

SOIL IS GRADUALLY DYING AFTER THE CENTRAL HIGHLANDS' GOLDEN HARVESTS

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SUMMARY

Terms such as "degradation" or "depletion" seem insufficient to describe the current condition of soils in the Central Highlands. The soil is not merely weakening; it is gradually losing its fundamental life-supporting functions. When biological cycles are disrupted and certain thresholds are crossed, the soil system can no longer regulate itself and may enter a state comparable to "clinical death." In this paper, the phrase "soil is gradually dying" is not intended to exaggerate the problem, but to emphasize a reality: soil has weakened to the point where its capacity for self-recovery is being lost.

From that starting point, the paper examines a paradox behind the Central Highlands' golden harvests: output may be maintained, or even increase, while the ecological foundation - the soil - continues to decline. This paradox does not stem from a single technical mistake, but from the cumulative effects of multiple, intertwined factors, notably farming practices that exceed ecological thresholds, market pressures, and gaps in the knowledge system.

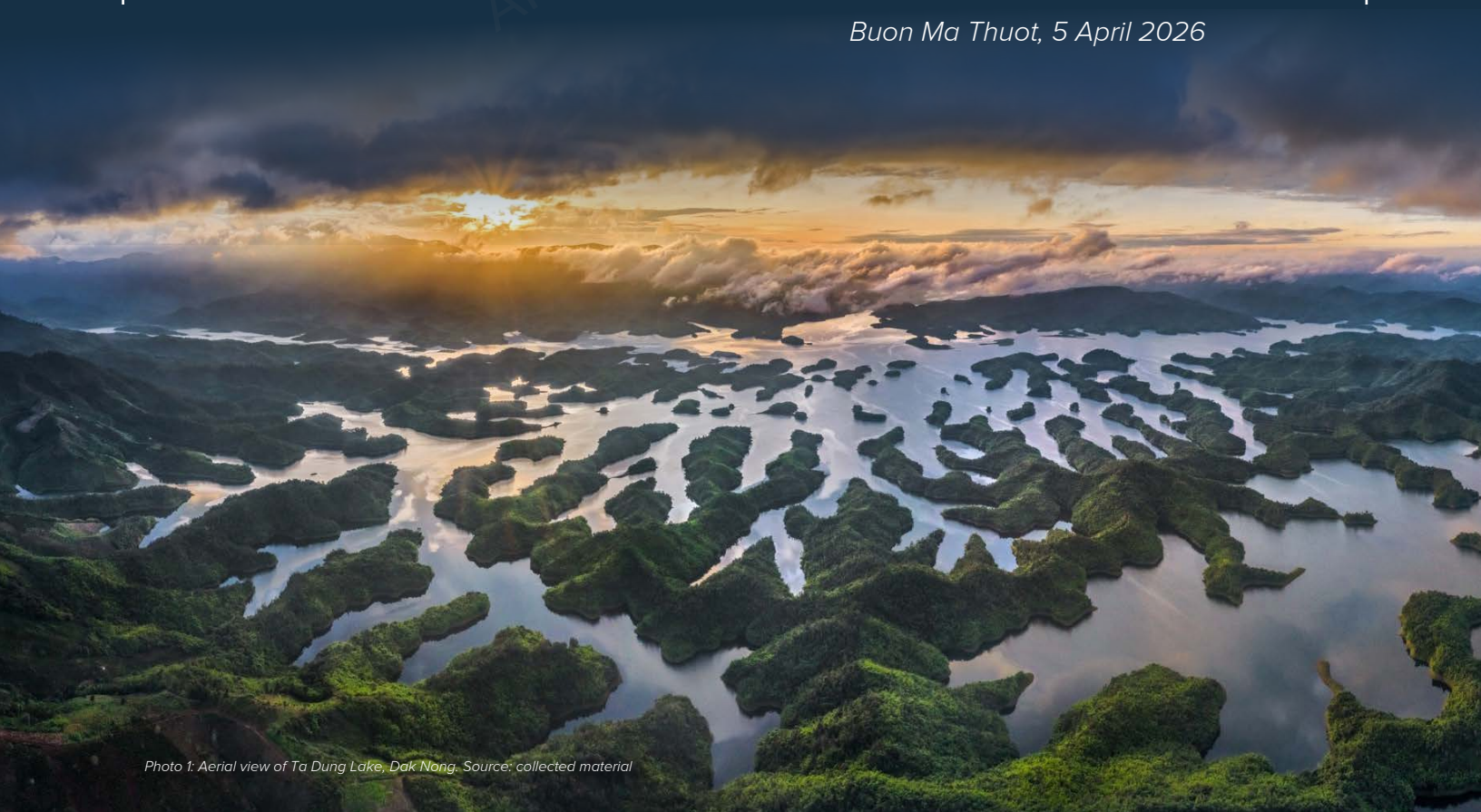
Building on this analysis, the paper proposes a systems-based approach. Soil restoration is not merely a technical challenge, but a process of restructuring the entire agricultural production system. The transition framework is organized around four pillars: integrating "soil health" into measurement and management systems; aligning economic incentives with soil condition; translating knowledge into practice through communities; and redesigning the long-term enabling conditions.

