member of the Lesser Antilles and lies 100 miles west of Barbados and 50 miles north of Grenada (CAIPA, 2021). See Figure 5 for visual reference.

Figure 5. Map showing the location of SVG (World Atlas, 2025)

SVG is a nation composed of 32 islands and cays, with St Vincent serving as the main island. To the south of St. Vincent lies the Grenadines, a chain of smaller islands and islets. The capital city, Kingstown, is situated on the main island. As of September 2021, the country's population was approximately 110,000 people speaking the official language, English (CAIPA, 2021). Among SIDS, SVG presents a particularly relevant case because its steep volcanic terrain, high rainfall and long history of fertiliser-intensive farming have created acute problems of soil acidification and erosion (Ministry of Agriculture, 2002), making it a useful lens through which to examine sustainable soil management SVG is characterised by a steep volcanic interior rising to 1,234 m, surrounded by narrow coastal plains where over 60 per cent of the population lives; the central highlands remain largely forested (CIA, 2025). The combination of rugged slopes and average annual rainfall of 1,800–2,200 mm concentrates runoff into fast-flowing streams (CIMH, 2018), driving sheet and gully erosion that strips thin topsoil.

In SVG, agricultural land constitutes 17.9 per cent of the total land area, with arable land accounting for 5.1 per cent, permanent crops occupying 7.7 per cent, and permanent pasture covering 5.1 per cent (CIA, 2025). Forests dominate the landscape, accounting for 73.2 per cent of the land area, while other uses comprise 8.9 per cent (CIA, 2025). This distribution highlights the limited proportion of land allocated to farming compared to the extensive forested regions across the island. Figure 6 shows how the land was used when the banana was the main crop being produced. All produce was cultivated in an area where the slopes were less steep, and the soil was more fertile.

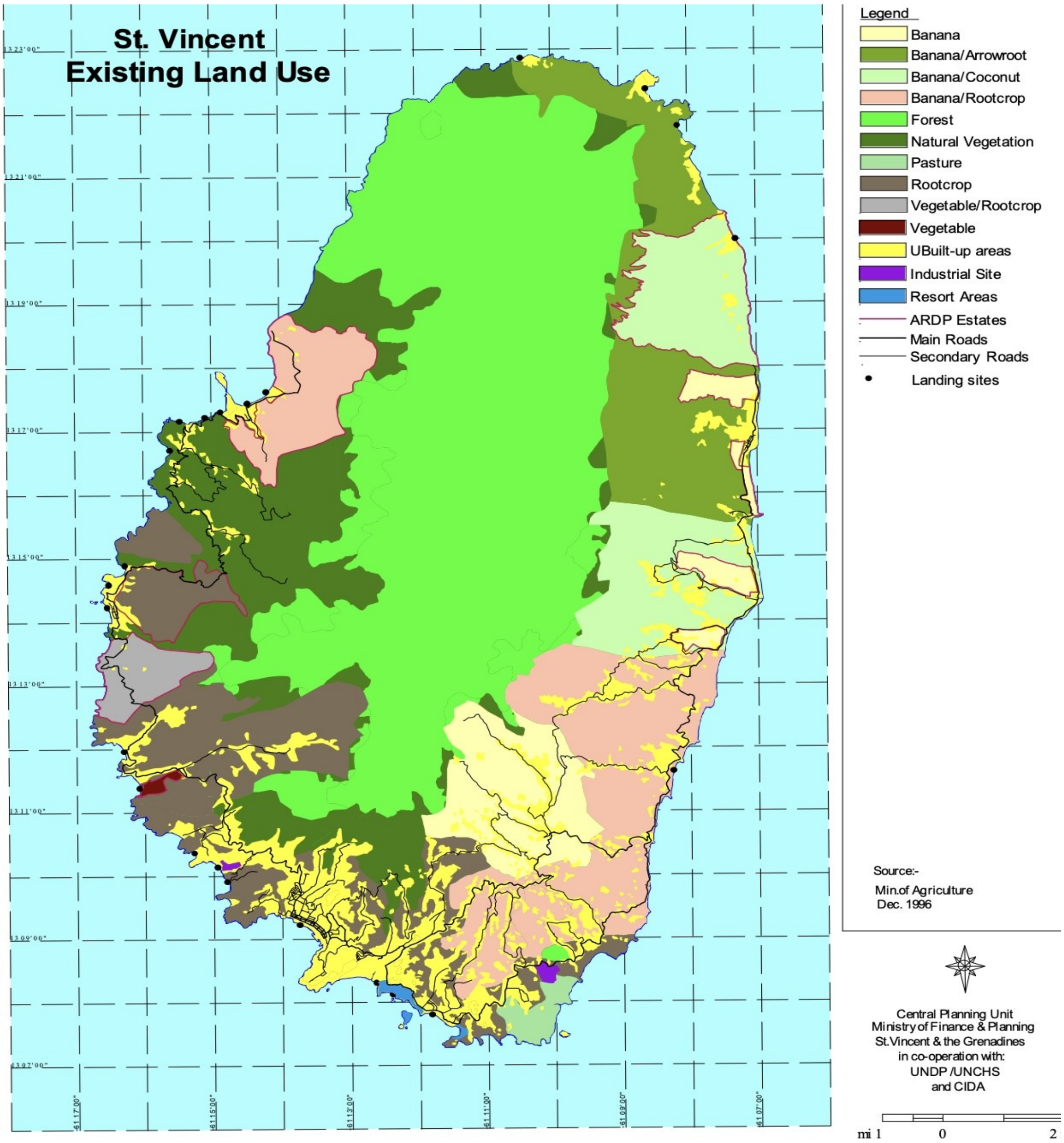

Figure 6. Map of previous land use of SVG (CBD, 2000).

The most common farm size ranges from 0.2 to 2.0 hectares, representing small-scale farms (University of the West Indies, UWI, 2018). The primary agricultural products of SVG include root vegetables, arrowroot starch, coconuts, spices, and bananas (Caribbean Agribusiness, 2020). Numerous food items available for sale within the country are sourced from rural regions and brought to the municipal market in Kingstown (FAO 2022). These mini-farms rely mainly on rain-fed plots on steep terraces, making mechanisation difficult and increasing labour intensity. High input costs mean producers often skip soil conservation measures, further exposing fields to erosion (Posthumus et al., 2013). The Taiwanese government provided advice for SVG to avoid nutrient deficiencies in the soil (Taiwan Republic of China, 2018). This guidance came through a bilateral agricultural cooperation programme, requested by the SVG Ministry of Agriculture, reflecting official recognition that soil fertility problems were undermining productivity and needed external technical support. They explained that it is necessary to supplement nitrogen and phosphorus by applying appropriate fertilisers. Secondly, due to the high potassium levels found in the soil based on soil analysis results across the land, farmers are encouraged to decrease the usage of potassium-based fertilisers to reduce production costs (Taiwan Republic of China, 2018). This advice indicates that there has been a struggle to retain healthy soils, and it is costly to import mechanisms to remediate the soil. This emphasises the need to remediate the soils to improve the agricultural industry once more, with the help of simple, sustainable practices such as using organic fertilisers.

SVG has a diverse range of soils shaped by elevation, rainfall, and topography. According to the Convention of Biological Diversity (2000) (CBD), above 600 ft, the high-level yellow earth soils classified as clayey loam soils are deeply weathered, poorly drained, and acidic due to heavy rainfall. Below this elevation, the low-level yellow and brown earth soils are better drained, less acidic, and more fertile, typically found on gentler slopes. The alluvial soils, covering about 1,800 acres in southwestern valleys, are the most fertile found on the island. Shoal clay soils, located along the southern and western coasts, are moderately fertile but challenging to cultivate due to their sticky nature when wet and hardness when dry. Meanwhile, in the mountainous interior, shallow central mountain soils with high organic matter are highly prone to erosion and generally unsuitable for cultivation.

Consequently, even in the most accessible lowland and coastal zones, soil quality is relatively poor, an outcome of intense tropical rainfall leaching and human pressures (Mandal et al., 2022). SVG had a lengthy history of human pressures, such as intensive monoculture farming, which encompasses crops such as cotton, sugarcane, arrowroot, and bananas. This form of agriculture has led to the degradation of topsoil. The agrochemicals involved primarily include pesticides and synthetic fertilisers (CBD, 2000). A national report to the United Nations Convention to Combat Desertification (UNCCD) was created in 2002 for an update. However, the information remains the same, and acid soils remain an issue (Ministry of Agriculture, 2002). The report shows that acid soils affect over 70% of St Vincent's farmland, but no national monitoring or recommended actions like soil surveys or conservation trials were ever implemented.

A follow-up report was created in 2006, and it is stated that an adequate assessment of past natural resource management efforts requires comprehensive national data collection (Ministry of Agriculture, 2006). However, such efforts have been hindered by limited data availability, particularly the absence of soil nutrient data (Ministry of Agriculture, 2006). As this was the last document report, this indicates that with reports and suggestions being made, the progress of adopting more sustainable practices is slow. Avoiding addressing the current issue at the time has led to a decline in the agricultural industry. The Minister of Agriculture highlighted that declining agricultural output in Saint Vincent and the Grenadines is affecting food availability in the wider region (Diana, 2025). For example, Barbados, traditionally a key recipient of Vincentian produce, is now facing market shortages and rising food prices due to the supply disruption (Diana, 2025). Although these impacts are highlighted, there have been no observations of improvement, which may be due to a lack of Governance within the agricultural industry.

Soil fertility is further undermined by heavy reliance on imported inorganic fertiliser known as Fersans, principally from Santo Domingo (Fersans, 2025). The chemical substances containing nitrogen, phosphorus and potassium at a ratio of 20-20-20, utilised by farmers, seep into the soil and can harm essential native plants and animals in the forest (CBD, 2000). The key chemical process is the release of hydrogen ions (H^+) during nitrification and ammonium conversion, which acidifies the soil and leaches essential nutrients like calcium and magnesium (Tetteh, 2015). Fersans is used without accompanying lime or organic amendments, leading over time to declining pH, lower cation-exchange capacity and soil organic matter (Brown and Lemon, 2023). Cation exchange capacity (CEC) measures how many positively charged nutrients a soil can hold; higher CEC stabilises structure, improves nutrient availability, moderates' pH change and shapes responses to fertilisers (Ketterings, Reid and Rao, 2007). Much of a soil's CEC resides in organic matter; therefore, building soil organic carbon increases nutrient retention in the topsoil and buffers acidification (Brown and Lemon, 2023).

Although human practices affect soil over time, the climatic extremes compound these pressures. For example, in April 2021, La Soufriere's eruption blanketed farms in ash, acidifying soils and clogging drainage (UNOCHA, 2021), while hurricanes Tomas (2010) and Elsa (2021) caused widespread topsoil loss and crop destruction (CDEMA, 2010; Stuart, 2021). With the increase of global warming, increasing the frequency of harsh weather, it is very difficult for SIDS to recover industries such as agriculture (Savarala, 2024). Especially if there are no sustainable farming practices that will help to rejuvenate the soil. Figure 7 illustrates the current soil health of SVG, via research conducted on soil health in Latin America and the Caribbean (Poppiel et al., 2025). The map for the study was derived using a hybrid methodology combining satellite-based land degradation assessments with ground-truthing data from field surveys and farmer interviews across multiple Latin American and Caribbean islands (Poppiel et al., 2025). The reference is considered highly reliable, as it uses peer-reviewed spatial modelling validated against in-field observations and national agricultural datasets. The map shows that the coastline, where there were more suitable locations due to flatter terrain for farming, is now poor (Poppiel et al., 2025).

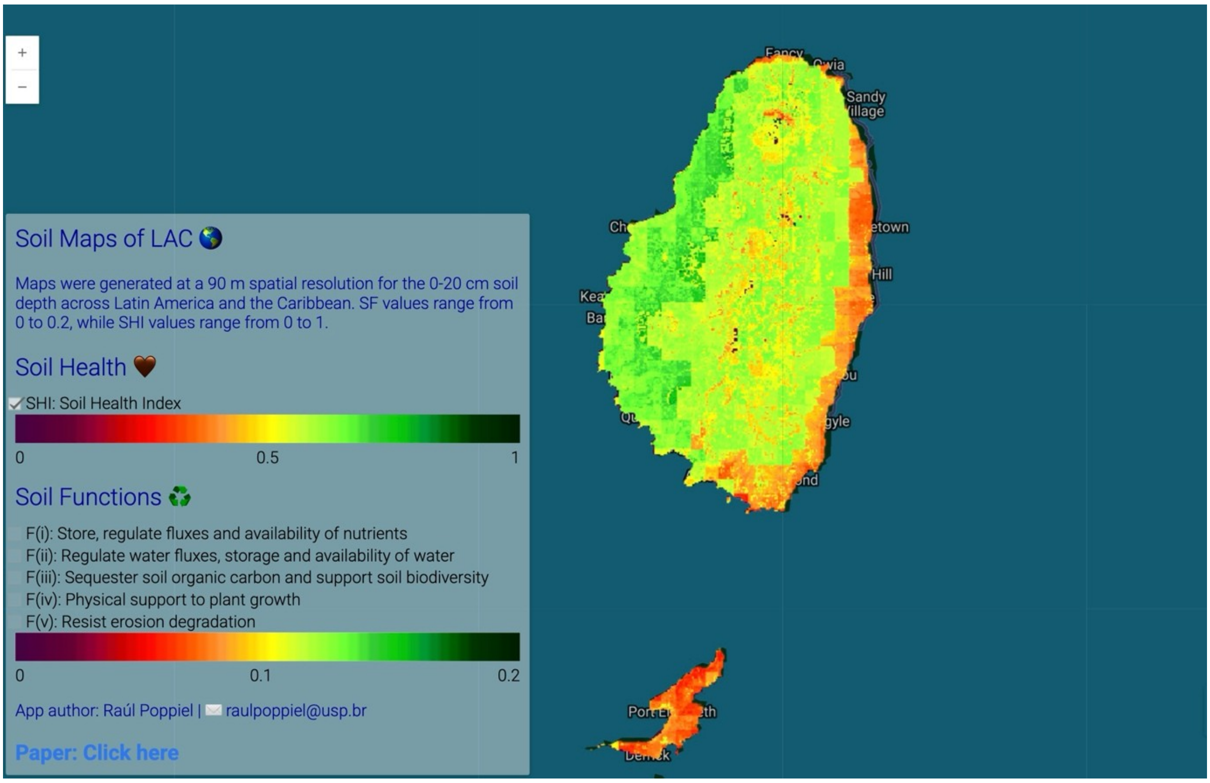

Figure 7. Map of soil health in SVG (Poppiel et al., 2025)

Once upon a time, bananas alone accounted for 42 per cent of merchandise exports in 2023, but EU market reforms dismantled preferential access between 2006 and 2009 (Fridell 2010). This forced export volumes down by 30 per cent and farm incomes down by 25 per cent (Fridell 2010). Loss of preferential tariffs under the EU-ACP Economic Partnership Agreement exposed farmers to global price competition they cannot match, exacerbating rural poverty and out-migration (Fridell, 2010). As a result of this, SVG is now one of the nations in the area where approximately one-third of the people experienced moderate to severe food insecurity throughout the period from 2020 to 2022 (Cooke, 2023). This emphasises the importance of having a prosperous agricultural industry.

Despite these constraints, agriculture remains a vital livelihood within the rural areas; at least 12 per cent of SVG's workforce depends directly on produce from farming. Rural household incomes can even rise by over 20 per cent through diversified vegetable and root-crop production on small slopes (Ministry of Agriculture, SVG 2024). Such diversification also strengthens food security by reducing reliance on expensive imports.

Given the twin challenges of steep, erodible terrain and tropical rainfall that has negative effects on soil regarding its health, SIDS require soil-conservation approaches which are fine-tuned to small areas. Practices like soil neutralisation and the use of organic fertiliser integration will protect soils and maintain moisture more effectively (Verma, Pramanik and Bhaduri, 2019). Tailoring interventions to local labour capacities and cost structures ensures adoptability and long-term sustainability in settings like SVG.

2.4 Lime and Organic Fertilisers as Soil Remediation Strategies

Soil remediation is the process of restoring soil's physical, chemical and biological functions to support healthy plant growth and ecosystem services. It includes neutralising harmful acidity, rebuilding organic matter and correcting nutrient imbalances (Nouri et al., 2017). In agricultural contexts, remediation enhances fertility, reduces erosion and increases crop yields while safeguarding water quality and biodiversity (Free Science, 2025). One of the techniques that aids in remediating soils is called soil neutralisation, also known as liming.

Lime application is the most widely used soil-neutralisation technique (Fielding, Newey and Pakeman, 2021). When lime is applied and mixed into the soil, it begins to alter the pH level. At least 35% of ground limestone (350 kg/tonne) consists of particles smaller than 0.15mm (Plunkett, 2020). This portion of the lime acts quickly and is highly reactive, starting its effect within a short time frame (0-6 months) (Plunkett, 2020). The remaining 65% of lime (650 kg/tonne) will decompose in the soil over a medium period (6-24 months) and aids in sustaining soil pH levels over the long run until the soils are re-evaluated in years 4-5. Agricultural lime, Calcium carbonate ($CaCO_3$), reacts with hydrogen ions in the soil, raising pH and precipitating toxic aluminium and manganese as hydroxides (Nouri et al., 2017). As pH approaches the optimal range of 6.0–7.0, phosphorus, calcium and magnesium become more available to plants, soil structure improves, and microbial activity rebounds (Webster, 2024).

A Nigerian study on acidic Alfisols investigated the liming potential of selected fertilisers by treating collected soil with crystalliser (CRYS), single superphosphate (SSP), an organic fertiliser (OF), and calcium hydroxide as the reference liming standard (Anetor and Akinrinde, 2006). These treatments were arranged in a completely randomised design with three replications, then incubated under controlled conditions. After incubation, soil pH and available phosphorus levels were measured to assess both the nutrient-supplying capacity and the liming effectiveness of the fertilisers. The objective was to determine whether these inputs could serve a dual function, improve soil fertility while also neutralise acidity, offering a cost-effective alternative for resource-limited farmers (Anetor and Akinrinde, 2006).

The study found that all fertiliser treatments increased soil pH compared to the unamended control (pH 4.8). Crystalliser (CRYS), single super phosphate (SSP), and organic fertiliser (OF) raised pH to between 5.0 and 5.5, while combinations of these fertilisers achieved slightly higher pH levels (5.6–5.8). The reference lime treatment ($Ca(OH)_2$) produced the highest pH increase (up to 7.2), which was most favourable. Additionally, phosphorus availability improved significantly with the amendments, rising from 4.24–7.09 mg/kg in the control to 15.09–17.33 mg/kg in treated soils. The conclusion states that it is anticipated that this will significantly reduce expenses for the financially constrained farmer, who would only need to apply one P fertiliser based on the type of crop being cultivated. Successive lime applications also eliminated exchangeable aluminium, enabling cereal crops to meet their optimal pH requirements and boosting yields by up to 30 per cent in tropical soils (Anetor and Akinrinde, 2006). This research provides evidence that liming soils can improve soil health and increase yield. The experiment also takes place in a tropical climate, facing issues of degrading acidic soils, making it comparable to issues that SIDS face. This aligns with similar findings in Brazil, where long-term liming and tillage trials improved wheat yields and corrected soil acidity (Silva et al., 2021).

Organic fertilisers supply nutrients and build soil organic matter, which enhances cation-exchange capacity, aggregate stability and water-holding ability (Ewunetu Tazebew et al., 2024). In South Korea, they practice Korean Natural Farming (KNF), which produces on-farm organic input through fermenting local resources such as food waste. KNF enhances soil health and crop resilience by using indigenous microorganisms, natural inputs, and on-farm resources. It reduces chemical dependence, lowers costs, and promotes a self-sustaining, eco-friendly farming system (Asian Farming, 2023). It is a combination of Fermented Plant Juice (FPJ) made by macerating fresh leaves in sugar water; Fish Amino Acid (FAA) produced by fermenting fish waste with brown sugar; and the fermented fruit juice (FFJ) made with fruits and brown sugar (Reddy, 2011; Keliikuli, 2019). In Hawaii, KNF treatments improved disease resistance and increased tropical vegetable yields over two seasons compared with conventional inorganic fertiliser alone (Olivier, 2020). KNF inputs also lower reliance on external purchases, closing nutrient loops and promoting self-reliance on small farms (AgriBusiness, 2023).

Combining lime with organic amendments often delivers the greatest benefits in tropical contexts. Trivedi et al. (2021) researched on 60 years of fertilisation and liming on sub-tropical paddy soils. This showed that plots receiving both farmyard manure (FYM) and lime maintained higher stocks of soil organic carbon in microaggregates and supported stable recalcitrant carbon pools, compared with FYM or fertiliser alone. In contrast, mineral NPK plus lime raised pH but reduced overall carbon stratification, underscoring the value of organic matter in long-term soil health. Similarly, Nigerian researchers found that mixtures of lime and organic fertiliser (compost or poultry manure) elevated soil pH to 5.6–5.8 (Falana et al., 2023). Compared with 5.0–5.5 for organics alone, and matched pure lime treatments in phosphorus availability, providing a cost-effective multi-purpose treatment. Based on the research conducted by Trivedi et al. (2021), combining lime with organic amendments delivers strong benefits in tropical soils. In SVG, adopting this dual strategy, occasionally liming alongside composted crop residues or livestock manures, offers a practical route to counter acidification and raise yields without increasing dependence on inorganic fertilisers.

2.5 Farmer Perceptions and Behaviour Change in Agriculture

Physical and economic barriers to SIDS soil health have been identified, but farming decisions ultimately determine whether techniques like liming, contour farming and organic amendments move from theory into practice. Access to training, financial constraints and local norms shape each farmer’s choice. The average farmer in SVG is over 55 years old, with the 2000 Agricultural Census reporting that 5 per cent of holdings were managed by those over 65. Few secondary schools offer agriculture as a GCSE or CSEC option, leaving young people without exposure to best practice (Ganpat & Webster, 2020; Ministry of Education, 2022). The latest education statistics report shows that no student signed up to write an exam for agriculture (Ministry of Education, 2022), which can be seen as a lack of interest from the younger citizens.

This knowledge gap fosters several unhelpful perceptions. Farmers who have worked the same slopes for decades may see no point in changing even if yields stagnate. Others may feel that global market pressures like the end of EU banana preferences make any extra effort futile, so they stick to quick-fix inorganic fertilisers (Goodison, 2007). Younger individuals who could be growers, never having learned farming best practices in school. This can lead to a view of agriculture as unimportant rather than vital for the future (Osbahr, 2023). Such attitudes have real impacts. Reliance on heavy-use NPK mixes without soil-building rotations or cover crops has degraded soils further, forcing higher input costs that squeeze thin profit margins.

Mentioned previously in section 1.1, Rogers' Diffusion of Innovations model is a theory that describes the way new concepts, practices, or technologies disseminate through a social system over time. It identifies five main stages in the adoption process: awareness, persuasion, choice, execution, and confirmation. The model also classifies adopters into five categories: innovators, early adopters, early majority, late majority, and laggards, depending on how swiftly they accept innovation (Rogers 2003). The speed of adoption is affected by factors such as the innovation’s perceived benefits, alignment with existing values, complexity, ability to be trialled, and visibility (Rogers 2003). The relative advantage, which highlights the significant yield increases observed in localised liming and organic research, must be effectively communicated. Therefore, trialability is supported by small-scale demonstration plots, allowing farmers to experiment with amendments on a limited number of beds, and observability relies on neighbours witnessing the successes of their peers. Meanwhile, Ajzen's Theory of Planned Behaviour suggests that a person's intention to engage in a behaviour is influenced by three main factors (Ajzen, 1991). Their attitude towards the behaviour, the social pressures they perceive (subjective norms), and their perceived control over the behaviour. In this research. The theory connects farmers' beliefs regarding liming and various soil-health practices, the impact of peers and advisors, and their confidence in having the necessary resources and skills (Ajzen, 1991). Analysing these three components uncovers the primary motivators and obstacles that affect farmers' decisions to adopt practices such as liming, contour farming, and the use of organic amendments.

By integrating controlled pot-trial findings with on-farm mini-demonstrations and subsequent surveys, this research can deliver solid evidence that lime and homemade Korean Natural Farming inputs can boost yields on SVG’s volcanic soils.

Breaking down obstacles of scepticism and routine necessitates fostering assurance through ongoing assistance and farmer advocates. Showing results alongside current plots and guiding farmers through straightforward preparation and application methods aids in creating a new standard. Support and farmer champions may also build self-efficacy and shift subjective norms, addressing perceived behavioural control according to (Ajzen 1991). On-farm demonstrations can enhance observability, accelerate progression through Rogers's adoption stages (Rogers 2003).

2.6 Identifying Gaps

Despite growing interest in sustainable soil management, few peer-reviewed studies test lime and compost in Caribbean Island field conditions. Searches reveal many liming trials in Latin America and tropical Asia (Alves et al., 2024; Mahmud & Chong, 2022; Silva et al., 2021), but none conducted under the high-leaching, volcanic-soil regimes typical of the Eastern Caribbean. Although Trinidad was mentioned in Section 1.1 for its efforts in liming soils, it is not a part of the Eastern Caribbean islands, which are further north. In particular, no study combines agricultural lime with organic composts or Korean Natural Farming inputs on island plots. However, recently, FAO (2025) has had a series of discussions and online seminars presenting initiatives that have encouraged alternative soil management practices in different countries across Latin America and the Caribbean. Driven by escalating soil degradation and food security concerns, FAO's seminars led to the formation of a regional steering committee and the launch of capacity-building and pilot soil-management initiatives across Latin America and the Caribbean. Concentrating on three primary themes, the present condition of soil fertility and plant nutrition in the region, possible sustainable options for managing soil fertility, including practices like liming, and policies designed to promote and expand these alternatives.

Currently, publicly available soil-nutrient data are absent for SVG. The Ministry of Agriculture (2006) notes that national soil surveys were last updated in the 1980s, and there have been no further updates since that report. Any more recent surveys may be available in hard copy or internal archives, preventing researchers and farmers from making evidence-based decisions. Strengthening governance, investing in soil data systems, and securing leadership commitment are critical to empowering decision-making for the adoption of sustainable soil management practices (Daedlow, Hansjürgens and Koellner, 2018).

A regional analysis indicated that the current legislative structure for environmental management in SVG is largely obsolete and insufficient to address present issues, particularly those related to competing demands for resource utilisation and development. “A number of laws exist which might be used to control and manage agriculture for conservation. These laws do not appear to be actively used at present” (CBD, 2000). The CBD report flagged ongoing erosion and siltation in major watersheds, yet the Ministry of Agriculture’s subsequent strategy document offered no new enforcement measures (CBD 2000; Ministry of Agriculture, SVG 2006). Without updated monitoring or public reporting, these laws remain largely aspirational.

In terms of social aspects, there is a notable absence of research centred on farmers that combines biophysical trials with behavioural studies. Global assessments of agricultural innovation indicate that pairing on-farm demonstrations with attitude surveys can significantly enhance the adoption of new practices (Dessart, Barreiro-Hurlé and van Bavel, 2019). However, no mixed-method research has been conducted for SVG or its neighbouring islands. Consequently, there exists a gap between the findings from labs or greenhouses and the actual decisions made by farmers in the Caribbean.

Part of the scarcity of such work stems from the government's focus on tourism development at the expense of agriculture. Constance (2021) observes, "While St. Vincent and the Grenadines certainly need tourism, the development of the agriculture sector need not decline in the face of tourism's development." Without renewed commitment, soil health research and outreach will continue to lag. Addressing this gap in the literature is essential for bridging scientific and policy deficiencies and securing long-term sustainability and food security in SVG. By producing relevant agronomic data specific to the local context and combining it with focused education, this research establishes a foundation for resilient, low-input farming systems that can benefit future generations. Overall, the review highlights a clear gap, despite extensive global evidence on liming and organic amendments, there is a notable absence of comparable peer-reviewed trials in the Caribbean context, particularly for small-island volcanic soils such as those in SVG.

2.7 Conclusion

Through this review, it has become clear that soil degradation from trends of erosion, nutrient loss, acidification, and high-rainfall landscapes of SIDS poses a compound threat to agricultural sustainability in SVG. Proven remedies like liming and organic amendments can rebalance pH and rebuild soil organic matter, yet none have been rigorously tested in the volcanic, high-leaching soils of the Eastern Caribbean. Meanwhile, farmers' entrenched habits and limited education may block the uptake of even simple, low-cost practices.

Bridging these gaps requires more than isolated agronomic trials or standalone surveys. It demands a coupled biophysical behavioural approach. Pairing a one-season lime and Korean Natural Farming experiment with pre- and post-trial interviews, this research will generate locally valid evidence of yield and soil-health gains, while also uncovering the social levers of trialability, observability and perceived advantage that drive adoption. In doing so, it lays the foundation for resilient, low-input farming systems that can restore productivity, safeguard livelihoods and improve food security.

3. Methodology

3.1 Introduction

This chapter describes in detail how the study was designed and carried out, explaining not only what was done but why each step was necessary to answer the research questions. It begins by reviewing the methods considered from literature searching and data-collection tools, analysis techniques, ethical safeguards and reflexivity and shows how each choice aligns with the study's overarching aim, objectives and questions.

The central aim is to determine how soil neutralisation (liming) and fertiliser type (organic versus inorganic) influence the yield and quality of lettuce *(Lactuca sativa)* grown in acidic, volcanic soils in SVG. Then, to assess whether sharing those experimental results changes farmers' willingness to adopt more sustainable soil-management practices. To achieve this, the project combines a controlled, one-season pot trial comparing four treatments (limed soil with inorganic fertiliser, limed soil with organic fertiliser, unlimed soil with inorganic fertiliser, unlimed soil with organic fertiliser) with pre- and post-trial surveys and semi-structured interviews of ten local farmers. The quantitative method generates precise data on plant growth, yield metrics, soil pH shifts and produce quality, and attitude shifts, while the qualitative strand captures farmers' beliefs, attitudes and decision-making processes around soil remediation.

Adopting a mixed-methods approach ensures that agronomic measurements are interpreted alongside human factors. Providing a broad understanding of both the biophysical impacts of liming and the social dynamics governing the adoption of sustainable practices. Each subsequent section explains how sampling was conducted, how the experiment was set up, how data were collected and analysed, and how challenges were addressed.

3.2 Literature search technique

The targeted review method for the literature review, as outlined in chapter 2, uncovered a strong global evidence base for liming and organic amendments and a notable gap in Caribbean-specific trials as noted in section 2.6. This section also highlights best practice for measuring yield (e.g. growth rate, biomass, colour and firmness) and frameworks for understanding behaviour change. In this way, the literature research not only grounded the methodology in established science but also ensured the research design would address the precise knowledge gaps identified for SVG.

3.3 Defining the data requirements

The study's data collection was designed to answer two distinct questions. Firstly, how liming and fertiliser type affect lettuce *(Lactuca sativa*) performance in acidic and volcanic soils. Secondly, how the presentation of those results influences local farmers' attitudes and intentions around sustainable soil management. To address the first question, a set of plant and soil metrics was required to detect treatment effects under controlled conditions. The literature on lettuce trials in acidic soils indicates that height, leaf count, biomass, and soil pH are reliable, sensitive indicators of liming and fertiliser effects (Marchi et al., 2015; Cera et al., 2022). In particular, Marchi et al. (2015) show that increases in plant height and leaf number under liming and fertiliser treatments closely track soil-pH improvements and yield gains, supporting their use here.

The second question required insight into farmers' current practices, beliefs and willingness to change. Semi-structured interviews and short surveys were conducted before and after sharing the trial results to capture shifts in awareness and readiness to adopt new techniques. Together, these social data clarify which aspects of the evidence resonate most with farmers, and whether seeing real-world trial outcomes can overcome scepticism or habitual reliance on conventional fertilisers (Creswell, 2009).

A mixed-methods approach was chosen because quantitative data alone cannot explain why farmers do or do not embrace sustainable practices, while purely qualitative insights lack the precision needed to compare treatment effects (Saunders, Lewis and Thornhill, 2019). This combination enhances the overall validity and reliability of the findings and offers a richer, more actionable understanding of both biophysical impacts and human decision-making (Sattar et al., 2017).

3.4 Consideration of alternative data-collection methods

3.4.1 Introduction

Several methods were evaluated for delivering fertiliser and gathering social data before finalising the approach. Each option is summarised below with its strengths, limitations and the rationale for inclusion or exclusion.

3.4.2 Fertiliser-Delivery Techniques

Fertigation

Defined as dissolving fertiliser in irrigation water and applying it directly to the root zone through manual watering using a hose or bucket (Kant, 2013). Advantages include ensuring even nutrient distribution, reducing waste and limiting leaching compared with solid broadcasting (Cherlinka, 2021). Local farmers in SVG already employ this simple form of fertigation using hoses or watering cans (CARDI, 2016). There is no significant disadvantage for this study, since the focus is on fertiliser type rather than delivery method, and existing manual watering practices are well-suited to small plots. Therefore, the decision made includes using this technique as the standard delivery method across all treatments, but it is not itself a variable under investigation.

Injection

Defined as using a mechanical injector to mix concentrated fertiliser into irrigation lines or directly into soil at the point of watering (Samson, 2024). The advantages include uniform delivery, reduced manual spread labour, and compatibility with greenhouse or nursery settings (Shaaban, 2009). However, fertilising via injection would be too labour-intensive and time-consuming for small-scale farmers in SVG to carry out manually (Farmers Magazine, 2024). Especially given the need to apply fertiliser individually to each plant across even modestly sized plots. Therefore, the final decision was to discard manual injection at the field scale, which proved infeasible for resource-limited, labour-intensive small farms.

Foliar Application

Defined by spraying liquid fertiliser directly onto leaves so nutrients are absorbed through the leaf surface (Gupta et al., 2023). The advantages include rapid symptom correction, bypassing soil-pH constraints, and targeted nutrient delivery to address deficiencies (BMS, 2018). The disadvantages are that it may cause leaf burn if concentrations are incorrect, provides only short-term relief, is insufficient for holistic soil remediation, and requires precise timing and multiple sprays (Niu et al., 2020). The final decision was to discard foliar feeding as it does not support the study’s aim of remediating soil acidity and building long-term soil health.

3.4.3 Alternative Crops

Radish (Raphanus sativus)

Radishes *(Raphanus sativus)* were considered because they are fast-growing, harvestable within 30 days, and the roots are visible after harvest (Burke, 2022). However, growth occurs mostly underground, making interim measurements for the growth rate of the edible produce difficult within pot trials; the final product would only be measurable after the experiment (Price and Munns, 2016). While researching crops that grow quickly, the decision was made to discard the use of radishes because their development cannot be monitored non-destructively throughout the trial window.

Tomato (*Solanum lycopersicum*)

Tomato (*Solanum lycopersicum*) was considered because it is a well-studied crop model, with distinct phenological stages, and potential for foliar and soil treatments (Liu et al., 2022). However, the disadvantages were that although the plant itself could grow and germinate quickly within the timeframe, the fruiting stage exceeded the 30-day experimental timeframe, and yield data would be unreliable (Gillette, 2023). The final decision made was to discard the tomato (*Solanum lycopersicum*) plant because it requires 100+ days from transplant to harvest under controlled conditions (Gillette, 2023), which is outside of the available timeframe for this experiment.