At the same time, the paper documents pioneering practices by farmers, cooperatives and businesses - actors that have begun shifting from "feeding the crop" to "feeding the soil" - showing that, in practice, economic efficiency and ecological restoration can coexist.

A consistent argument runs through the analysis: when soil is properly understood as a living system, production decisions begin to shift from serving only immediate yields toward sustaining long-term regenerative capacity. Soil restoration therefore becomes a condition for stable production systems, rather than simply a set of technical measures or farming methods.

At the macro level, the paradox is especially clear. Policies for export commodity development currently focus mainly on maximizing export value and expanding markets, while also emphasizing product quality and emissions criteria. Yet "soil health" - the foundation of sustainable productive capacity - has not been integrated into the policy "formula" for planning and implementation.

Buon Ma Thuot, 5 April 2026



AUTHOR'S NOTE

After more than thirty years connected to the Central Highlands, I have witnessed its shifts from close enough range to understand them deeply. Old forests have gradually receded, giving way to industrial crop plantations. Waves of migration. Harvest seasons following one another.

The longer I have stayed, the more I have noticed quiet changes that are difficult to name. Golden harvests still arrive, but the soil beneath has changed. Through many wet and dry seasons, the soil has become more compacted, the organic layer thinner, and its capacity to hold water weaker.

Once, an elderly farmer told me:

"The trees are still green, but the soil is already tired."

The words were simple, but they stayed with me.

This paper grew out of those experiences, combined with published research on nutrient decline and depletion of cultivated soils in the Central Highlands, together with field observations accumulated over many years of work in the region.

I write to recognize pioneering farmers who have chosen a different path - farming in ways that rebuild the soil, with fairness and understanding: not only feeding the crop, but also feeding the soil.

I also write to share with the many other farmers who already see the problem clearly, but still face difficult choices under intense livelihood pressures.

Above all, I write with the belief that, with collective effort and support for farmers, the soil can become healthy again in the not-too-distant future.

From research data to farming practice, this paper hopes to help shape a different way of thinking about soil health, while opening space for dialogue on the future of the Central Highlands' soils among farmers, scientists, businesses and policymakers.

Soil is not only a means of production; it is the foundation of all life. When that foundation weakens beyond a certain threshold - a condition comparable to "clinical death" - the livelihoods and prosperity built above it also become more fragile.

Photo 2: A coffee farmer practicing soil-nurturing cultivation in the Central Highlands. Source: Pham Tuan Anh



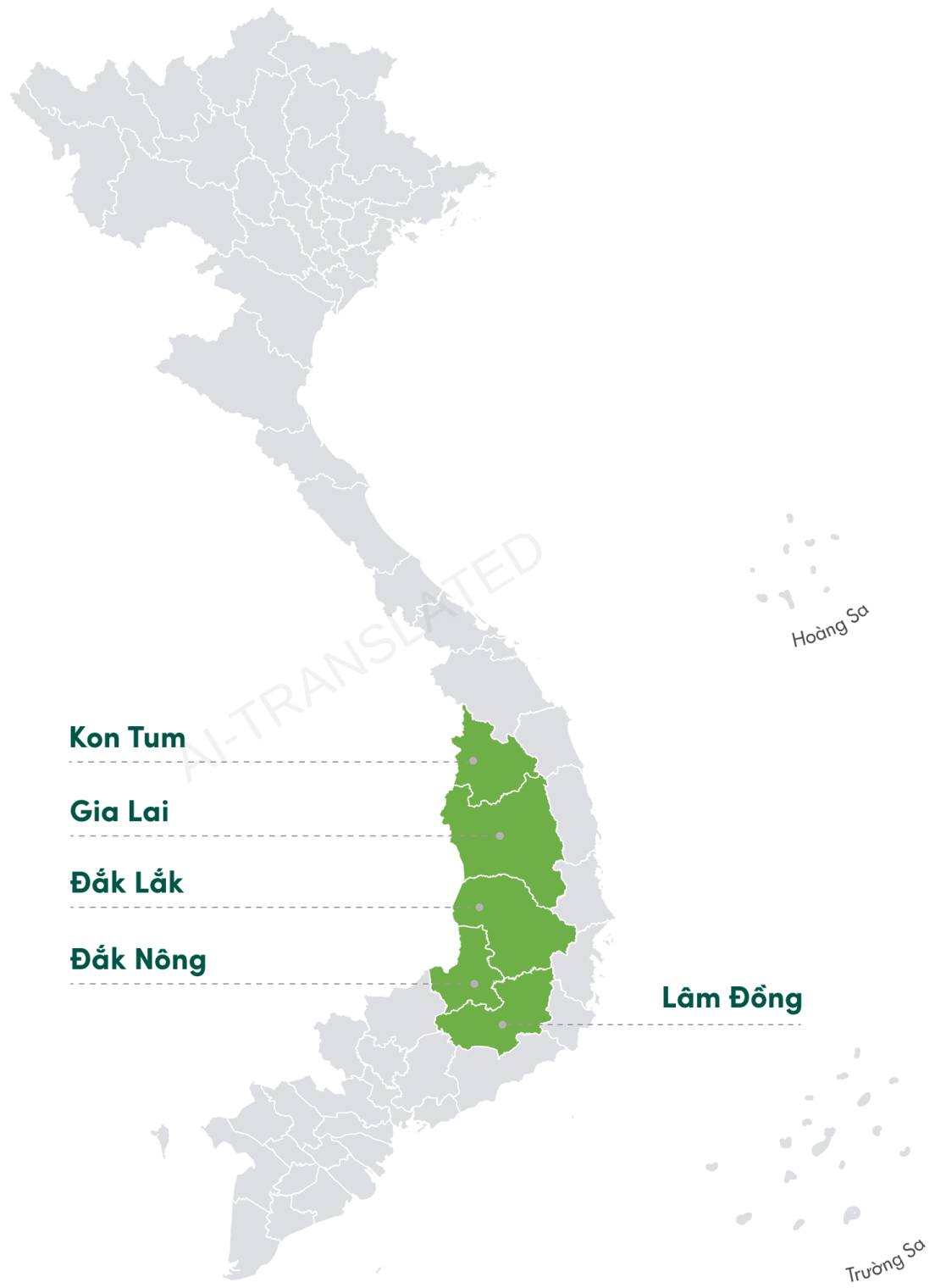
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APRIL 2026