3.4.4 Social-data collection formats

Interviews and Surveys

Semi-structured interviews were utilised to gather detailed insights into farmers' educational experiences, their knowledge of soil-management best practices, and their openness to altering practices, which closed-ended surveys may not fully address. This qualitative method allows for the examination of the dispositional, social, and cognitive elements that influence adoption decisions, ensuring that the study's conclusions are rooted in the actual experiences and motivations of the participants (Dessart et al., 2019).

Surveys are essential for systematically capturing representative data on attitudes and behaviours, providing the empirical foundation needed to design and evaluate interventions (Lavrakas, 2008). Administering the survey twice before and after introducing best-practice guidance lets you track real behavioural shifts rather than mere awareness, aligning with Rogers' diffusion logic where locally generated evidence through small trials converts interest into concrete adoption decisions (Michie et al., 2018; Rogers, 2003).

The original plan was to interview one individual from the Ministry of Agriculture in SVG, two experienced farmers, and also conduct a youth focus group discussion.
However, 5 interviews and 10 surveys (before and after the experiment) were conducted. This strengthens the reliability of the results because it is hard to tell whether the intervention caused the opinions or just happened naturally over time (Kennedy et al., 2019). Instead, the qualitative data expanded to ten individual farmer interviews, paired with pre- and post-trial surveys to enable

quantitative comparison of attitude shifts. This approach helps measure changes and assess the impact of interventions, allowing for data-informed decisions and continuous improvement (Winslow, 2025).

By systematically discarding methods that are technically or practically incompatible with conditions in SVG, the study focuses on soil mixing of pre-neutralised acid soils, manual application of organic (KNF) and inorganic fertilisers, and a mixed-methods social survey that optimises relevance and feasibility.

3.5 Data Collection Procedure

3.5.1 Introduction

This section outlines the systematic approach used to collect both the physical soil and plant measurements (primary data) and farmer perception information (secondary data) for the study. It details the experimental design and procedures, survey and interview instruments, and ethical protocols followed throughout the research. Mixed-methods design was chosen because it combines precise quantification of soil and plant responses with in-depth exploration of farmer perceptions (Creswell, 2011; O'Cathain, 2010). Whereas purely quantitative approaches would miss the "why" behind adoption, and purely qualitative methods would lack the statistical power to compare treatment effects.

Location

The study took place in Belair, a village located in St. Vincent, at the coordinates 13.155677, 61.197073, (see figure 8 & 9). The chosen site includes a sheltered porch, creating a controlled outdoor atmosphere where the plants receive natural sunlight while being shielded from outside influences that could affect the results of the experiment. This environment helped maintain natural, uniform conditions by reducing exposure to negative factors.

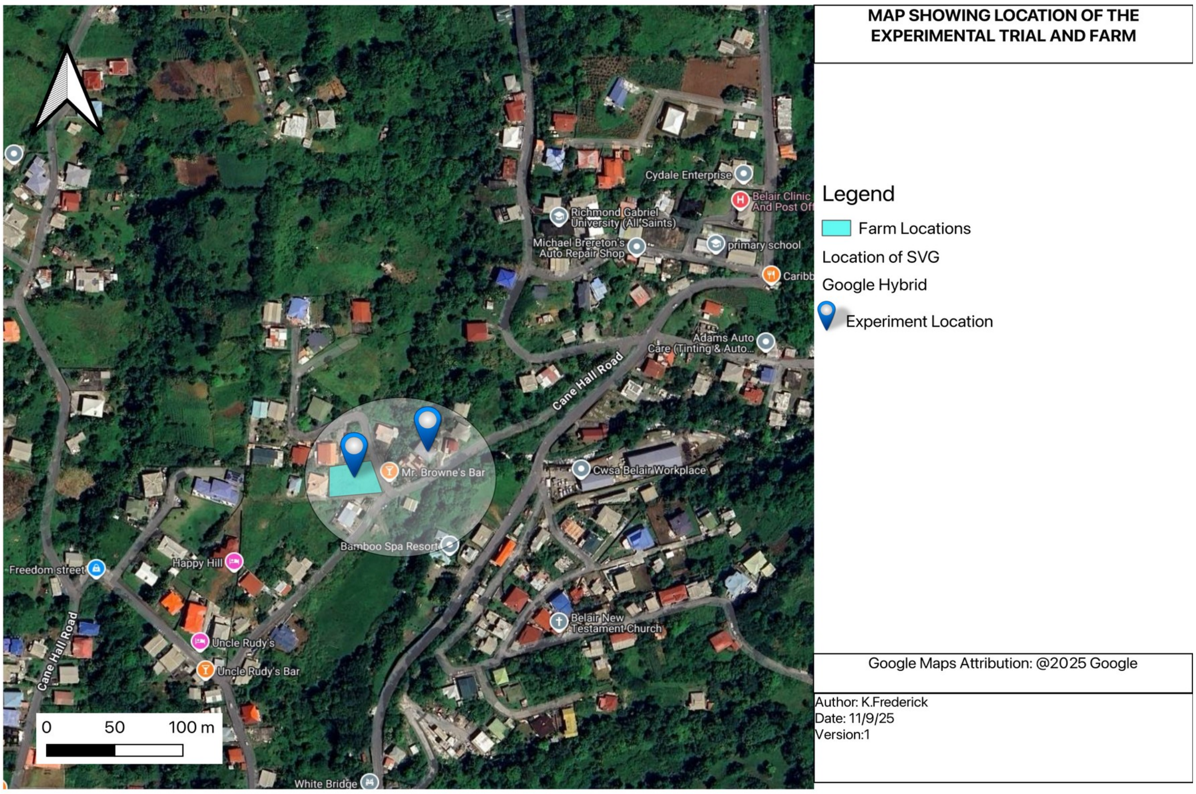

Figure 8. Map identifying where the soil was retrieved and where the experiment took place (Frederick, 2025b)

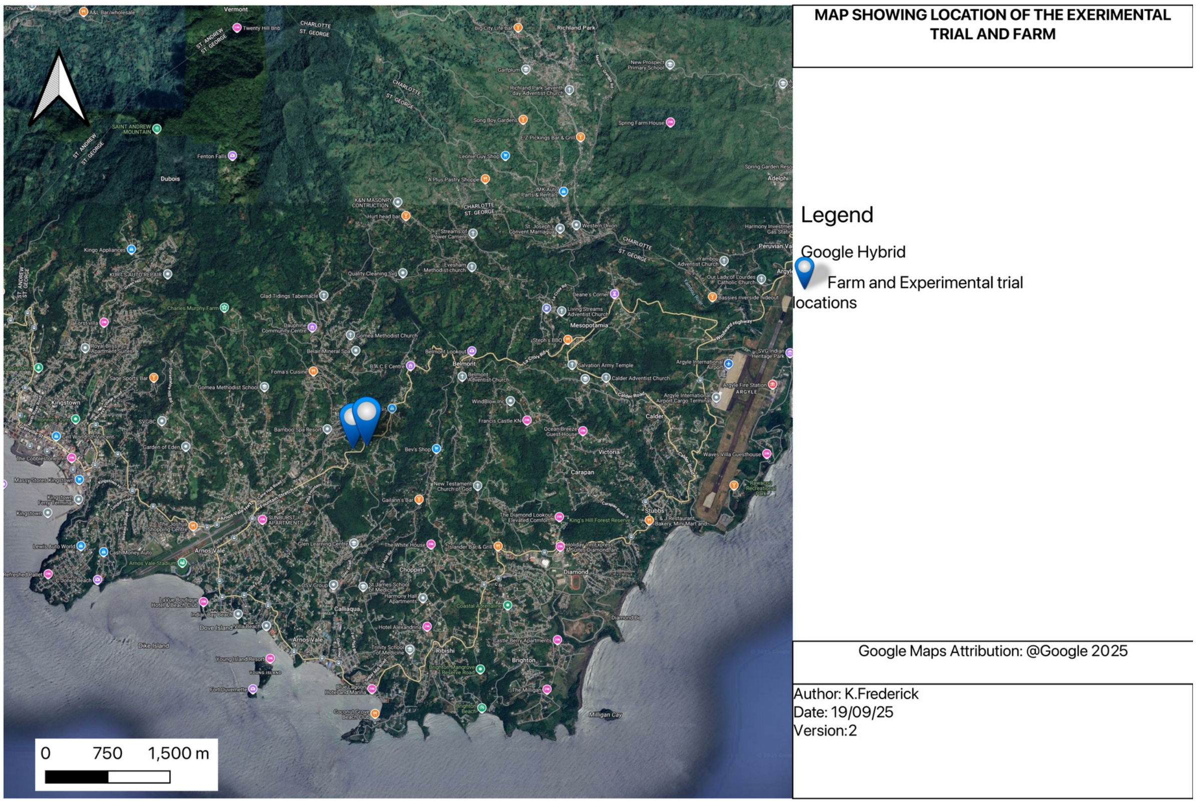

Figure 9. Map identifying where the soil was retrieved and where the experiment took place (Frederick, 2025j)

3.5.2 NPK Organic Fertiliser Preparation

The approach for this research was created using the findings from Keliikuli (2019) and Reddy (2011), whose extensive research on farming methods shaped important decisions in the experimental design. This procedure was adapted from methods in the literature (section 2) but modified for SVG's constraints. For example, while many liming trials outlined in (section 2) use large field plots and powdered lime, this study used potted soils neutralised with a liquid calcium carbonate product. This deviation was necessary because Agri-cal acts quickly and does not require machinery (Caribbean Chemicals, 2025), making it feasible under both the short timeframe of this experiment and the resource conditions faced by SVG farmers. Similarly, organic fertiliser preparation followed Korean Natural Farming protocols but was scaled to a household level, reflecting what farmers in SVG could realistically replicate using their own local products. These adjustments ensured that, although simplified, the experiment remained scientifically valid while also modelling approaches that are practicable for local farmers. The following outlines the procedure:

1. Preparation of Organic Mixtures:

To create a liquid organic fertiliser that is rich in nutrients, a method based on Korean Natural Farming (KNF), as mentioned in chapter 2, was utilised. The components and the process involved included:

Fermented Plant Juice (FPJ): The method suggested the use of any green leafy plant. Therefore, 86g of fresh plant material, such as young lettuce *(Lactuca sativa)* leaves and spinach *(Spinacia oleracea)*, and Bok Choi (*Brassica rapa subsp*), giving a total of 258g, was finely chopped and mixed with brown sugar in equal (258g) proportions by weight. 50ml of rainwater was added to the dry leaves. The mixture was placed in an airtight container to ferment (25-29 degrees Celsius) in a dark drum for 7–10 days (from 5th-12th July 2025). During this process, the plant material released its nutrients, forming a liquid known as Fermented Plant Juice (FPJ). The liquid was strained to remove any solids after 10 days.

Fermented Amino Acids (FFA): The method suggested the use of fish to prepare this mixture. On the 20th of June, 2lbs of Jack fish *(Caranx hippos)* was combined with an equal weight of brown sugar (2lbs) to facilitate microbial fermentation. The fish had moisture already; therefore, no rainwater was added. The mixture was placed in an airtight container and left to ferment for three weeks in the drum, during which the decomposition process occurred. The fermentation was considered complete on 5 July, when the strong ammonia odour had dissipated, indicating nutrient stabilisation. On this day, the dark liquid was carefully strained to remove solid residues and stored in a sealed container in the drum found on the farm for future use as the nutrient-rich organic input.

Fermented Fruit Juice (FFJ): To create the fermented fruit extract, 130g of an over-ripened banana and 130g of an English apple *(Malus x domestica)* were mashed thoroughly and combined with 206g of brown sugar. 50ml of the rainwater was added to the mixture. The mixture was placed in an airtight container and left to ferment for 7-10 days (from 5th-12th July 2025). The mixture was stirred daily to ensure even fermentation and prevent unwanted microbial growth. Once the process was complete, the syrup-like liquid was strained to remove solids. The solution was stored in a sealed container in a drum on the farm in Belair until needed.

2. Extraction and Dilution:

To create an organic fertiliser of a ratio close to 3-1-2, the final solution was mixed accordingly: 3 cups FPJ, 1 cup FFA and 2 cups FFJ, then stored in a container, see figure 10. This ratio was chosen because it provides a balanced nitrogen, phosphorus, and potassium (N-P-K) profile that promotes vigorous leaf growth and soil fertility, mirroring Korean Natural Farming protocols that have successfully used this exact ratio in similar leafy-vegetable trials. The liquid was strained and diluted with rainwater to ensure it was safe for plant application. 40ml of the concentrated solution was added to 5 gallons of rainwater, which is adjusted for a ratio of 1:500. The diluted mixture is contained in a sealed 5-gallon bucket.

Figure 10. Image of the concentrated KNF organic mixture (Frederick, 2025f)

3.5.3 Soil Neutralisation and Preparation

Soil Sampling and Initial Testing

Soil was tested on site to ensure that it was acidic and was collected at 17:00 on 2nd July 2025 from a representative plot on a small farm in Belair, near where the experiment took place. Although there were multiple farms of a similar size, this particular plot in Belair was selected because it was readily accessible, there were time constraints for this experiment, and explicit landowner permission for soil removal was obtained. Individual samples were immediately again tested using a three-in-one pH metre see figure 11, which also measures moisture and light absorption, yielding a reading of 6.0 and confirming the soil's acidic status.

Figure 11. Image of the three-in-one pH metre (Frederick, 2025o)

Pot Preparation and Neutralisation

Sixteen two-litre pots were acquired for this experiment. The 2-litre pots were selected because they provide roughly 2,000 cm^3 of growing medium, enough to support full lettuce growth through harvest without root confinement (Poorter et al., 2009). Sixteen pots were used in total. Each treatment had four replicates; replication allows variability to be measured and provides enough statistical power to detect treatment effects. This approach follows established guidance in agricultural statistics (Gomez, 1984).

Each was filled with two litres of the acidic soil from the chosen site. Eight pots were assigned to the neutralisation treatment. Following the manufacturer's instructions, Agri-cal (a liquid calcium-carbonate product) (Caribbean Chemicals, 2025) was mixed at four tablespoons per gallon of rainwater; 750 mL of this suspension was applied to each neutralised pot treatment as mentioned in (section 3.5.3). See Figure 12 for a visual of the Agri-cal solution. Agri-cal was selected because it reduces soil acidity over ten times faster than agricultural lime, it is relatively affordable and does not require mechanical incorporation into the soil (Caribbean Chemicals, 2025). Due to the short duration of the experiment, a fast-working neutralising solution was required.

Figure 12. Image of the Agri-cal solution used to neutralise the soil (Frederick, 2025c)

Each pot was then labelled 1–16 and arranged in a block design as follows in (Table 1):

Table 1. Pot Assignment

Pot Numbers	Code	Contents
1–4	N-ON	Neutralised soil + Organic fertiliser
5–8	N-ION	Neutralised soil +

		Inorganic fertiliser
9–12	A-ON	Acidic soil + Organic fertiliser
13–16	A-ION	Acidic soil + Inorganic fertiliser

See figures 13-18 to visualise the experiments set up.

Figure 13. All 16 pots aligned at the experiment location Frederick, 2025e

Figure 14. Image of the pots being labelled (Frederick, 2025e)

Figure 15. Image of the N-ON pots alongside each other, labelled and numbered (Frederick, 2025e)

Figure 16. Image of the N-ION pots alongside each other, labelled and numbered (Frederick, 2025e)

Figure 17. Image of the A-ON pots alongside each other, labelled and numbered Frederick, 2025e)

Figure 18. Image of the A-ION pots alongside each other, labelled and numbered (Frederick, 2025e)

<u>Pre-Irrigation</u>

On 3 July at 20:00, each pot was drenched with 750 mL of collected rainwater to achieve uniform moisture levels while minimising evaporative losses. Rainwater was chosen for its purity, lacking chlorine or fluoride, and its sustainability as a free resource (Maxwell-Gaines, 2004).

<u>Seeding</u>

Between 21:00 and 21:15 on 3 July, six seeds of Lettuce *(Lactuca sativa)* were sown per pot at a ¼-inch depth with three seeds each hole, in line with recommendations to prevent poor emergence from soil in fragile lettuce seedlings (Utah State University, 2020). See Figure 19 of the seeds within the pot. Planting multiple seeds per pot increased the likelihood that at least one seedling would establish successfully (Ababa, 2020).

Figure 19. Visual of Lettuce *(Lactuca sativa)* seeds sewn, where the positions are indicated with three circles (Frederick, 2025d)

Germination Monitoring and Seedling Replacement

Seedlings were monitored daily for germination, which typically occurs within 7–10 days under controlled conditions (Laudie, 2023). On the 10th of July (Day 7), no germination was observed; the absence of germination by Day 7 may be due to loss of seed viability during storage. As seeds were previously stored in an envelope under uncontrolled ambient conditions, they often undergo moisture fluctuations or oxidative damage, which reduces their ability to germinate (Michela Pirredda et al., 2023). Therefore, two seedling trays of three-week-old nursery-grown lettuce *(Lactuca sativa)* seedlings were procured from the St. Vincent Central Market, see Figure 20. Most seedlings measured 3¾ inches from root base to apical tip, making this the starting measurement that was used, see figure 22. They were all planted in alkaline soil containing peat moss and coconut coir; therefore, they were rinsed in rainwater to remove potting media and then held for transplant, see figure 21.

Figure 20. Image of one Lettuce *(Lactuca sativa*) seedling tray (Frederick, 2025a)

Figure 21. Image of the roots of the lettuce seedlings (*Lactuca sativa*) washed off in Rainwater (Frederick, 2025j)

Figure 22. Image of the lettuce seedlings (*Lactuca sativa*) being measured (Frederick, 2025i)

Transplantation and Acclimatisation

At 11:00 on 10 July, pots were irrigated with 250 mL of rainwater. The plants were watered at 11 am daily for 4 weeks. Less rainwater was used because the soil moisture content was still high after testing using the moisture content metre. Then from 15:00 to 15:15, three uniform seedlings measuring 3 ¾ inches were transplanted into each pot. To mitigate transplant shock, the physiological stress plants experience upon relocation (The Seed Collection, 2024), fertilisation was postponed for 48 hours, allowing root systems to re-establish.

Fertilisation

At 12:00 on 12 July, fertilisation commenced, and organic treatment (pots 1–4 and 9–12) received 125 mL of diluted KNF-based liquid fertiliser per pot. While the inorganic treatment (pots 5–8 and 13–16) received 2 g of Fersans NPK granular fertiliser via the broadcast method. Broadcasting entails evenly distributing dry or granular fertilisers over the entire surface of the field; this method is ideal for small and large-scale agricultural operations (Cropnuts, 2023).

Maintenance, Data Recording and Analysis

The growth of plants can be assessed through four indicators: the height of the plant, the size of the leaves, the rate of growth in fresh specimens, and the condition of the roots (Science Buddies, 2012). Throughout the four-week trial, plants were watered daily at 11:00 am with 125 mL of rainwater to maintain optimal moisture and reduce nutrient leaching. Watering was scheduled for the morning to minimise evaporative losses and shorten leaf-wetness duration, a standard practice that improves irrigation efficiency and reduces foliar-disease risk (Waddington and Ori, 2022).

Every three days, plant height (recorded with a ruler), leaf count and visual health indicators were recorded, and standardised photographs were taken to document growth and treatment effects. This is because measurements taken at shorter time intervals tend to show higher correlation than those taken at longer intervals (Muhammad, 2023). Visual health descriptions were normalised to a 4-level health code and summarised in two compact tables using guidance from Visual assessments were conducted in accordance with a study conducted by Wong (2005) to identify potential causes of changes, such as discolouration. This will be further described in (Section 4.).

Experimental data were analysed by calculating growth trajectories (absolute growth rate, leaf number, survival, and final root mass) across treatments. Independent-samples t-tests compared mean differences between groups, and descriptive statistics were used to identify the significance in growth (height vs time and leaf number vs time). These raw values were entered into SPSS for analysis. Descriptive statistics (means, standard deviations, and standard errors) were calculated for each treatment group. both organic and inorganic fertiliser regimes.

The Absolute Growth Rate (AGR) was selected as the primary metric to quantify plant development across treatments, as it provides a direct measure of biomass accumulation over fixed time intervals (Ivanov and Dubrovsky, 2013). This approach is particularly suited to short-term experiments involving similarly sized units, where the goal is to compare total growth rather than proportional change (Ivanov and Dubrovsky, 2013). According to Ivanov and Dubrovsky (2013), the most straightforward measure of plant growth is the increase in size over a specified time period, making it an ideal approach for short-duration experiments that evaluate overall biomass accumulation among comparable units. This data is presented as a graph in (section 4.5).

The roots were removed, dried, and weighed to determine their mass. Root mass was examined qualitatively from pots No. 4 (N-ON), No. 8 (N-ION) and No. 9 (A-ON); no recoverable roots were found under A-ION, consistent with poor survival in acidic soil see Section 4.4.1 for details.

3.5.4 *Interview* and Survey Questions

This section outlines the semi-structured interview and survey approach used to gather in-depth perspectives from ten farmers, encompassing ethical approval, consent procedures, interview modalities, and secure data management. Before any participant contact, formal ethics approval was obtained from the UWTSD Ethics Committee, authorising both interviews and surveys. Written consent was secured from each farmer before data collection began, with participants informed of their right to withdraw at any time without penalty and assured that all responses would remain confidential.

Five interviews and ten surveys were carried out with Participants, either face-to-face or via call. With permission, each interview was audio-recorded and later transcribed to ensure accuracy, and the surveys were distributed via email. After the trial, a presentation was created with a voice-over explaining the findings equally to each participant. The presentation was used so each participant could receive the same standardised explanation, ensuring consistency and fairness despite differing schedules that made a single in-person or live session impractical. All audio files, transcripts and consent forms were stored on the UWTSD OneDrive cloud, accessible only to the principal investigator. Participant identities were anonymised by assigning numeric codes (Participant 1–10) and (interviewee 1-5).

The interview and survey questions can be found in Appendices A.1 &. A.3. The interview layout was combined with open-ended questions (to capture farmers' experiences, perceptions, and motivations in depth) and closed-ended survey items (including yes/no and Likert-scale responses). To generate data that could be systematically compared across participants. This mixed approach was selected because it balances rich qualitative insight with quantitative measurability, thereby strengthening the validity of the findings by ensuring both depth and comparability (Dessart et al., 2019; Lavrakas, 2008).

Interview transcripts were coded using Braun and Clarke's (2006) six-phase thematic analysis see section 4.2). This six-phase framework is best practice for this research because each step is transparent and traceable, while allowing locally grounded patterns (e.g., labour constraints, declining extension services) to emerge naturally. The fixed guide ensures comparability across respondents, and the flexibility to follow up in real time yields richer, more authentic accounts than structured surveys can provide (Creswell, 2013).

A paired-samples t-test is used to determine whether the mean difference between two related sets of observations is statistically different from zero (Touhidul, 2025). Paired/related t-tests were used to compare respondents' survey answers before and after viewing the study's findings. A negative mean difference indicates Post more than (>) Pre (an increase); a positive value indicates Post less than (<) Pre (a decrease). Survey responses were first coded numerically; for example, yes or no answers were converted to binary values (1 = yes, 0 = no). Then the Likert-scale items were assigned integer scores from 1 (strongly disagree) to 5 (strongly agree). These datasets were imported into SPSS, where descriptive statistics were generated and paired-samples t-tests were conducted to test for significant changes in knowledge, attitudes, and intended practices after presentation of the study's findings. This combination allowed both overall trends and statistically meaningful changes in farmers' views to be captured. In addition to the closed question, both surveys had one open-ended question designed to capture expectations or suggestions. These statements were documented and evaluated in (section 4.3).

3.6 Challenges faced

This section outlines the principal methodological and logistical obstacles encountered during the study and describes the adaptive strategies employed to mitigate their impact. Two principal challenges emerged during the study, each addressed through targeted mitigation strategies informed by best practice.

Initially, the lack of current, site-specific information for SVG posed a challenge to the study, specifically regarding the data sources on the behavioural aspect of farmers and sustainable farming practice. Based on observation while gathering sources, national databases were out of date or not available, and locally collected data were often found in various institutional reports instead of centralised repositories. To address these shortcomings, research suggested finding case studies in a similar context. When there is a lack of directly relevant data or literature, researchers should utilise comparable case studies from similar environments to address gaps in evidence and enhance the contextual richness of the study (Saunders, Lewis and Thornhill, 2019). At the same time, primary data tools were improved by incorporating customised survey questions and interview prompts to directly gather missing information that may be valuable. When current tools fail to reflect the intricacies of the research environment, scholars ought to create new instruments like customised surveys or interviews (Creswell, 2009). This guarantees that the information gathered corresponds with the unique goals of the study.

Second, the initial seeding protocol (six lettuce *Lactuca sativa* seeds per pot) failed to produce any germination by Day 7, a setback frequently linked to seed viability issues (Durham Master Gardeners, 2018). Therefore, the method was altered to use seedlings. This adjustment preserved experimental continuity and ensured uniform plant establishment without compromising the controlled design.

3.7 Conclusion

This section has laid out mixed-method designs that align directly with the study's dual objectives. Quantifying how soil neutralisation and fertiliser type influence lettuce performance in acidic volcanic soils and assessing whether sharing those findings shifts farmers' attitudes toward sustainable soil-management practices. By embedding a one-season, four-treatment pot trial within a framework of pre- and post-trial surveys and semi-structured interviews, the methodology harnesses both the precision of quantitative agronomic measurements and the nuance of qualitative behavioural insights (Bryman, 2012).

The controlled pot experiment replicating limed versus unlimed soils and organic versus inorganic fertilisers was defended on grounds of validity, allowing clear attribution of growth and yield responses to specific treatments. Simultaneously, the choice to employ manual bucket fertigation mirrored farmer routines in St Vincent and the Grenadines, preserving ecological and operational realism (CARDI, 2016).

Ethical approval was granted by UWTSD; informed consent was obtained, and the identities of participants were anonymised (Participant 1–10). All raw data were stored in encrypted UWTSD OneDrive folders. These measures safeguard participants and strengthen the study's credibility (Shenton, 2004).

The inherent constraints of seed germination failure, the short trial duration, and the scarcity of SVG-specific secondary data were identified early in the protocol. To preserve continuity and enrich contextual depth, the study swiftly implemented adaptive strategies: procuring nursery-grown seedlings to overcome viability setbacks, drawing on analogous case studies to fill data gaps, and refining survey and interview instruments to capture emergent local insights. Such methodological flexibility exemplifies the reflexive responsiveness that underpins rigorous research design, ensuring data integrity and relevance despite unforeseen challenges (Creswell, 2009). Together, these measures transformed limitations into opportunities for methodological resilience.

4. Results and Discussion

4.1 Introduction

This chapter combines results and discussion. Given the multi-faceted design (experimental pot trials, surveys, and interviews), an immediate interpretation follows each results subsection to aid readability and begin the discussion. A fuller synthesis drawing mechanisms together, integrating social and agronomic factors, appears in Section 4.6 (Discussion). Section 4.7 then summarises the chapter.

This chapter presents the core findings of the dissertation and interprets them in light of the research aims and objectives. It begins with the thematic coding of qualitative interview data, revealing farmers' perspectives on soil management, institutional support, and generational change. Next, there is a showcase of visual data and observational insights from the experimental trials, illustrating soil-neutralisation effects and crop responses. This is followed by a rigorous statistical treatment of survey responses, including both descriptive and quantitative analyses. After each section, an interpretive discussion and justification for the methodological choice are presented. Finally, a conclusion by synthesising how these qualitative and quantitative strands collectively address the study's objectives and underpin the recommendations.

The chapter Is structured as follows:

1. Thematic Coding of Interview Data- Interview Data
2. Statistical Analysis of Survey Data- Survey Statistical Results
3. Statistical Analysis Experimental Results- Experimental Statistical Results
4. Visual Observations- Visual and Observational results

4.2 Interview Data

Semi-structured interviews were utilised to gather detailed insights into farmers' educational experiences, their knowledge of soil-management best practices, and their openness to altering practices, which closed-ended surveys may not fully address. This qualitative method allows for the examination of the dispositional, social, and cognitive elements that influence adoption decisions, ensuring that the study's conclusions are rooted in the actual experiences and motivations of the participants (Dessart et al., 2019).

The qualitative data from five semi-structured interviews were analysed using Braun and Clarke's six-phase thematic analysis framework (2006) because it combines systematic rigour with the flexibility to surface context-specific insights. The full interview transcript for interviewees 1-5 can be found in Appendices A.2. Below are the six steps that guide the analysis:

1. Familiarisation and immersing in transcripts to grasp context and note initial impressions.
2. Initial coding and assigning concise labels to meaningful text segments.
3. Theme generation to group related codes into provisional themes.
4. Theme reviewing and ensuring each theme coherently represents the full data set.
5. Defining theme boundaries and selecting clear, descriptive labels.
6. Reporting and integrating themes into a cohesive narrative tied to research questions.

See Appendices A.6 – A.10 for the complete transcript of the theme mapping.

4.2.1 Emergent Themes

Five themes emerged from the coding process. Each theme is presented with a brief description, supporting summarised excerpts from the interviews, and its relevance to the research objectives. Some of the excerpts reported below are summaries and quotes of participants' responses, full responses can be read in Appendices A.2.

Labour and Resource Constraints

Farmers across all interviews emphasised labour shortages and limited access to suitable inputs as critical barriers to effective soil management.

- "The main farming challenges include. 1 availability of labour. 2. Ah, high input cost. And. Also. Availability of. Optimal inputs/appropriate input." – (Interviewee 1).

- "Labour availability is low, so it is hard to find workers, so you have to work on the farm yourself mostly which can be hard. Plus, market prices keep moving."- (Interviewee 3).
- "My body's slowing down, no new machinery to assist, and if we get something there's nobody qualified to repair it locally" – (Interviewee 5).

This theme emphasises how limited labour and material resources hinder sustainable practices, directly linking them to economic choices. This trend aligns with evidence from SVG and the broader Caribbean regarding an ageing agricultural workforce and a lack of formal training (Ganpat & Webster, 2020; Ministry of Education, 2022), along with market pressures post-preference that prioritise fast-acting fertilisers (Goodison, 2007) and the detachment of youth from farming (Osbahr, 2023). It also reflects global research indicating that reliance on fertilisers for intensification may degrade long-term soil health and increase dependence on inputs (Tilman et al., 2002).

Institutional Support and Extension Services

A strong consensus emerged that formal government support has declined since the mid-1980s, undermining farmers' capacity to manage soil health.

- "40 years ago, the main crop that I cultivated was banana, which had a formal management system that provided inputs at regular intervals and proper extension services guiding the production process." – (Interviewee 1).
- "Well, back then, because the crop of bananas was so important, the Government prioritised training and support for farmers, but now the

culture is leaning heavily towards focusing on tourism, and it looks like they forgot about agriculture. It's hard to find any proper assistance now or advice; it's like nobody wants to even help you now." – (Interviewee 4).

- "A few extension officers come around the area, but hardly. I trust my own experience more than any leaflet I get from the ministry, though." – (Interviewee 3).

Declining institutional backing exacerbates knowledge gaps and forces reliance on traditional practices (Yang, 2023).

Economic Drivers and Input Costs

Cost considerations consistently shaped choices around fertiliser type, liming, and soil amendments.

- "It influences my soil management decisions by the number of plants I can farm. It is very difficult to have a steady rotation of organic fertilisers, either because it is far too expensive in stores, mainly because St. Vincent does not have sufficient composting facilities, and animal manure collection is rare." – (Interviewee 2).
- "It's cheaper to buy the NPK than the Organic fertiliser; it is too expensive to afford labourers, so it is cheaper to do the work yourself, once it's not too difficult, because as I get older, it is harder. I pick the cheapest quick fix, even if it's bad long-term." –(Interviewee 3).
- "Well, if it costs too much to make the soil better to use, then I probably would not be able to afford it. And if I can't find someone willing to help and accept some small money, then I won't be able to either." - (Interviewee 5).

Economic pressures push farmers toward fast-acting inorganic solutions despite long-term soil health trade-offs.

Soil Health Practices and Knowledge

Participants displayed a wide spectrum of soil-management practices and varying levels of technical understanding.

- Advanced practitioners conduct pH testing every two years and apply dolomite or liquid lime, reporting increased vigour and yield – (Interviewee 1).
- Others rely on visual cues, leaf colour, and some have never neutralised acidity formally – (Interviewees 3 and 4).
- Motivations ranged from formal training and research exposure to health concerns and experiential learning (Interviewees 1, 2).

This theme underscores the interplay between knowledge sources and the adoption of sustainable techniques.

Education and Youth Engagement

All respondents noted systemic gaps in agricultural education and waning youth interest.

- “Many schools teach no practical agriculture, just a few classes on crops. Also, Youths don’t see farming as a skilled profession, so they quit before they start”, and “Schools lack field labs and qualified agriculture teachers. Without hands-on experiences, youths see farming as guesswork, not a career path.”- (Interviewees 3 and 4).

- "Since the embracing of the universal secondary education system (Education Revolution) in SVG over the past 25years, our youths have been influenced by the government's policies, such as limited mechanisation, which goes counter to advancements in the agricultural industry, leading to a vivid trend in the youths not gravitating to farming in a meaningful way." – (Interviewee 1).
- "Younger people have little interest in getting dirty and working hard in the sun. Most times, that is a turn-off, and not enough schools provide programs to influence students in agriculture, so there is a gap now." – (Interviewee 5).

The absence of hands-on, soil-focused training contributes to generational disengagement from agriculture. Evidence from Trinidad & Tobago shows that when agriculture is absent from the secondary curriculum, student interest in pursuing it as a career drops sharply, therefore, a lack of school exposure is identified as an initial deterrent (Ramdwar & Ganpat, 2010)

4.2.2 Summary:

The thematic analysis revealed interconnected challenges of labour scarcity, reduced institutional support, economic constraints, uneven technical knowledge, and educational gaps. Together, these factors shape farmers' soil-management decisions and highlight priority areas for policy intervention and training programmes. Labour shortages and high input costs indicate that mechanisation and affordable input supply chains are not easily accessible for sustainable soil management. The collapse of extension services reflects policy shifts towards tourism and away from agriculture, undermining climate-resilient farming (Princess Mariam Danjumah et al., 2024). Economic drivers favour quick-fix fertilisers, risking long-term soil degradation consistent with global studies on fertiliser dependency (Tilman et al., 2002). Although research on various soil-health practices indicates that conducting formal pH tests and applying lime produce significant advantages, adoption seems minimal without focused educational efforts. Finally, the lack of practical agricultural training points to a critical need for curriculum reform to re-engage youth and pass on generational knowledge (FAO, 2019).

4.3 Survey Statistical Results (Pre vs Post)

Surveys are essential for systematically capturing representative data on attitudes and behaviours, providing the empirical foundation needed to design and evaluate interventions (Lavrakas, 2008). Administering the survey twice, before and after introducing best-practice guidance for tracking real behavioural shifts rather than mere awareness, aligns with Rogers' diffusion logic, where locally generated evidence through small trials converts interest into concrete adoption decisions (Michie et al., 2018; Rogers, 2003). Tables 2-6 show the summarised results for the survey. Each survey result can be viewed in Appendices A.4.

Table 2. The total number of yes/no responses before the experiment.

Question	Yes	No
Have you ever conducted a soil pH test on your farm?	5	4
Have you heard of liming (adding lime to neutralise soil acidity) before today?	6	4
I primarily use inorganic fertilisers for nutrient management.	6	4
I primarily use organic fertilisers for nutrient management.	5	5

Table 3. The total number of yes/no responses after the experiment.