Figure 1. The Central Highlands region*



(*) Map of the Central Highlands before the provincial mergers in July 2025

INTRODUCTION: THE PARADOX OF THE GOLDEN HARVESTS

These observations are not limited to personal impressions. They are increasingly reflected in research and empirical evidence. It is at the intersection of experience and evidence that the paradox of the "golden harvests" becomes clear.

Recent assessments indicate that more than 20% of agricultural land in the Central Highlands is already severely or very severely degraded (Truong Hong, 2024). This figure is not only about productivity. It points to a deeper problem: the production base itself is weakening.

As soil weakens, meeting market requirements becomes more difficult. And as market standards rise, the limits of the soil become more visible. These two processes are intertwined - and their convergence exposes the bottlenecks in the current production system.

Indigenous knowledge as an ecological reference point

The Central Highlands - a series of plateaus stretching from Kon Tum and Gia Lai through Dak Lak to Dak Nong and Lam Dong - has long been home to many Indigenous communities, closely associated with fertile basalt soils and rich forest ecosystems. In the memories of people who have lived here for many years, before the forests receded, the landscape moved at a slower and more balanced rhythm.

Small swidden plots lay along forest edges, not to extract as much as possible from the land, but simply enough to "keep the stove burning and the stomach full" through the lean season. Above them were dense forest canopies. The soil was covered by a moist, nutrient-rich layer of organic humus. Beneath that cover, ecological cycles operated continuously: water infiltrated deeply, roots intertwined, and microorganisms decomposed and renewed organic matter.

In that landscape, soil was not forced to produce continuously. Shifting cultivation followed cycles of use and rest - a necessary pause that allowed vegetation to regenerate and soil fertility to recover. Livelihoods drew on multiple sources - cultivation, gathering and small-scale livestock - spreading pressure across individual plots.

Life was not without hardship, but it reflected a deep Indigenous understanding: soil needs time to recover, just as a living body needs rest after work - and prosperity should not come at the cost of soil exhaustion.

This memory is not intended to idealize the past. Rather, it provides an ecological reference point - a time when Central Highlands soils functioned within a naturally regenerative cycle, where humus accumulated over years and soil structure was maintained by stable vegetation cover. Against that reference point, the paradox of today's "golden harvests" becomes clearer: extraction is outpacing recovery, and the soil is beginning to send distress signals while people are still learning how to listen.

The paradox of the golden harvests

Each harvest season, the Central Highlands still conveys a familiar sense of abundance: hillsides covered in red-ripe coffee cherries, pepper gardens heavy with fruit, and convoys of trucks leaving the plateau carrying the results of a year of labor. It is an image of prosperity - vibrant rural life, rising incomes, and a once-remote region that has become an important link in global agricultural supply chains. On the surface, this is a success story of commodity agriculture and impressive growth.

But a closer look at the soil underfoot reveals a different reality. In many long-established monoculture areas, organic matter has declined, surface crusting has increased, and water runs off rather than infiltrating. These changes do not cause immediate consequences; they accumulate quietly season after season (WASI, 2020; 2021) - slowly enough to be overlooked, but deeply enough to weaken the very ecological foundation supporting abundant harvests.

The core paradox is this: output may rise while soil health declines

When biological functions are replaced by fertilizers, irrigation and other inputs, the production system can maintain yields but gradually loses its capacity for self-recovery. Growth then depends less on the soil's inherent capacity and increasingly on external compensation - a form of "drawing down natural capital" (FAO, 2015; IPCC, 2022).

What is striking is that this process is largely invisible in familiar indicators. Figures such as output, cultivated area or export value may show the results of each season, but they do not capture what is happening beneath the soil surface. Slower changes - declining humus, weakening soil structure or reduced biological activity - are therefore easily overlooked in monitoring, especially when such indicators are absent from agricultural assessment systems.

In this context, soil degradation cannot be understood as a single technical deviation. It is the outcome of a broader structure - where market signals favor the short term, livelihood pressures narrow the room for choice, and economically rational decisions produce harmful consequences for soil. It is a loop in which "rational" economic choices gradually erode the very land that sustains farmers.

In many cases, farmers are not making the wrong choices; they are doing what circumstances and markets compel them to do.

The issue, therefore, is not only to improve farming techniques, but to change the conditions that shape farming decisions. If those conditions remain unchanged, technical solutions - even sound ones - may sustain output in the short term while the soil underneath continues to weaken over time.



CHAPTER I

SOIL IS A LIVING ENTITY

Soil management, therefore, is not simply about adjusting farming techniques; it is about managing a foundational biological infrastructure.

(Schoonover & Crim, 2015)

To understand how these paradoxes can occur - with output still rising while the soil weakens - we need to begin with a more fundamental question: what is soil within this production system? Soil is not an inert growing medium. It is a living ecosystem. Every handful of soil is a complex structure of minerals, organic matter, water, air and dense communities of microorganisms. Their continuous interactions give soil its capacity for self-regulation - retaining water, storing nutrients, decomposing organic matter and maintaining stable structure.

Viewed through a broader conceptual lens, soil degradation is no longer a single technical problem. Soil is the foundation of most terrestrial food systems and provides essential ecosystem services - from water regulation and nutrient cycling to biodiversity support and surface stability for livelihoods (Schoonover & Crim, 2015). In a broader sense, soil is the ecological infrastructure on which production depends.

From a scientific perspective, soil is a three-phase system - solid, liquid and gas - continuously exchanging with its surroundings and changing over time under the influence of climate, organisms, topography and parent material (NRCS, 2014; SSSA, 2008). Across these approaches, soil is understood as a system in constant exchange of matter and energy with the environment.

When functions such as water retention, nutrient renewal or structural stability weaken, the problem is not merely lower productivity. It is a sign of damage to the entire system. Soil management, therefore, is not simply about adjusting cultivation techniques; it is about managing a foundational biological infrastructure (Schoonover & Crim, 2015).



Photo 3: Kon Plong forest, Central Highlands. Source: Phuc Tran



1.1. When Indigenous knowledge resonates with science

Remarkably, this scientific perspective resonates deeply with Indigenous knowledge in the Central Highlands. Traditional livelihoods have long operated in ways aligned with the soil's regenerative cycles. Swidden plots were not cultivated continuously, but alternated between use and rest. After several cropping cycles, land was returned to nature so vegetation could recover, biomass could accumulate and soil structure could be rebuilt.

This resting cycle was not a waste. It was a form of ecological management that dispersed pressure, maintained fertility and prevented degradation. With forests functioning as an "ecological bank," every fallow period also reconnected the plot with the surrounding ecosystem.

Diversified livelihoods - combining cultivation, livestock and forest use - created a flexible buffer that reduced pressure on each parcel. The rhythms of livelihood and recovery could therefore remain in relative balance.

Although these practices did not arise from modern scientific theory, they reflect core principles of sustainable soil management: maintaining cover, returning organic matter, minimizing disturbance and respecting recovery time. These principles are consistent with contemporary soil science (NRCS, 2014).

This also suggests a different approach: rather than imposing procedures from outside, institutions should listen and work alongside farmers so that farmers become the agents of transition - an important condition for sustaining good practices over the long term.

1.2. Healthy soil - a scientific perspective

Healthy soil is a self-sustaining system: organic matter is replenished, microorganisms remain active, structure is stable and nutrient cycles function smoothly. When these flows are disrupted, soil gradually loses its capacity to recover on its own.

Degradation often proceeds quietly beneath crops that still produce acceptable yields. The production system then becomes increasingly dependent on external inputs such as chemical fertilizers, pesticides and irrigation.

From an ecological perspective, healthy soil is the foundation of resilience: it retains moisture during drought, reduces erosion during heavy rain and helps crops withstand pests and disease. Seeing soil as a living system is therefore no longer an abstract concept, but a basis for farming decisions.



1.3. Central Highlands basalt soils - potential and limits

Central Highlands basalt soils, formed from weathered volcanic rock, are among Vietnam's soils with the greatest agricultural potential. With deep profiles (often 1-2 m), high cation exchange capacity (CEC), and relatively stable aggregate structure, basalt soils can retain and supply nutrients efficiently to perennial crops. Under natural conditions, especially beneath forest cover, soil organic carbon (SOC) commonly reaches about 3-5%, providing a foundation for biological activity and sustainable nutrient cycling (FAO, 2015).