Question	Yes	No
Did you find the experimental results easy to understand?	10	0
Would you consider or continue to consider conducting soil pH test on your farm?	10	0
Would you continue to primarily use inorganic fertilisers for nutrient management?	2	8
Would you continue to primarily use organic fertilisers for nutrient management?	10	0

Table 4. The shift from yes-no/ no-yes between the participants

Question	Yes-No	No-Yes	Stayed Yes	Stayed No
Have you ever conducted a soil pH test on your farm? – Would you consider or continue to consider conducting soil pH test on your farm?	0	4	5	0
I primarily use inorganic fertilisers for nutrient management.- Would you continue to primarily use inorganic fertilisers for nutrient management?	4	0	2	4
I primarily use organic fertilisers for nutrient management. – Would you continue to primarily use organic fertilisers for nutrient management?	0	5	5	0

Table 5. The response from participants before the experiment

Question	Definitely disagree	Mostly disagree	Neither agree nor disagree	Mostly agree	Definitely agree
To what extent would you agree that soil acidity negatively impacts my crop yield?	0	1	2	2	5
I believe regular soil pH testing is important for maintaining my farm's soil health.	0	0	2	5	3
Do you agree that inorganic fertiliser is healthy for soils?	4	1	2	3	0
To what extent do you believe using organic fertilisers can improve your soil's long-term quality.	0	0	0	0	0
I believe liming to neutralise soil acidity benefits my crop growth and yield.	0	0	4	1	5

I have a strong understanding of soil-neutralisation techniques.	0	6	1	2	1
I am likely to adopt liming if its efficacy is demonstrated.	0	1	3	2	4
I would agree on seeking training or support to implement improved soil-management practices.	0	1	2	3	4

Table 6. The response from the participants after the experiment

Question	Definitely disagree	Mostly disagree	Neither agree nor disagree	Mostly agree	Definitely agree
To what extent would you agree that soil acidity negatively impacts my crop yield?	0	0	0	4	6
I believe regular soil pH testing is important for maintaining my farm's soil health.	0	0	0	2	8
Do you agree that inorganic fertiliser is healthy for soils?	6	4	0	0	0
To what extent do you believe using organic fertilisers can improve your soil's long-term quality.	0	0	0	4	6
I believe liming to neutralise soil acidity benefits my crop growth and yield.	0	0	0	2	8
I have a strong understanding of soil-neutralisation techniques.	0	0	3	4	3
I am likely to adopt liming if its efficacy is demonstrated.	0	0	0	2	8
I would agree on seeking training or support to implement improved soil-management practices.	0	0	0	2	8

A negative mean difference indicates Post more than (>) Pre (an increase); a positive value indicates Post less than (<) Pre (a decrease). Table 7 identifies the significance with a brief explanation.

Table 7. Paired/related t-tests for survey items (Pre vs Post)

Pair (Pre → Post)	Mean diff (Pre−Post)	Direction	95% CI	t (df)	p	Significance	Interpretation
Primarily inorganic- Continue organic	0.400	Post < Pre (decrease)	[0.031, 0.769]	2.449 (9)	0.037	Yes	Intention to keep using inorganic as the main fertiliser decreased.
Primarily organic – Continue organic	-0.500	Post > Pre (increase)	[-0.877, -0.123]	-3.000 (9)	0.015	Yes	Intention to continue using organic increased.
Ever did soil pH test – Would consider/continue soil pH tests	-0.444	Post > Pre (increase)	[-0.850, -0.039]	-2.530 (8)	0.035	Yes	Willingness to test soil pH increased.
Acidity impacts yield (agreement)	-0.500	Post > Pre (increase)	[-1.006, 0.006]	-2.236 (9)	0.052	No	Agreement that acidity harms yield increased (borderline).
pH testing is important (agreement)	-0.700	Post > Pre (increase)	[-1.046, -0.354]	-4.583 (9)	0.001	Yes	Agreement that pH testing is important increased.
Inorganic fertiliser is healthy for soils (agreement)	1.000	Post < Pre (decrease)	[0.326, 1.674]	3.354 (9)	0.008	Yes	Agreement that ‘inorganic fertiliser is healthy’

							decreased (more sceptical of inorganic).
Organics improve long-term soil quality (agreement)	-0.500	Post > Pre (increase)	[-1.006, 0.006]	-2.236 (9)	0.052	No	Agreement that organics improve long-term soil quality increased (borderline).
Liming benefits yield (agreement)	-0.700	Post > Pre (increase)	[-1.289, -0.111]	-2.689 (9)	0.025	Yes	Agreement that liming benefits yield increased.
Understands neutralisation techniques (self-rated)	-1.200	Post > Pre (increase)	[-2.079, -0.321]	-3.087 (9)	0.013	Yes	Self-rated understanding of neutralisation increased.
Likely to adopt liming	-0.900	Post > Pre (increase)	[-1.526, -0.274]	-3.250 (9)	0.010	Yes	Likelihood of adopting liming increased.
Seek training/support	-0.800	Post > Pre (increase)	[-1.457, -0.143]	-2.753 (9)	0.022	Yes	Willingness to seek training/support increased.

Interpretation:

After seeing the experimental results, respondents showed :

- A significant increase in willingness to test soil pH.
- Agreement that pH testing matters.
- Belief that liming benefits yield.
- Understanding of neutralisation.
- Likelihood of adopting liming.
- Willingness to seek training.

At the same time, agreement that 'inorganic fertiliser is healthy for soils' decreased, suggesting greater scepticism about solely inorganic approaches.

Table 8 below compiles each participant's free-text answers from the pre-trial (Survey 1) and post-trial (Survey 2). Survey 1 refers to each participant's pre-trial open-ended comment about what would most influence them to adopt a new soil-management practice (see survey instrument, Appendices A.3). Survey 2 response refers to the post-trial open-ended comment stating the single factor that influenced their final decision after reviewing the presentation of results, see (Appendices A.5).

Table 8. Open-ended Responses by Participant

Participant	Survey 1: Adoption factor	Survey 2: Decision factor
P1	Evidence of better yields and soil health.	Switching to organic and liming after seeing yield gains.
P2	Clear guidance and training.	I will start liming next season based on these results.
P3	Continued support and access	Will continue and increase

	to organic inputs.	organic use and regular pH tests.
P4	Proof of cost-effectiveness.	Results convinced me to reduce inorganic and add organic plus lime.
P5	More information and examples from nearby farms.	Now confident to adopt liming and increase organic use.
P6	The understanding of Bricks levels (because the higher the bricks levels the healthier the plants. Also, at a certain bricks' percentage pests naturally	long term soil deficiencies using inorganic fertilizers which damages the soil bio life after constant use
P7	Evidence of improved crop yield, from result demonstration.	The research presentation was clear, well-structured, and easy to follow. It featured well-labelled photographs that effectively supported the content, along with a voice-over recording that provided helpful guidance throughout. A concise summary of findings was included, and the overall layout made the presentation easy to navigate and understand.
P8	Once I know my soil will be organic and healthy, I will definitely try new soil	I believe organic fertilizers are not just best for the plants but also the organisms living in the soil.

	management practices.	The result of your experiment proves that organic soil with less acidity is best for plant growth.
P9	Once it is proven to have positive results especially in the improvement of productivity	I was already a firm believer in Organics but the results also show that Neutralisation and the use of organics were the best choice so I will continue
P10	Real results that show an improvement in crop yields.	The results show a clear winner

Interpretation:

Before the trial, participants highlighted the need for convincing and localised evidence that a new soil practice could enhance yields and soil health (P1, P4, P7, P8, P9, P10), in addition to practical support and training (P2, P3, P10). There was less frequent mention of access to inputs (P3) and the cost-effectiveness of the practices (P4). Some also mentioned that examples from peers and trusted information served as confidence boosters (P5). After the trial, the responses evolved into tangible plans, with most intending to increase their use of organic methods (P1, P3, P4, P5, P6, P8, P9) and implement liming and pH management, sometimes alongside a reduction in inorganic fertilizer use (P4), while a few chose to maintain their current practices (P3, P9). This pattern is consistent with the interview-derived themes found in section 4.2, education, youth engagement, soil health practices and institutional support and extension services, labour and resource constraints and economic drivers(cost-effectiveness concerns).

In addition to the themes identified, the results also indicate that seeing locally generated evidence moved farmers from general interest to specific decisions, such as trialling liming next season or seeking a soil-pH test. The on-farm evidence appears to have built confidence in soil-building practices, especially organic matter additions and pH correction, which are visible, relatively low-risk steps. At the same time, the comments still hint at practical needs (cost, access to inputs, and guidance), suggesting that on-going governmental support and input access will be important for sustained adoption.

The surveys validate the literature's diagnosis and Rogers' diffusion logic, where locally generated, visible evidence through small trials and demonstrations converts general interest into concrete adoption decisions, particularly for liming or pH correction and organic matter additions. These steps were perceived as low-risk, compatible with current systems, and clearly beneficial to soil function, which explains their prominence after the trial. Ajzen's theory of planned behaviour explains that behavioural intentions arise from three constructs (Ajzen, 1991), including attitudes toward the behaviour, subjective norms, and perceived behavioural control. In this study:

- Attitudes toward liming and organic soil amendments improved following observation of local trial outcomes (Related themes: Soil Health Practices and Knowledge).
- Subjective norms strengthened through peer examples and trusted communication channels (Related themes: Education and Youth Engagement).

- Perceived behavioural control increased when guidance was provided and inputs (lime and organic amendments) were both affordable and accessible (Related themes: Institutional Support and Extension Services, Economic Drivers and Input Costs).

These shifts from initial curiosity to firm adoption plans demonstrate how Rogers' focus on trialability, and observability opens the door to innovation, while Ajzen's theory explains the underlying psychosocial drivers (attitude change, normative pressure, and control beliefs) that propel participants toward concrete intentions (Rogers, 2003; Ajzen, 1991).

4.4 Experimental Statistical Results

This section reports the statistical outcomes from the physical pot experiment, comparing four treatments N-ON (neutralised soil + organic inputs), N-ION (neutralised + inorganic), A-ON (acidic soil + organic), and A-ION (acidic soil + inorganic) on plant height, leaf number, survival, and final root mass.

An independent-samples t-test is a parametric procedure used to compare the means of two unrelated groups on a continuous outcome (Touhidul, 2025). Independent-samples t-tests compared treatment pairs, for example, N-ON vs A-ON. For height, comparisons not involving A-ION use the final date 9 Aug 2025. This is because A-ION plants died by 9 Aug 2025, and no data was available. This complicates direct endpoint comparisons across all treatments (VSNi, 2021). Therefore, the data of the final height recorded (6 Aug 2025) was used for treatments, including A-ION. Figures 23, 24 and 25 show the raw results for the plant height, leaf number and survival. Tables 9,10, and 11 summarise the statistical significance between height, leaf number, and survival against the treatment.

HEIGHT EVERY THREE DAYS

N-ON

Date	Pot 1	Pot 2	Pot 3	Pot 4
10.07.25	3.75	3.75	3.75	3.75
12.07.25	3.75	3.75	3.75	4
16.07.25	4	3.8	4.25	4.1
19.07.25	4	3.8	4.25	4.3
22.07.25	4.3	4.1	4.3	4.4
25.07.25	4.3	4.1	4.3	4.45
28.07.25	4.3	4.1	4.3	4.45
31.07.25	4.3	4.1	4.3	4.45
3.08.25	4.55	4.95	4.8	4.9
6.08.25	4.7	5.9	5.65	5.65
9.08.25	6.5	6.5	7	7

N-ION

Date	Pot 1	Pot 2	Pot 3	Pot 4
10.07.25	3.75	3.75	3.75	3.75
12.07.25	3.75	3.75	3.75	4
16.07.25	4.5	4.25	4.6	4.5
19.07.25	5.6	6	5.5	5.6
22.07.25	6.4	6.1	6.4	6.3
25.07.25	6.7	6.1	6.1	6.1
28.07.25	7.25	6.2	7.5	6.6
31.07.25	7.5	6.9	8.5	7.6
3.08.25	7.65	7.7	8.56	7.65
6.08.25	7.8	7.95	9	8.8
9.08.25	0	8.5	9.2	8.8

A-ON

Date	Pot 1	Pot 2	Pot 3	Pot 4
10.07.25	3.75	3.75	3.75	3.75
12.07.25	3.9	4	3.8	3.9
16.07.25	4	4	4	4
19.07.25	4.1	3.85	4.1	4
22.07.25	4	3.75	4.3	4.1
25.07.25	3.75	4	4	3.8
28.07.25	3.76	4.1	4.3	4.1
31.07.25	3.8	4.15	4.3	4.1
3.08.25	3.8	4.2	4.3	4.15
6.08.25	3.9	3.6	4.75	4.35
9.08.25	5.5	0	0	4.5

A-ION

Date	Pot 1	Pot 2	Pot 3	Pot 4
10.07.25	3.75	3.75	3.75	3.75
12.07.25	3.8	4	4.1	4.2
16.07.25	4.25	4.25	4.25	4.65
19.07.25	5.6	5.65	5.5	5.3
22.07.25	5.75	6	5.45	5.95
25.07.25	6.3	6.85	6	6.3
28.07.25	7.25	7.3	6	7.2
31.07.25	8	7.55	6.25	8.4
3.08.25	8.15	7.8	6.25	9
6.08.25	4.2	8	0	9
9.08.25	0	0	0	0

Figure 23. Table of the raw data for the Lettuce *Lactuca sativa*) height

Table 9. Height comparisons by treatment and date.

Date	Comparison	95% CI	t	df	p	Significance
9.8.25	N-ON vs N-ION	[-2.757, 9.257]	1.722	3	0.184	Not significant
9.8.25	N-ON vs A-ON	[-0.362, 8.862]	2.901	3.059	0.061	Borderline
9.8.25	N-ION vs A-ON	[-2.359, 10.609]	1.557	6	0.171	Not significant
6.8.25	N-ON vs A-ION	[-6.275, 6.625]	0.085	3.101	0.938	Not significant
6.8.25	N-ION vs A-ION	[-3.346, 9.521]	1.492	3.129	0.229	Not significant
6.8.25	A-ON vs A-ION	[-7.659, 5.259]	-0.582	3.085	0.600	Not significant

Leaf Number																
	N-ON				N-ION				A-ON				A-ION			
Date	Pot 1	Pot 2	Pot 3	Pot 4	Pot 1	Pot 2	Pot 3	Pot 4	Pot 1	Pot 2	Pot 3	Pot 4	Pot 1	Pot 2	Pot 3	Pot 4
10.07.25	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
12.07.25	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
16.07.25	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
19.07.25	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
22.07.25	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
25.07.25	4	5	4	3	4	5	5	5	3	3	4	4	6	5	5	5
28.07.25	4	5	4	3	4	5	5	5	3	3	4	4	6	5	5	5
31.07.25	5	5	5	4	5	6	7	6	5	4	5	5	7	6	5	6
3.08.25	6	6	6	5	6	7	7	7	5	5	6	5	8	7	6	7
6.08.25	6	7	6	5	7	7	8	8	6	4	6	6	8	8	0	0
9.08.25	8	7	6	7	0	7	9	9	6	0	0	7	0	0	0	0

Figure 24. Table of the raw data for the Lettuce *Lactuca sativa*) leaf number

Table 10. Leaf number comparisons by treatment

Comparison	Mean diff	95% CI	t (df)	p	Significant?	Plain language
N-ON vs N-ION	0.75	[-4.57, 6.07]	0.345 (6)	0.742	No	No significant difference (N-ON had 0.75 more leaves).
N-ON vs A-ON	3.75	[-2.11, 9.61]	1.942 (3.28)	0.140	No	No significant difference (A-ON had 3.75 more leaves).
N-ON vs A-ION	7.00	[6.00, 8.00]	17.146 (6)	< .001	Yes	Highly significant; A-ION had 7 more leaves than N-ON.
N-ION vs A-ON	3.00	[-3.98, 9.97]	1.052 (6)	0.333	No	No significant difference (A-ON had 3 more leaves).
N-ION vs A-ION	6.25	[-0.55, 13.05]	2.926 (3)	0.061	No	Almost significant; A-ION

						had 6 more leaves.
A-ON vs A-ION	3.25	[-2.76, 9.26]	1.722 (3)	0.184	No	No significant difference (A-ION had 3 more leaves).

SURVIVAL																		
	N-ON					N-ION					A-ON					A-ION		
Date	Pot 1	Pot 2	Pot 3	Pot 4		Pot 1	Pot 2	Pot 3	Pot 4		Pot 1	Pot 2	Pot 3	Pot 4		Pot 1	Pot 2	Pot 3	Pot 4
10.07.25	1	1	1	1		1	1	1	1		1	1	1	1		1	1	1	1
12.07.25	1	1	1	1		1	1	1	1		1	1	1	1		1	1	1	1
16.07.25	1	1	1	1		1	1	1	1		1	1	1	1		1	1	1	1
19.07.25	1	1	1	1		1	1	1	1		1	1	1	1		1	1	1	1
22.07.25	1	1	1	1		1	1	1	1		1	1	1	1		1	1	1	1
25.07.25	1	1	1	1		1	1	1	1		1	1	1	1		1	1	1	1
28.07.25	1	1	1	1		1	1	1	1		1	1	1	1		1	1	1	1
31.07.25	1	1	1	1		1	1	1	1		1	1	1	1		1	1	1	1
3.08.25	1	1	1	1		1	1	1	1		1	1	1	1		1	1	1	1
6.08.25	1	1	1	1		1	1	1	1		1	1	1	1		1	1	0	1
9.08.25	1	1	1	1		0	1	1	1		1	0	0	1		0	0	0	0

KEY	
ALIVE	1
DEAD	0

Figure 25. Table of the raw data for the Lettuce *Lactuca sativa*) plant survival

Table 11. Survival (1=alive, 0=dead) by treatment.