This potential, however, is not permanent. When vegetation cover declines, organic matter is not sufficiently returned, and intensive cultivation continues for long periods, soil structure breaks down, infiltration declines, and compaction and nutrient leaching increase. Research in the Central Highlands shows that SOC in many coffee monoculture areas has fallen below 2%, and even below 1.5% (WASI, 2020; 2021). This is an important threshold: at low SOC levels, soil structure becomes unstable, microbial activity declines and input-use efficiency falls markedly (IPCC, 2022).

Central Highlands basalt soils therefore have a dual character: high potential, but high sensitivity to degradation. Once ecological thresholds - especially the organic-matter threshold - are crossed, the soil system shifts from a self-recovering state to one dependent on external inputs.

1.4. From awareness to action

The question is no longer how to maximize short-term yields, but how to maintain the soil's long-term regenerative capacity. This is a fundamental shift: from extraction to stewardship.

Soil degradation does not happen suddenly. It accumulates through small, repeated disturbances over time. Once the ecosystem's tolerance threshold is exceeded, the soil begins to send clear signals - declining organic matter, structural breakdown and weakening biological functions (Schoonover & Crim, 2015).

Evidence from the Central Highlands shows that these are no longer early warnings. Organic matter in many coffee monoculture areas has already fallen below levels needed to maintain soil structure and biological activity (WASI, 2020; 2021).

Viewed together, these symptoms are not isolated warning signs; they indicate a systemic state of decline.

Recognizing soil as a living ecosystem therefore changes not only how farming is practiced, but how degradation itself is understood: not simply as declining productivity, but as a gradual loss of system functions.

Recognizing that condition is the first step toward adjusting farming practices - and the necessary transition to the next chapter, which examines the specific manifestations of soil degradation.



CHAPTER II

SIGNS THAT SOIL IS GRADUALLY DYING

..."soil is gradually dying" reflects a cumulative decline of the entire soil ecosystem.

These signs are not distant forecasts. They are already visible on the hillsides and plantations of the Central Highlands - seen with the eye, felt in farmers' hands, or confirmed by scientific indicators.

In this paper, "soil is gradually dying" is not a metaphor, but an integrated expression describing a severe decline in the soil's fundamental ecological functions - when its capacity for self-regulation and internal regeneration can no longer be maintained, as reflected in scientific indicators of organic matter, structure and biological activity.

When multiple indicators simultaneously decline toward critical levels - depleted organic matter, increasing acidity, weakened structure and reduced water-holding capacity - soil approaches a state in which it loses its self-regulating functions. In this sense, "soil is gradually dying" describes the cumulative decline of the soil ecosystem as a whole.

If Chapter I laid the foundation for understanding soil as a living ecosystem, this chapter forces us to face a harsher question: what happens when that living system begins to fail?

At the global scale, soil degradation - especially declining organic matter and weakening soil structure - is no longer a localized phenomenon (FAO, 2021). About one-third of the world's cultivated land is experiencing varying degrees of degradation (FAO, 2015).

The signs described below are not distant forecasts. They are already visible on the hillsides and plantations of the Central Highlands - observable to the eye, felt in farmers' hands, or confirmed by scientific indicators. As industrial crop areas expand rapidly, these signs are becoming increasingly evident and should be read as an interconnected system of signals.