Comparison	Mean diff (N1−N2)	95% CI	t	df	p	Significant
N-ON vs N-ION	0.250	[-0.546, 1.046]	1.000	3	0.391	Not significant
N-ON vs A-ON	0.500	[-0.419, 1.419]	1.732	3	0.182	Not significant
N-ION vs A-ON	0.250	[-0.684, 1.184]	0.655	6	0.537	Not significant
N-ION vs A-ION	0.750	[-0.046, 1.546]	3.000	3	0.058	Borderline
A-ON vs A-ION	0.500	[-0.206, 1.206]	1.732	6	0.134	Not significant

Interpretation:

Height differences were mostly non-significant, with one borderline comparison (N-ON vs A-ON). Leaf number showed a clear, highly significant difference between N-ON and A-ION (A-ION had more leaves at the earlier time point), and a near-significant difference for N-ION vs A-ION. This is due to the rapid nitrogen release from inorganic fertilisers driving shoot expansion, while phosphorus, essential for root proliferation, is either under-supplied in the fertiliser mix or becomes fixed and unavailable in acidic soil, thus restricting root development (O' Kennedy, 2022).

4.4.1 Final Root Mass at Harvest and Average Leaf Number

Root Mass

Root system development underpins nutrient and water uptake, making final root mass a critical indicator of treatment efficacy. Table 12 shows the results from weighing one plant from each treatment, while Figure 26 gives visuals of the root mass. All A-ION treatments were zero because there were no roots attached when uprooted. Therefore, a four-plant average could not be computed consistently across treatments according to (Gomez, 1984). Root mass is reported for one alive and thriving representative plant per treatment and interpreted descriptively.

Table 12. The root mass (grams) measured at harvest by treatment

Treatment	**Root mass (g)**	**Rank**	**Observations**
N-ON	0.26	1	Fibrous, well-branched network visible.
A-ON	0.17	2	Compact tuft of fine roots.
N-ION	0.14	3	Sparse, thinner roots; some breakage visible.
A-ION	0.00	4 (none)	Plant failed prior to harvest; no root mass available to measured.

Figure 26. Image of the root mass (Frederick, 2025m)

Interpretation:

Root mass was greatest in N-ON (0.26 g), followed by A-ON (0.17 g) and N-ION (0.14 g), while A-ION produced no measurable roots at harvest. Organic amendments promote healthier root systems by enhancing soil structure, facilitating nutrient availability, and encouraging beneficial microbial activity (Pantelides et al., 2023). In contrast, inorganic fertilisers, particularly in acidic soils, may hinder root development through rapid nutrient spikes, soil acidification, and decreased phosphorus availability (Yadav et al., 2020). For instance, Amartey et al. (2025) found that carrot plants treated solely with organic fertilisers yielded significantly greater root production compared to those receiving inorganic fertilisers, attributing this to improved moisture retention, gradual nutrient release, and a more active soil microbiome that supports root growth. Additionally, prolonged inorganic fertiliser uses increases hydrogen concentration and solubilises toxic aluminium and manganese ions (Yadav et al., 2020). These bind to root cell walls, damage membranes, which inhibit cell division and cause root damage, often described as roots burning or boiling under corrosive conditions (Yadav et al., 2020), this could have been the result of the A-ION treatments.

Average Leaf Number

Table 13. The average leaf number up until completion

Date	N-ON	N-ION	A-ON	A-ION
10.07.25	3	3	3	3
12.07.25	3	3	3	3
16.07.25	3	3	3	3
19.07.25	3	3	3	3
22.07.25	3	3	3	3
25.07.25	4	4	4	5
28.07.25	4	4	4	5
31.07.25	5	6	5	6
3.08.25	6	7	5	7
6.08.25	6	8	6	8
9.08.25	7	8	7	0

Across the observation period, all treatments began with 3 leaves and increased over time, but their trajectories diverged. N-ION consistently produced new leaves peaking at 8 leaves and finishing with the highest. N-ON rose steadily to 7 leaves by the end, while A-ON followed a slightly flatter path to a similar final value (7). A-ION also produced 8 leaves but then ended at 0 leaves due to plant death. Overall, the data indicate that the inorganic fertiliser treatment (N-ION) drove the most sustained leaf growth, whereas A-ION showed early gains that were not maintained to the final sampling point. Table 13 summarises the average leave data.

Interpretation:

Across both pH conditions, organic treatments yielded greater root biomass. The complete absence of roots in A-ION is consistent with the observed mortality by the final date. Taken together with leaf counts, the pattern supports a well-established allocation response, when readily available nitrogen is high, plants tend to allocate proportionally more biomass to shoots or leaves and less to roots (i.e., a lower root: shoot ratio) (AGREN, 2003). This is due to fast-releasing fertilisers (Yue et al., 2020). Conversely, organic amendments improve the root-zone environment, enhancing aggregation, aeration, and water-holding capacity so plants invest more below ground Yue et al, (2020), building a foundation that can sustain leaves over time.

This interpretation is supported by the following lines of evidence:

- Meta-analyses and theory show that added nitrogen reduces the root: shoot ratio, shifting biomass to shoots (Morrissey et al., 2014)
- Organic amendments decrease bulk density, increase aggregation, and improve water retention, all of which facilitate root proliferation (Yue et al., 2020).
- Higher soil organic carbon is associated with improved water-holding capacity and resilience under moisture stress (Bhadha, et al., 2021).

4.5 Visual and Observational Results

This section presents visual documentation and graphical analysis of plant development across the four treatment groups. Photographic observations taken throughout the trial illustrate differences in leaf colour and overall vigour, offering qualitative insight into how each influenced plant health. Alongside these images, a line graph plots the absolute growth rate (AGR) over time, calculated as the change in height per day between measurement intervals.

Absolute Growth

Figure 27 shows plant height (inches) from 12 July to 9 August. N-ON rises steadily and finishes highest, N-ION climbs fastest early but declines late, and both acid-soil treatments deteriorate in the final week, with A-ION collapsing (mortality). Table 14 summarises the trends found within the graph.

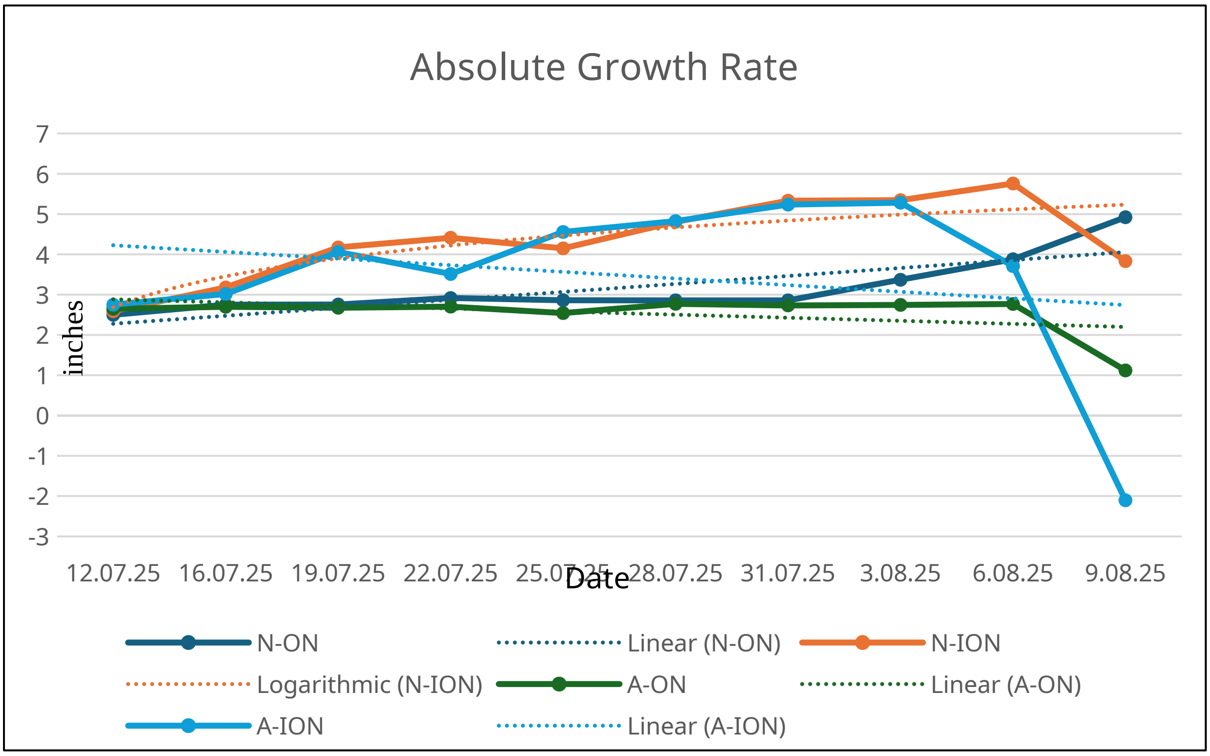

Figure 27. Absolute plant height by date across four treatments (Frederick, 2025n).

Table 14. Summary of absolute growth patterns.

Treatment	Initial height (in)	Peak height (in, date)	Final height (in, 9 Aug)	Observation
N-ON	2.6–2.8	5.0 (9 Aug)	5.0	Slow start then steady gains; best sustained growth.
N-ION	2.6–2.8	5.7–5.8 (6 Aug)	3.9	Early surge followed by late decline; maintenance issues.
A-ON	2.5–2.8	2.8 (late Jul)	1.3	Acid soil limits height despite organic inputs.
A-ION	2.6–2.8	5.4 (3 Aug)	Collapsed (mortality)	Brief surge then sharp crash under acidic plus inorganic conditions.

Plant Health Status

This section shows a simplified presentation of the qualitative observations. Table 15 explains the code for the observations, Table 16 identifies the observed health over the 4 weeks, and Figure 28 shows the visuals of the quality of each plant in the 3rd week. Table 17 identifies visible ailments at the end of three weeks and interprets the cause. Figure 29 in this section visually represents the treatments over the 4 weeks.

Table 15. The key explaining the plant health observation

Code	Meaning	Description
Good	Healthy	firm, glossy, upright; no discolouration
Warning	Early stress	slight discolouration; lighter green; minor droop
Poor	Clear stress	soft, matte, droopy; yellowing; leaf spots; withered
Dead	No live tissue	died

Table 16. Plant health observations grade

Date	N-ON	N-ION	A-ON	A-ION
10.07.25	Good	Good	Good	Good
12.07.25	Good	Good	Good	Good
16.07.25	Good	Good	Good	Good
19.07.25	Good	Warning	Poor	Poor
22.07.25	Good	Warning	Poor	Poor
25.07.25	Good	Warning	Poor	Poor
28.07.25	Good	Warning	Poor	Poor
31.07.25	Good	Warning	Poor	Poor
3.08.25	Good	Warning	Poor	Poor
6.08.25	Good	Warning	Dead	Dead
9.08.25	Good	Warning	Dead	Dead

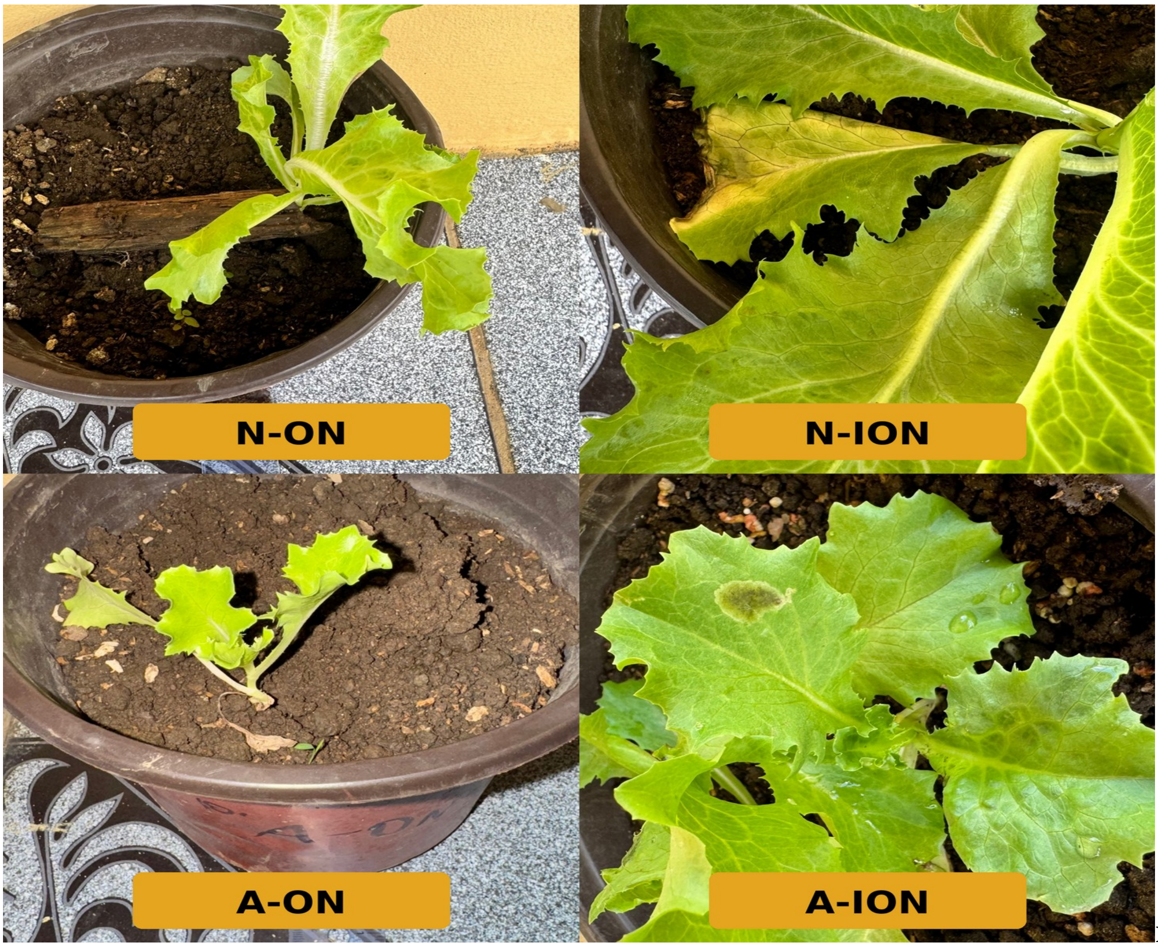

Figure 28. Lettuce (*Lactuca sativa*) appearance for each treatment at the 3-week mark 28.08.25 (Frederick, 2025k).

<u>Table 17. Visual interpretation of plant appearance at the end of week three</u>

Treatment	**Leaf colour**	**Leaf turgor**	**Visible ailments**	**Interpretation**
N-ON	Green	Upright, and turgid	No obvious lesions; margins intact	Looks healthy and steady; typical of slower but sustained growth.
N-ION	Yellow	Slightly	Yellowing of	Suggests faster early

	and green	droopy	leaves which can indicate root damage or insufficient uptake of nutrients (Wong, 2005)	growth but limited structural development.
A-ON	Green	Upright, firm	No discolouration; margins intact	Looks healthy, may have been focusing on root development more than leaf growth.
A-ION	Bright to light green and yellow	Turgid	Patchy blemishes/necrotic spots on some leaves,	Rapid leaf growth with some quality issues; later decline in health observed as time passed.

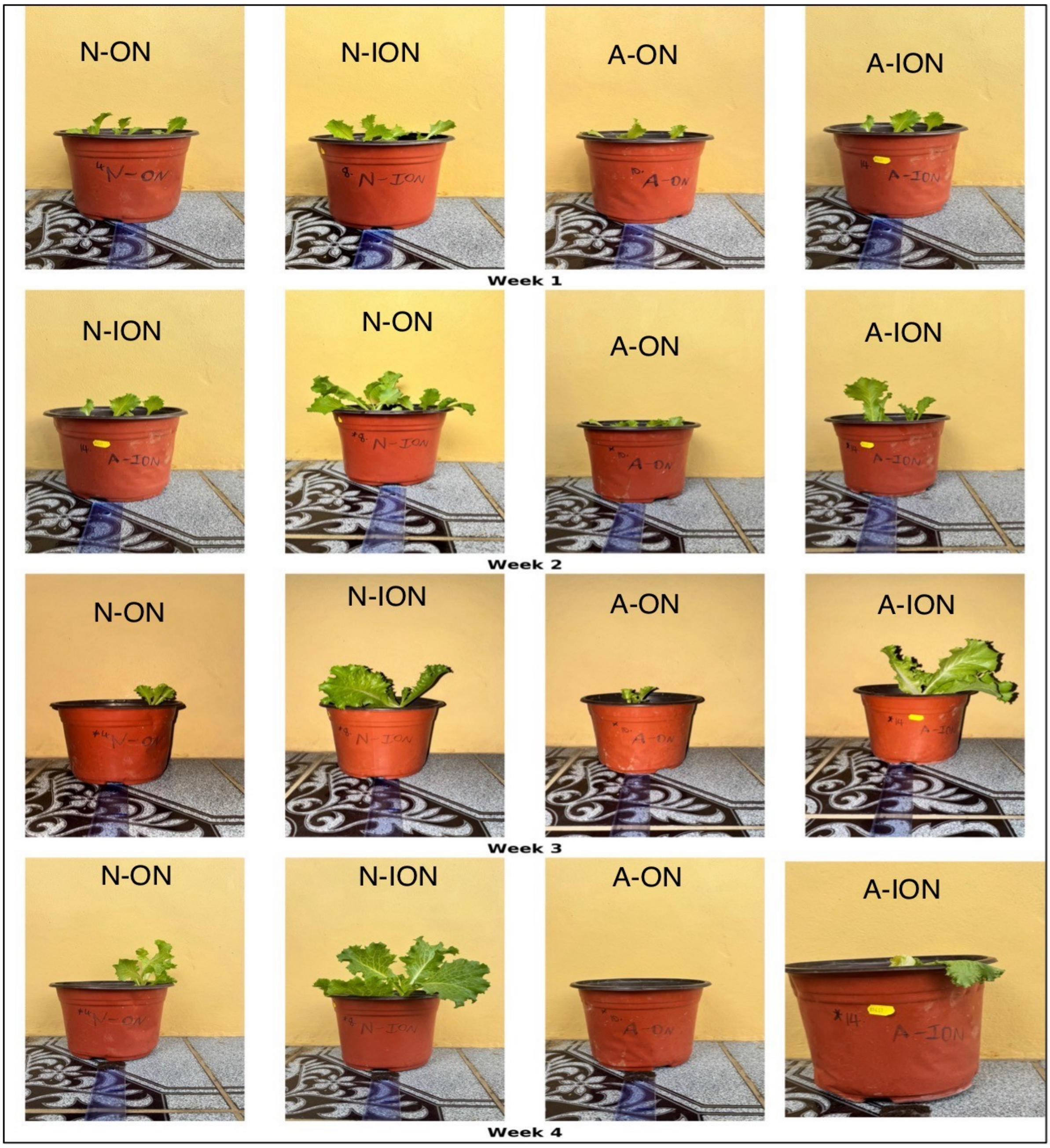

Figure 29. Image of each treatment over the four weeks (Frederick, 2025l).