Photo 4: Degraded cultivated soil. Source: Pham Tuan Anh



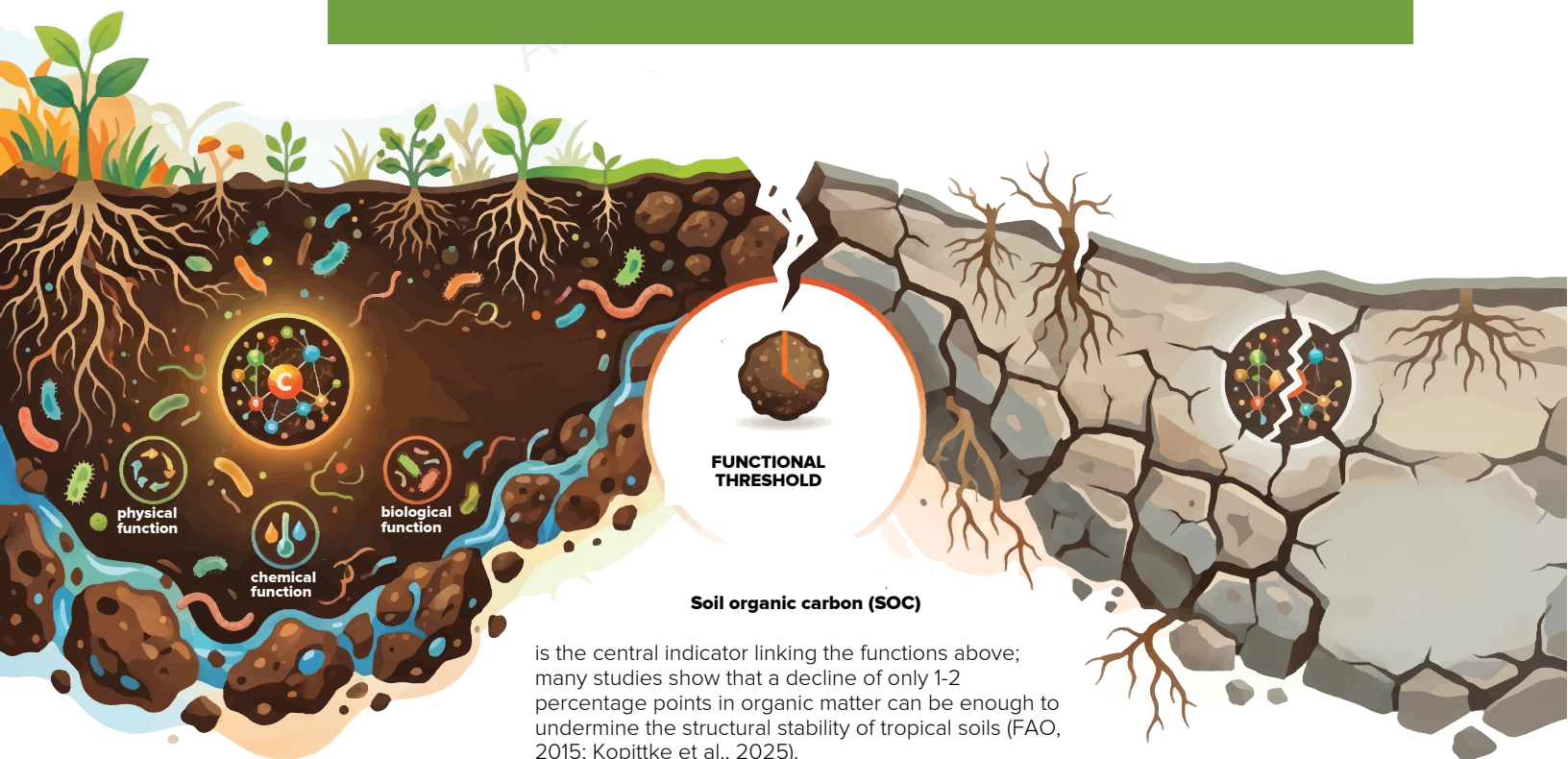
2.1. "Dead soil" - an ecological concept

In scientific terms, "dead soil" describes a simultaneous and severe decline in fundamental ecological functions: unstable soil structure, depleted organic matter, declining microbial activity, and impaired capacity to retain water and nutrients. When these functions weaken together, soil loses its ability to regenerate and becomes almost entirely dependent on external inputs (FAO, 2015; IPCC, 2022).

In the field, this condition is not an abstract concept. It appears in familiar signs: soil becomes hard and difficult to crumble by hand, absorbs water poorly, dries quickly in the dry season and erodes easily during heavy rain; crops respond weakly to fertilizer, and soil organisms gradually disappear.

Box 1. "Dead soil" from a functional science perspective

The concept of "dead soil" describes a simultaneous decline in physical functions (maintaining structure), chemical functions (regulating nutrients and pH), and biological functions (microbial activity). The key issue is not any single symptom, but the combined decline beyond a "functional threshold." At that point, the soil system shifts from a resilient state to a dependent one: yields can be maintained only through fertilizers and irrigation, while natural biological mechanisms are largely paralyzed.





2.2. Breakdown of the physical framework

Soil structure - the network connecting mineral and organic particles - is the physical foundation for life below ground. Good structure allows water to infiltrate deeply, air to circulate and roots to grow. Yet in many monoculture areas of the Central Highlands, this network is gradually breaking down.

According to WASI (2020), long-established coffee soils show significantly higher bulk density, lower porosity and far less plant-available water than forest soils. Compaction reduces the pore space needed for water, air and soil organisms. Rainwater then runs across the surface instead of infiltrating - what farmers simply describe as "water runs off instead of soaking in."

2.3. When the ecological energy flow is depleted

Organic matter is the energy source that sustains the entire system and plays a central role in water and nutrient cycles. When less biomass is returned than is removed, soil organic carbon reserves decline continuously - a quiet process that accumulates over time.

Surveys in Bao Loc - Di Linh show that organic matter in coffee soils can be 16% to 60% lower than in forest soils (Nguyen & Luu, 2017). Many areas record levels below 1.5% - beneath the threshold needed to sustain basic biological functions.

Farmers recognize this in practice: the soil holds less moisture, cracks more easily in the dry season and responds weakly to fertilizer. The saying "we fertilize heavily, but the crop cannot take it up" reflects a soil ecosystem so weakened that it can no longer transform nutrients effectively.



Photo 5: Coffee farmer in the Central Highlands. Source: Pham Tuan Anh



2.4. The silence of the "underground city"

Healthy soil is a vibrant "underground city" where microorganisms and soil fauna sustain cycles of decomposition and transport. In simplified farming systems, these organisms are declining sharply in both abundance and diversity.

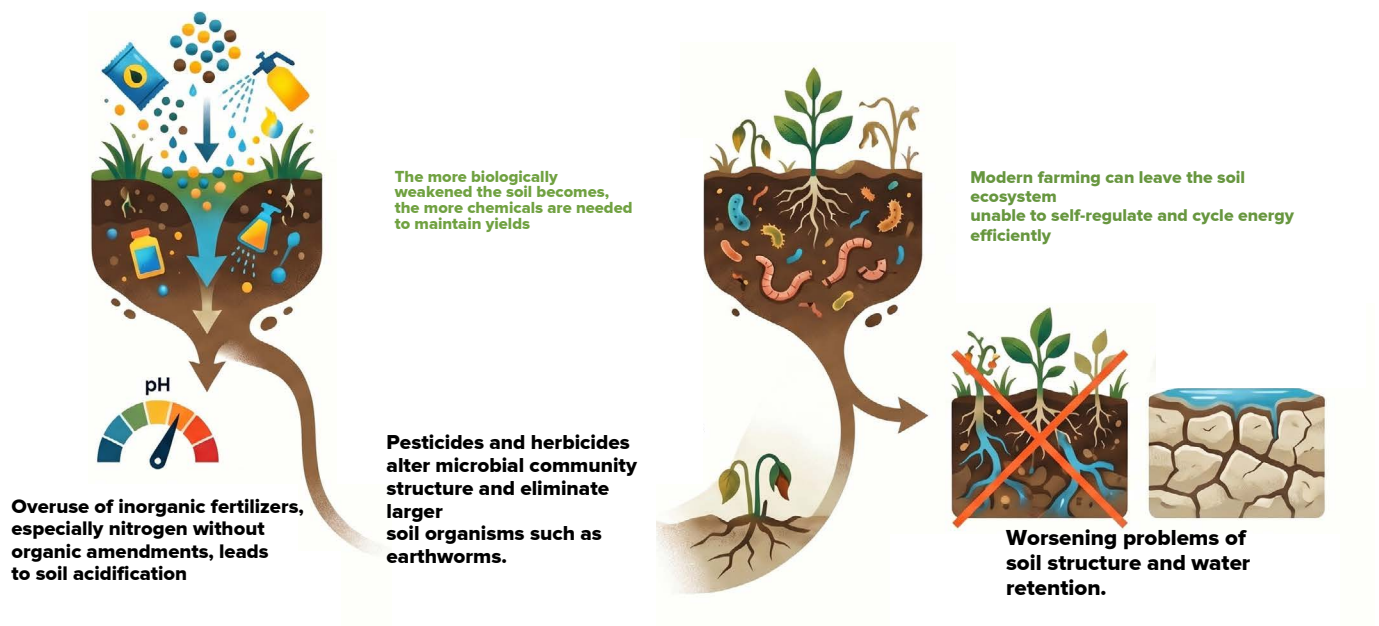
Replacing multi-layered ecosystems with monocultures interrupts natural organic-matter inputs, causing soil to lose its characteristic humus smell and become biologically "silent." In perennial industrial-crop monocultures, the abundance and diversity of soil organisms are significantly lower than in natural forests (IPCC, 2022).

Box 2. Effects of agricultural chemicals on life in soil

Overuse of inorganic fertilizers, especially nitrogen without sufficient organic amendments, leads to soil acidification (lower pH). When pH moves outside the optimal range, key biological processes such as nitrogen fixation and mineralization are inhibited. A dependency loop emerges: the more biologically weakened the soil becomes, the more chemicals are needed to maintain yields (Wang et al., 2024).

Broad-spectrum active ingredients in pesticides and herbicides also alter microbial community structure while eliminating larger soil organisms such as earthworms. The loss of these "ecosystem engineers" slows humus formation and destroys biological channels, directly worsening problems of soil structure and water retention (Jeyaseelan et al., 2024).

In short, modern farming is disrupting core operating mechanisms so severely that the soil ecosystem can no longer self-regulate or cycle energy efficiently.





2.5. Nutrient-rich soil that is not healthy

A common paradox is that soil may contain abundant nutrients because of excessive fertilization, yet crops still grow poorly. This is a sign that nutrient transformation and uptake have become impaired.

The soil becomes "overfed," even "toxic," as nutrients accumulate in forms that are difficult to absorb, the environment becomes acidified and biological processes are suppressed. When pH falls too low - in some places below 4.0 (MONRE, 2023) - roots cannot take up nutrients even when those nutrients are present in the soil.

The result is soil that is "rich" in theory but "weak" in practice, accompanied by steadily rising input costs.

Mechanistically, this condition results from chemical inputs accumulating beyond ecological thresholds. When inorganic fertilizers exceed the absorption capacity of crops and the soil system, nutrient ions accumulate as soluble salts, disrupting chemical balance and increasing acidity. Repeated use of pesticides and herbicides simultaneously alters microbial community structure and weakens natural transformation processes.

The result is a familiar farming paradox: nutrients remain present in the soil, but crops cannot absorb them efficiently - a condition comparable to "starving in the middle of a feast." Under these conditions, adding more inputs no longer solves the problem; it only deepens the imbalance that has accumulated.

2.6. The reinforcing degradation loop

These signs do not exist in isolation; they link together into a degradation loop. Broken soil structure increases erosion; erosion removes organic matter; loss of organic matter reduces soil organisms; and as biological functions become paralyzed, the soil gradually loses its capacity for self-recovery.