The observed patterns of plant height and health across treatments underscore the critical roles of soil pH and organic matter in sustaining growth. The non-acidified control achieved steady biomass gains, while the non-acid inorganic treatment's initial surge, followed by a late decline, reflects nutrient supply without pH regulation. In contrast, the acid soil treatments exhibited constrained growth and high mortality under combined acidity and inorganic inputs. These findings corroborate Fageria and Baligar (2008), who demonstrated that liming ameliorates soil acidity to enhance nutrient availability and root development. While Bonilla et al. (2012) reported that organic amendments improve soil structure, microbial activity, and plant vigour, thereby highlighting the necessity of integrated soil health management for optimal crop performance.

4.6 Discussion

4.6.1 Integrating Experimental, Survey and Interview Findings

Across every method used, the takeaway was the same: fixing soil acidity and adding organic show better steady results. By contrast, pots that stayed acidic but received only synthetic fertilizer sprouted leaves at first before the organic treatments then quickly wilted and collapsed. After sharing these results with farmers, a big shift was evident. More of them were willing to begin testing soil pH, liming their fields, and mixing in compost or manure. In one-on-one interviews, they explained why these steps mattered and why they had not tried sooner. High costs and limited access to inputs, fewer extension services, and just not knowing enough about soil health were all barriers. Taken together, our data show that two simple steps correcting pH and adding organics aren’t just agronomically sound; they’re practical for farmers, too, as long as the evidence feels local and the how-to guidance is clear.

4.6.2 Mechanisms Underpinning the Observed Patterns

The agronomic mechanism was well-established where liming reduces aluminium toxicity and increases phosphorus availability within the 6.0–7.0 pH range, while organic inputs improve structure, water-holding, Cation holding capacity, and biological activity. This combination favours root development and resilience, matching our root mass ranking (N-ON > A-ON > N-ION > A-ION) and the health codes observed in photo series. The early leaf surge under inorganic fertiliser especially in acidic soil aligns with fast N pulses that raise shoot growth briefly while constraining roots in low-pH, low-P-availability conditions. Hence the late decline and mortality in A-ION.

4.6.3 Adoption Dynamics

The on-farm demonstration and the clear visuals made the benefits easy to see. This helped farmers move from general interest to real intention. After viewing the results, more participants planned to lime, to test soil pH, and to use organic inputs (Rogers, 2003). Attitudes toward liming and organics became more positive. Local examples and peer evidence strengthened the sense that these practices are normal and acceptable. Practical guidance increased people's confidence that they could carry out the steps (Ajzen, 1991). Interviews also show that this confidence can be fragile when inputs are expensive and advice is hard to access. These conditions can slow or stop actual uptake even when intentions are good, implying that cost is an also a leading factor of influence.

4.7 Summary

The integrated summary below synthesises independent, sequential measurements (growth rate, leaf number, survival, root mass) to show the overall treatment pattern, even where individual growth-rate tests were not statistically significant.

Although statistically there was no significance between the growth rates and treatments, the experimental trial clearly demonstrated that organic amendments under both neutral and acidic conditions produced healthier root systems and more resilient above-ground growth than their inorganic counterparts. Neutral-pH organic (N-ON) plants developed the greatest root mass (0.26 g) and sustained steady leaf increases to seven leaves, while acid-pH organic (A-ON) plants produced the second highest root biomass (0.17 g) and similar leaf counts. In contrast, inorganic treatments, especially acid-inorganic (A-ION), which yielded zero root mass, showed rapid early leaf expansion followed by collapse, reflecting nutrient pulses and soil acidification that inhibit phosphorus availability and damage root tissues (Yue et al., 2020; Yadav et al., 2020).

Survey results before the trial revealed farmers' primary need for convincing, locally relevant evidence, training, and cost-effective solutions. After the demonstration, paired-sample tests showed significant increases in intentions to test soil pH, adopt liming, and continue organic practices, alongside a drop in confidence that inorganic fertilisers alone were healthy. Open-ended responses pinpointed on-farm yield improvements and visible soil health gains as catalysts for commitment to liming and organic inputs. This aligns with Rogers' diffusion logic: small trials generate observable, low-risk evidence that shifts farmers from passive interest to active adoption of innovations (Rogers, 2003; Michie et al., 2018).

Qualitative interviews conducted during the trial surfaced critical structural barriers, labour shortages, high input costs, and declining extension services that shape soil-management decisions. While demonstration plots effectively changed mindsets, farmers repeatedly stressed that without accessible inputs, mechanisation, and reliable technical support, intentions may not translate into practice (FAO & CDB, 2019). This echoes Ajzen's theory of planned behaviour, which highlights perceived behavioural control as a key determinant of actual uptake (Ajzen, 1991). Ajzen's Theory of Planned Behaviour (1991) explains that behaviour is driven not just by intention, but by perceived behavioural control, which is how capable someone feels of acting. In this study, farmers often expressed positive attitudes toward liming and organic amendments, yet hesitated to adopt them due to barriers like cost, labour, and limited access to inputs. This reflects Ajzen's model, even with strong intentions, adoption falters when individuals feel constrained by external factors.

Taken together, the mixed-methods evidence suggests a two-pronged strategy for scalable soil-health interventions. First, hands-on demonstration trials provide the visible proof needed to overcome scepticism and build confidence in liming and organic amendments. Second, parallel investments in affordable input supply chains, mechanisation services, and revived extension networks are essential to empower farmers to act on newfound intentions and sustain improvements (Tilman et al., 2002)

5. Limitation & Conclusion

5.1 Introduction

This chapter brings the study to a close by clarifying the strength and boundaries of the evidence and stating what it means for practice and future research. First, it outlines the principal limitations in design, measurement, sample size, and data access and explains how these factors shape the certainty, scope, and generalisability of the findings. It then offers a concise conclusion that answers the research aim, integrating results from the pot experiment, surveys, and interviews. Finally, it sets out practical implications for farmers and extension services in Saint Vincent and the Grenadines, and priorities for future work needed to validate and scale the most promising practices.

5.1.1 Limitations and Recommendations

Table 18. Summary of the limitations, mitigation and recommendations

Component	**Limitation**	**Why it matters**	**Mitigation**	**Implication for interpreting results**	**Recommendations**
Experimental outcomes: mortality and missing end-point data	All four plants in the acidic soil with inorganic fertiliser treatment (A-ION) were non-viable at the final measurement date (9 August 2025). As a result, any	The absence of end-point observations for one treatment introduces missing-data bias and reduces comparability across treatments. The single-specimen root masses are not representative and cannot support	Explicitly stated the date switch and documented that root mass was recorded for a single exemplar per treatment. The root mass was treated as descriptive illustrations and triangulated treatment effects using height, leaf number and survival.	Comparisons that involve the acidic-inorganic treatment reflect plant status at the earlier time point, and conclusions about root mass are illustrative rather than inferential.	Plan interim harvests and non-destructive root assessments (for example, root imaging) so that end-point data exist for all treatments. Include contingency replicates to avoid entire groups failing at the final date.

	comparison that included this treatment had to use the most recent common time point (6 August 2025). In addition, only one root mass value could be recorded per treatment at harvest.	inferential statistics.			
Experimental timeline and duration	The pot trial ran for approximately thirty days within a single growing season.	A short and single-season window cannot capture longer-term soil processes such as organic matter turnover, the residual effects of liming, or seasonal variability. This limits external validity for multi-season performance.	Positioned findings as short-term responses and avoided strong mechanistic claims in the Results, referring to the literature where appropriate.	The effects reported here describe immediate responses; persistence over multiple seasons remains unknown.	Conduct multi-season field trials and measure soil organic matter, soil pH, and crop yield across successive cycles.
Pot conditions compared with field conditions	Potted plants experience root restriction and a relatively uniform	These differences can limit generalisability to farm plots and may either over- or under-estimate	Acknowledged these constraints explicitly and paired the experiment with farmer interviews to provide	Results are preliminary and do not translate one for one to fields, they need field validation.	Run on-farm trials (for example, farmer-managed split-plots) to confirm whether pot-based effects hold under field

	microclimate, which differ from field heterogeneity.	treatment effects.	contextual grounding.		conditions.
Root mass measurement	Only one specimen per treatment was weighed for root mass at harvest, and masses were recorded as fresh weight.	A single specimen has low representativeness and is vulnerable to handling losses, which can bias comparisons.	Disclosed the single-specimen approach, provided photographs of the extracted roots, and interpreted the masses as descriptive rather than definitive.	Root mass complements the other outcomes, but it would have been best to have an average.	Use oven-dried mass with multiple specimens per treatment and predefine a transparent selection rule or random sampling protocol.
Survey design: sample size	The survey included approximately ten respondents.	A small sample size reduces precision, increases uncertainty, and makes the results more sensitive to idiosyncratic responses.	Reported changes descriptively, used paired tests where appropriate, and avoided over-generalisation.	The survey findings are directional signals for this small cohort only; percentages and pre post shifts lack precision and should not be generalised for the entire population.	Increase the number of respondents.
Secondary data: access and availability	Several reports specific to Saint Vincent and the Grenadines were difficult to obtain or	Limited access reduces transparency and may leave gaps that cannot be independently verified.	Cited the best available sources, documented access constraints, and cross-checked figures where possible.	Readers should treat unsupported gaps cautiously and consider them as areas for further data collection.	Establish formal data-sharing agreements with ministries and agencies, document data gaps systematically, and archive study data for reuse

	not publicly accessible, and some datasets were available only in print or as summary statistics.				where permitted.
Single location a	The experiment was conducted at one site on volcanic soil using a single crop (lettuce).	Using a single location limits generalisability across other soils, climates and crops.	Scoped the conclusions to similar contexts and avoided broad claims beyond comparable conditions.	Applicability is context-bound and should be validated elsewhere before policy or large-scale recommendations are made.	Replicate the study across multiple sites and crops, including farmer-managed plots in different parishes.
Researcher workload and resources	The project operated to a tight timeline with limited personnel and equipment.	Resource constraints can prevent repeats or additional measurements and may increase the risk of missed checks.	Prioritized core outcomes and quantitative and qualitative methods to compensate for gaps.	Findings are preliminary and appropriate for an exploratory study but necessarily limited in scope	Plan buffer time, recruit research assistants, and phase data collection to spread workload and reduce risk.

5.1.2 Conclusion

This conclusion synthesises the research by addressing the aim and objectives set in Chapter 1, to understand how soil neutralisation (liming) and the choice of organic versus inorganic fertiliser influence short-term crop performance on acidic volcanic soils, and whether locally generated evidence can motivate farmers to adopt soil-building practices.

Objectives 1 and 2 were completed the findings in Chapter 4 clearly point in a consistent direction across multiple measures. Treatments that neutralised acidity and or used organic inputs produced healthier root systems and were more resilient leaf growth compared to treatments combining acidic soil and inorganic fertiliser. Although some comparisons of growth rates and plant height were not statistically significant due to small sample sizes and mortality in the acidic–inorganic group, according to literature. The overall pattern remains consistent across outcomes and illustrations. As can be seen with the height and leaf number tables (Tables 9–10), the final root mass (Figure 26), and visual observation (Figures 27–29). These observations are aligned with established agronomic mechanisms, such as liming, reducing aluminium toxicity and enhancing phosphorus availability, while organic amendments improve soil structure, water retention, and cation exchange capacity, supporting sustained growth (Anetor & Akinrinde, 2006; Donn et al., 2014; Fageria & Baligar, 2008; Brown & Lemon, 2023; Yue et al., 2020; Yadav et al., 2020). In relation to the stated aim, the evidence indicates that neutralising soil acidity and incorporating organic inputs improved plant performance under SVG conditions,

The social evidence presented in Chapter 4 demonstrates that witnessing local results shifted participants from general interest to solid intentions. Before the trial, survey and interview responses emphasised the need for credible proof, guidance, and affordable access to inputs. After the trial, most respondents indicated intentions to adopt liming/pH management and increase organic inputs, with some planning to reduce reliance on inorganic fertiliser. This shift aligns with Rogers' concept of trialability and observability, fostering adoption, and also fits within Ajzen's Theory of Planned Behaviour, where attitudes, perceived norms and perceived behavioural control improve once workable pathways and peer examples are visible (Rogers, 2003; Ajzen, 1991). Against the aim and Objective 3, the pre/post evidence indicates a clear shift toward adoption intentions after exposure to local results, aligning with Rogers and Ajzen (Rogers, 2003; Ajzen, 1991). To translate intentions into behaviour, next steps should pair ongoing demonstrations with subsidies for neutralising soil, local compost supply, and scheduled extension officer visits and track actual practice change via follow-up surveys and on-farm checks over time.

The scope of the evidence, outlined in Section 5.1 and detailed in the limitations table, shapes the extent to which these results can be generalised. The pot trial was short-term and limited in scale. The acidic inorganic plants were no longer viable by 9 August, so comparisons involving this treatment used the earlier date of 6 August. The root mass at harvest was recorded for only one representative plant per treatment. The survey and interview samples were also modest in size. Collectively, these factors mean the findings should be considered preliminary indicators for this setting rather than definitive estimates applicable to all farms in SVG. At the same time, these early signals create a practical opportunity to pilot low-cost pH testing and farmer-feasible liming routines through extension services, generating a larger farm-scale evidence SVG currently lacks.

Even within these constraints, two practical implications emerge. First, correcting soil acidity and adding organic matter are low-risk steps that improve plant health on acidic soils, consistent with the constraints such as acidic, leached volcanic soils and a legacy reliance on quick-acting inorganic fertilisers described in Chapters 1–2. Second, adoption is more likely when farmers can observe local demonstrations and receive practical guidance, along with reliable access to lime and organic inputs, conditions that enhance perceived control and social proof (Rogers, 2003; Ajzen, 1991).

The recommended next steps are straightforward; implement small-scale on-farm demonstrations of liming and organic matter addition. Coupled with hands-on coaching and a dependable supply of inputs. Then validate these effects through larger, multi-season field trials across different sites and crops, with expanded surveys to measure adoption and outcomes at scale. Rooted in local evidence and established mechanisms, this dissertation presents a feasible pathway toward healthier soils and more resilient agricultural production in Saint Vincent and the Grenadines. However, it is also clear that farmer understanding and willingness to adopt new practices alone is not sufficient. Interviews highlighted structural barriers including limited extension services, uneven government support, high input costs, and gaps in farmer education. These governance and economic constraints could limit the reach of promising agronomic practices unless addressed. The findings therefore point not only to agronomic opportunities but also to the need for supportive policies, affordable input supply chains, and targeted capacity-building initiatives. Being realistic about these wider constraints strengthens the credibility of the study, while at the same time underlining its contribution in demonstrating that change is possible when credible, locally relevant evidence is made accessible to farmers.

Overall, this study successfully achieved its aim and objectives despite the small setbacks faced during the research process including a lack of relevant data specific to SVG and denatured seed that did not germinate. The findings provide clear, context-specific evidence that soil neutralisation and organic inputs can improve both crop performance and farmer intentions in SVG. While the trial was small in scale, it offers a strong foundation for expansion into larger, multi-season field trials. Giving farmers, a first taste of what can be achieved, this research serves as a stepping stone toward strengthening sustainable practices and revitalising the agricultural industry in St. Vincent and the Grenadines

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7. Appendices

Appendices 1 (A.1): Interview Questions

1. *How long have you been farming, and what crops do you typically grow?*
2. *What are the main farming challenges you face today?*
3. *What differences can you think of between farming 40 years ago (1985) and currently?*
4. *Do you assess the health of your soil? If yes, how and how often?*
5. *What is your understanding of soil acidity and its effects on plant growth and nutrient availability?*
6. *Which types of fertiliser do you use most often, organic, inorganic or both, and why?*
7. *Have you ever applied lime or other soil-neutralising amendments? If yes, what changes did you observe?*
8. *If you have any, what sustainable soil-management practices do you currently follow (e.g. cover cropping, composting, crop rotation)?*
9. *What motivated you to adopt those practices?*
10. *How do economic factors such as input costs, crop prices or labour availability influence your soil-management decisions?*
11. *Where do you obtain information or training on soil and crop management? Which sources do you trust most?*
12. *How do societal norms and practices influence your decisions around soil amendments?*
13. *Thinking about your daily workload and resources, what challenges would you anticipate or are facing if you were to introduce or already practice*

soil-management practices such as soil neutralisation and organic fertiliser use?

14. *After seeing local trial data, how likely are you to change your soil-management routine? Why?*
15. What barriers or gaps in the local education system limit effective agricultural training, and how do these shortcomings contribute to a youth's interest in farming?

Appendices 2 (A.2): Interview Transcriptions

Interviewee 1

1. I have been farming for 45 years. I grow a multitude of crops, such as temporary and permanent crops, namely vegetables and root crops. For permanent crops, I grow plantains and fruit trees (bananas).
2. The main farming challenges include. 1 availability of labour. 2. Ah, high input cost. And. Also. Availability of. Optimal inputs/appropriate input. Isn't a
3. 40 years ago, the main crop that I cultivated was banana, which had a formal management system that provided inputs at regular intervals and proper extension services guiding the production process. At present, that system no longer exists, so farmers have to purchase the inputs directly out of pocket. Labour was readily available then, but today there is a significant shortage of labour within the agriculture industry. Also, because of multiple crop choices, there isn't a wide variety of inputs to optimally grow these crops, leading to minimised production volumes.

4. Yes, I usually do some testing either self or commissioning the plant protection units' resources in the MOA(Ministry of Agriculture). Monitoring is done about every two-year intervals.
5. Soil acidity occurs when the pH of the soil falls below a reading of 7, causing soil nutrients to become locked in the soil and preventing plants from absorbing them.
6. I use both organic and inorganic fertilisers to allow for a more balanced production system, allowing for some increase in levels of soil microbiome.
7. Yes, I have been using dolomite limestone specifically in areas where I plant root crops and permanent and liquid lime, namely Agri-Cal, in vegetable plots for about 30 years. Upon use, I've observed increased plant vigour, larger plants, increased root biomass, and increased productivity.
8. I have adopted cover cropping, mulching with vegetative material, crop rotation and minimal tillage.
9. By reading and research, I was exposed to the benefits of employing environmentally friendly techniques.
10. Many times, certain plots may not get cultivated, especially for the root crops, which most of the time warrants tillage of the soil, which allows for the broadcasting of the dolomite limestone.
11. I was exposed to the benefits of soil management from formal studies in soil science and also workshops and seminars while being an extension officer in the late 1990s. I also do a lot of research online and conduct additional experiments to verify the researched information.

12. They do not have any influence on my decisions around soil management since I learned about the benefits of it and its broader role in sustainable farming, hence fully on board with its utilisation.
13. One of the major challenges is accessing the Agrical. Sometimes, when needed, it isn't available at the agri shops, hence more labour-intensive methods are utilised.
14. No, I have conformed to using these soil management practices since they have proven to be advantageous to my farms' productivity.
15. Since the embracing of the universal secondary education system (Education Revolution) in SVG over the past 25years, our youths have been influenced by the government's policies, such as limited mechanisation, which goes counter to advancements in the agricultural industry, leading to a vivid trend in the youths not gravitating to farming in a meaningful way.

Interviewee 2

1. I have been farming for approximately 8 years. I mostly grow lettuce, pak choi, tomatoes, sweet peppers and Cannabis.
2. Pest control.
3. The advancement of new technology and the rapid increase in pesticides and inorganic fertilisers.
4. I do not have a device to identify. However, I practice crop rotation and soil amendments.

5. Soil acidity is soil’s pH above 7.0. Farmers need a soil pH reader to identify and keep control. However, there are other ways to know if your soil pH is above 7.0 by identifying nutrient burn and wilting.
6. I use organic fertilisers most often because it's not about feeding your plants the specific nutrient requirement; it's about feeding your soil and giving it diverse soil biology. Happy and healthy soils equal happy and healthy plants.
7. No, I have not. I normally prep my soils before planting, and I never needed to reduce soil pH because of acidity levels.
8. I practice crop rotation, composting , and liquid fertilizers. As well as manure soil prepping, and microbial inoculants, I also feed animal manure in timely feedings (note different animal manure for different plants and plant stages) must be mindful because plants use different levels of nutrients depending on the stages they are in for example ; tomatoes in early vegetative stage require a more nitrogen and calcium dense soil and in flowering/ fruiting stage they require a potassium and phosphorus dense soil.
9. Health reasons.
10. It influences my soil management decisions by the number of plants I can farm. It is very difficult to have a steady rotation of organic fertilisers, either because it is far too expensive in stores, mainly because St. Vincent does not have sufficient composting facilities, and animal manure collection is rare.
11. I do research online mainly on soil health rather than plant health. I also practice experimental growing using organic-based fertilisers for

different plants, as well as using Bio-stimulants such as compost teas and microbial inoculants.

12. It gives me a broader understanding of soil amendments. No one man knows it all, but when you are surrounded by like-minded individuals, it is easy to ask difficult questions and get clear answers. For instance, how do I feed microbes? Someone with knowledge only of feeding plants rather than soil would find that nearly impossible to answer, whereas persons who practise the same farming techniques would be able to tell you that microbes thrive on organic fertiliser and soil diversity and bio-stimulants. (microbes feed plant health).
13. Fertiliser rotation. Not having enough organic fertiliser to keep up with soil health.

14. It is unlikely, however, that if there is no choice, I would ration my fertilisers with 90% organic and 10% salt-based fertilisers. to be able to keep the soil biology thriving using the organic and boost plant growth with salt-based inorganic.
15. To my knowledge, the education system does not offer traditional farming techniques but rather modern farming techniques. It also teaches more about growing plants rather than improving soil biodiversity. In my opinion, having students more involved in improving soil would retain more interest in agriculture. Having an understanding of soil health and how it impacts food, and our society will bring about higher awareness of the food's individuals eat.

Interviewee 3

1. I’ve farmed for 30 years, mainly bananas and ground provisions, plus a small scotch bonnet pepper patch that I sell roadside.
2. Unpredictable weather and little support from the government, especially in providing equipment or technology to help farmers. Labour availability is low, so it is hard to find workers, so you have to work on the farm yourself mostly which can be hard. Plus, market prices keep moving.
3. Back then, EU preferences meant a guaranteed market and stable income. Now,
   no guaranteed large-scale buyers and more people are interested in farming back then than now no Nobody is interested in farming besides the people who used to farm for a living.
4. I eyeball it, look for weeds, note how mushy or dry it feels, but no formal testing. Never saw the point when it was easier to throw on fertiliser on it (NPK).
5. I have heard from someone that acidic soil locks up nutrients, making plants weaker, but I never really pay any mind. Once I get a few of my plants to grow, I am usually content.
6. I use chemicals for quick growth because Organic alone is usually very slow usually and sometimes I need my plants to grow fast.
7. No, I don’t neutralise or lime soils, never really heard about that either until now.
8. I don’t usually do much besides harvesting the crop and then preparing the soil again to sow seeds again usually in the same spot.
9. It is just easier to replant and go again.
10. It’s cheaper to buy the NPK than the Organic fertiliser; it is too expensive to afford labourers, so it is cheaper to do the work yourself, once it’s not

too difficult, because as I get older, it is harder. I pick the cheapest quick fix, even if it's bad long-term.

11. A few extension officers come around the area, but hardly. I trust my own experience more than any leaflet I get from the ministry, though.
12. Well, I know what I know from my parents teaching me, so whatever they taught me is what I do, it is embedded in me cause it's the way I survive.
13. Time might be the biggest thing because we juggle farming with selling at the market. So, I don't know how long it would take for the liming to kick in and how it long it will take to see the progress.
14. Yeah, I don't mind trying if it's not too hard to keep up with, because time is hard, and it's worth trying something.
15. Many schools teach no practical agriculture, just a few classes on crops. Also, Youths don't see farming as a skilled profession, so they quit before they start.

Interviewee 4

1. I've been on the land for 15 years, growing bananas, a variety of vegetables, cocoa, and a small plot of root crops for local sale.
2. High input costs because sometimes you take out investments to grow a crop, and it doesn't always turn out well, land erosion, and a generation gap because no one younger wants to take over.
3. Well, back then, because the crop of bananas was so important, the Government prioritised training and support for farmers, but now the culture is leaning heavily towards focusing on tourism, and it looks like they forgot about agriculture. It's hard to find any proper assistance now or advice; it's like nobody wants to even help you now.

4. No, I don't test my soil, not even for pH or anything like that, never thought about that.
5. I know that it's generally bad for your crops and can burn them and cause them to turn yellow.
6. I use both urea and NPK for fast nutrition. Sometimes, I would try to make a homemade compost, but I don't always keep up with it, so I end up using the artificial fertiliser.
7. No, not really. I never had to study those things. I usually plant and go and repeat.
8. The most I would do is plant crop rotation, where I would plant different crops in the same spot.
9. But only because I plant what is in season and what people want, so the produce is never the same.
10. It is usually too costly to afford those types of materials to help improve the soil, so the most we can do is use natural animal down, but then again, that can only happen if you have farm animals and if you don't, then you would have to buy or ask someone for some animal down. When we talk about labour now, most of us farmers are family, so we help each other out as we are a part of the same household, but none of us really focus much on what you say? Amending soils.
11. What I know is what I grew up learning from my parents; nobody comes around to show us anything new, and if they do, then I can't see it or know where to find it.
12. We are very used to planting one thing over and over again and then switching over to whatever else is in demand. It is also very easy to just broadcast fertiliser on the soil to get it going again.

13. I think it might be physically taxing if I am required to bend over often to check on my soil's health or remediate it. Also, finding a balance to keep up with that and running my side business might be hard because it's usually just me; even if I ask for some help, it's not much.
14. Highly likely a solid trial results will give me confidence to invest in lime if I know the yield would be better, because I hear what happens sometimes, I plant and they die off quickly before I could even harvest them, and I would have to start over again.
15. Schools lack field labs and qualified agriculture teachers. Without hands-on experiences, youths see farming as guesswork, not a career path.

Interviewee 5

1. I've worked this land since I was a boy, for over 60 years growing bananas, coconuts, breadfruit, and some ground provisions.
2. My body's slowing down, no new machinery to assist, and if we get something there's nobody qualified to repair it locally. Farming is a dying interest, especially among the younger people. The soil is not what it used to be; it's harder to grow crops and see results, they die faster, and they are more prone to diseases.
3. 1985 felt like the golden age. We made a lot of money from selling bananas, but all that is over now, and agriculture is dying as a top industry. Tourism has taken over, and most of the ministers focus on tourism.
4. I judge by crop performance and leaf colour. Formal tests never entered my mind until recently.

5. I know that if the soil is too sour, plants wilt and leaves turn yellow and stunt the growth after a while, but I couldn't tell you anything about pH numbers.
6. Inorganic, I use a sack of fertiliser. Organic is costly, and it's a lot of work to compost, so I stick with what's quick.
7. Yes, tried lime once about ten years ago because I was given a liquid sample to try from the Taiwanese Government, the produce came out green and looked better, but I never got back into it.
8. I rotate my crops, so when more people ask me for tomatoes, I plant those instead and if people ask me for peppers, I will plant peppers after on the plot of land. In other spots on the land, I would grow other things like cucumbers, but I allow those to keep growing in that same spot, so yeah, I do a variety of things.
9. This is how I grew up doing it over the years, so that's what I follow.
10. Well, if it costs too much to make the soil better to use, then I probably would not be able to afford it. And if I can't find someone willing to help and accept some small money, then I won't be able to either.
11. Word of mouth from other old hands and the occasional radio programme, and my own family traditions.
12. Once it's a customary thing that we do, it will get done; if not, then not likely that I will do it unless it's easy and makes sense to do.
13. At my age, digging and trying to bend over to do more things to my soil other than planting is taxing, unless I have help or machinery to do so, or it is not an additional workload.
14. If other people try it, yes, I might try it too. I want to see more people trying it, and I can be convinced fully, especially at my age. If it seems easy

enough too, I don't mind trying because I know it works, it's just a habit I would have to add, which isn't so easy all the time.

15. Younger people have little interest in getting dirty and working hard in the sun. Most times, that is a turn-off, and not enough schools provide programs to influence students in agriculture, so there is a gap now.

Appendices 3 (A.3): Survey Question pre- and post-trial

Survey 1 (Pre-trial)

Questions	Yes	No	Definitely agree	Mostly agree	Neither agree nor disagree	Mostly disagree	Definitely disagree	Open response
Yes/No								
Have you ever conducted a soil pH test on your farm?								
Have you heard of liming (adding lime to neutralise soil acidity) before today?								
I primarily use inorganic fertilisers for nutrient management.								
I primarily use organic fertilisers for nutrient management.								
Agreement (Likert scale)								
To what extent would you agree that soil acidity negatively impacts								

my crop yield?								
I believe regular soil pH testing is important for maintaining my farm's soil health.								
Do you agree that inorganic fertiliser is healthy for soils?								
Do you believe using organic fertilisers can improve your soil's long-term quality?								
I believe liming to neutralise soil acidity benefits my crop growth and yield.								
I have a strong understanding of soil-neutralisation techniques.								
I am likely to adopt liming if its efficacy is demonstrated.								
I would agree on seeking training or support to implement improved soil-management practices.								
Open-ended								
What one factor would most influence you to adopt a new soil-management								

practice?								

Survey 2 (post-trial)

Questions	Yes	No	Definitely agree	Mostly agree	Neither agree nor disagree	Mostly disagree	Definitely disagree	Open response
Yes/No								
Did you find the experimental results easy to understand?								
Would you consider or continue to consider conducting soil pH test on your farm?								
Would you continue to primarily use inorganic fertilisers for nutrient management?								
Would you continue to primarily use organic fertilisers for nutrient management?								
Agreement (Likert scale)								
To what extent would you agree that soil acidity								

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negatively impacts my crop yield?								
I believe regular soil pH testing is important for maintaining my farm’s soil health.								
Do you agree that inorganic fertiliser is healthy for soils?								
To what extent do you believe using organic fertilisers can improve your soil’s long-term quality.								
I believe liming to neutralise soil acidity benefits my crop growth and yield.								
I have a strong understanding of soil-neutralisation techniques.								
I am likely to adopt liming if its efficacy is demonstrated.								
I would agree on seeking training or support to implement improved soil-management practices.								
I believe the trial results convincingly demonstrate the								

benefits of liming and using organic treatments for crop growth and yield.								
I am likely to apply lime amendments based on these research findings.								
I plan to reduce the frequency of inorganic-fertiliser applications in my next cropping cycle.								
I plan to increase my use of organic fertilisers in my next cropping cycle.								
I plan to conduct soil pH tests at least once each planting season.								
Open-ended								
What is one factor that has influenced your overall decision?								

Appendices 4 (A.4): Survey Results

Participant 1:

Participant 2:

Participant 3:

Participant 4:

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Participant 5:

Participant 6:

Participant 7:

Participant 8:

Participant 9:

Participant 10:

Appendices 5 (A.5): Post-trial presentation of results

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Appendices 6 (A.6): Data Preparation

1. Transcribed all five interviews verbatim.
2. Imported transcripts into Copilot. The prompt was to apply an inductive thematic analysis to these five semi-structured interview transcripts on farmers' soil health practices by following Braun and Clarke's six-phase framework. Begin by familiarising yourself with the data and generating initial codes.

Appendices 7 (A.7): Phase 1: Familiarisation

- Read transcripts three times, noting initial impressions in memos.

Appendices 8 (A.8): Phase 2: Generating Initial Codes

Code	Description	Sample Excerpt
Labour shortage	References to lack of farm labour	"Labour availability is low…" Interviewee 3 (INT3)
Input cost	Mention of high fertiliser	"Organic fertiliser is too

	or amendment costs	expensive…" (INT 2)
Extension declines	Loss of formal agricultural support	"Banana production… extension services no longer exist" (INT1)
Visual soil assessment	Judging soil health by sight and feel	"Eyeball it… look for weeds…" (INT 3)
Formal soil testing	Conducting pH or nutrient analyses	"Monitoring… every two-year interval" (INT 1)
Lime application	Use of dolomite, Agri-Cal, or liquid lime	"Been using dolomite limestone… for about 30 years" (INT1)
Crop rotation	Rotating crops to improve soil fertility	"I practice crop rotation, composting" (INT2)
Youth disengagement	Youth lack of interest in farming	"Youths don't see farming as a skilled profession" (INT3 & INT4)
Education gaps	Lack of practical agricultural training	"Schools lack field labs and qualified ag teachers" (INT4)
Economic trade-offs	Choosing quick-fix inputs vs. long-term soil health	"Pick the cheapest quick fix even if it's bad long-term" (INT3)

Appendices 9 (A.9): Phase 3: Theme Development

Theme	Constituent Codes
Labour and Resource Constraints	Labour shortage, Input cost
Institutional Support	Extension declines, Education gaps
Economic Drivers	Input cost, Economic trade-offs
Soil Health Practices	Formal soil testing, Visual soil assessment, Lime application, Crop rotation
Youth Engagement	Youth disengagement, Education gaps

Appendices 10 (A.10) :Phases 4–6- Reviewing, Defining, Writing Up

1. Reviewed themes against full transcripts; merged overlapping codes.
2. Defined each theme with concise labels and descriptions.
3. Selected representative quotes for the Results section.
4. Summarised detailed process here; reported concise findings in Chapter 4.

Appendices 11 (A.11): Example of Transcript-to-Theme Mapping

Step 1: Familiarisation
Read each interview transcript line by line, jotting initial impressions and potential points of interest in memos.

Step 2: Generating Initial Codes
Assign short labels (codes) to every meaningful phrase or sentence.

Step 3: Searching for Themes
Cluster related codes into broader themes.

Step 1-Transcript Excerpt	Step 2- Initial Code(s)	
"Labour availability is low, so you have to work on the farm yourself." (INT3)	Labour shortage; Manual work burden	Labour and Resource Constraints
"Organic fertiliser is too expensive; animal manure collection is rare." (INT2)	High input cost; Lack of organic inputs	Economic Drivers and Input Costs
"Forty years ago… banana production had proper extension services… now… out of pocket." (INT1)	Extension declines; Historical support lost	Institutional Support and Extension Services