Importantly, these processes do not unfold as a simple linear chain; they create reinforcing feedback loops. When one link weakens, it not only affects the next but feeds back to intensify the original problem. For example, loss of soil structure not only increases erosion but also reduces water retention, which further damages structure and accelerates degradation.

Under intensive cultivation, this loop is amplified by increasing chemical inputs. Once soil biology has weakened, adding more fertilizer and chemicals no longer restores the system; instead it may deepen the state of "overfeeding" and "toxicity," making already weakened biological processes even harder to re-establish.

In the Central Highlands, steep terrain and highly seasonal rainfall make these loops occur rapidly and accelerate over time. Each season removes not only crops but also part of the soil's underlying ecological "capital." Once a certain threshold is crossed, degradation can no longer be easily reversed through isolated interventions and instead requires systemic change.



2.7. Diagnostic conclusion and spatial differentiation

The signs above form a consistent picture: soil decline is occurring through a systemic process, not as a collection of isolated phenomena.

Degradation, however, is not uniform; it varies by farming system and ecological conditions. Coffee areas face strong acidification and compaction pressure; pepper areas can deteriorate rapidly under intensive production cycles; annual crops may degrade faster but can also recover more readily if practices are adjusted in time.

This variation shows that no single solution can be applied everywhere.

These changes do not happen on their own. Behind every depleted plot lies a chain of choices shaped by specific production conditions.

To understand why the degradation loop continues, we must move from observing symptoms to examining what happens in everyday farming practice.

Chapter III therefore examines farming practices - the direct factors shaping soil health.



Photo 6: Farming practices that deplete the soil. Source: Pham Tuan Anh



CHAPTER III

DIRECT IMPACTS ON SOIL:

WHEN FARMING PRACTICES EXCEED ECOLOGICAL THRESHOLDS

...whenever a crop shows signs of weakness, a little more fertilizer is added – and when the plant turns green again, the response gradually becomes habitual.

This chapter focuses on what happens every day in the field - where small, repeated farming decisions gradually accumulate into visible changes in how soil functions and supports crops.

3.1. Fertilization beyond thresholds and nutrient imbalance

In many intensive farming systems, fertilizer is no longer used only to "replace deficiencies" but increasingly to "push yields." Nitrogen is often prioritized because it produces rapid visible effects on crops, while secondary and micronutrients receive less attention.

When fertilizer applications exceed actual crop demand, nutrients are not only wasted; the soil gradually becomes imbalanced. Over time it becomes more acidic, its structure less stable, and natural soil processes are disrupted. These changes are not immediately obvious. At first they are difficult to detect. Then the soil holds less water. Structure weakens. Eventually the vitality of the soil declines. Beyond a certain threshold, the soil can no longer recover as it once did.

In some coffee-growing areas of the Central Highlands, actual fertilizer use is commonly 1.5-2 times higher than recommended rates, especially for nitrogen, as a form of "insurance" for yields (WASI, 2021).

Such practices are common: whenever a crop shows signs of weakness, a little more fertilizer is added - and when the plant turns green again, the response gradually becomes habitual.



Photo 7: Foliar fertilizer being sprayed in a coffee garden. Source: Phuc Tran

**Box 3. Chemical fertilizers: the issue is not the product itself, but how it is used**

Chemical fertilizers remain an important tool in modern agriculture, helping sustain yields and production. Many studies show that when used correctly - the right product, rate, timing and method - and combined with good soil care, fertilizers can be effective without causing substantial negative impacts (FAO, 2015).

The problem, therefore, is not fertilizer itself, but how it is used in practice. As soil weakens, fertilizer is often used to compensate for functions the soil can no longer perform. This may sustain short-term yields, but it also increases dependence on external inputs while the soil gradually loses its ability to nourish itself (IPCC, 2022).

Evidence from the Central Highlands shows that fertilizer use above recommended rates is common, particularly in intensive systems such as coffee (WASI and related studies). What is missing, therefore, is not a choice between "using" and "not using" fertilizer, but a way for farmers to use fertilizer as support for the soil rather than as a substitute for it.





3.2. Dependence on chemical inputs and decline of soil biology

When fertilizers and pesticides become the primary solution, the role of natural soil processes gradually shrinks. Microorganisms - which decompose organic matter, retain nutrients and support crops - decline in both abundance and diversity.

In many coffee-growing areas, fertilizer application rates and pesticide-use frequency tend to increase over time, even when pest pressure does not rise correspondingly.

Soil therefore gradually shifts from a living system to a less vital medium that depends increasingly on external inputs. As natural soil activity weakens, self-recovery declines as well, and each subsequent season requires more intervention than the last.

When pests appear or crops grow slowly, the familiar response is often to look for a "stronger" pesticide or fertilizer - and the immediate visible effect encourages the same response to be repeated.

3.3. Declining organic matter and broken material cycles

In many production systems, agricultural residues are not returned to the soil but removed or burned. At the same time, additions of organic matter - manure, compost or mulch - have become less common.

In many gardens, coffee husks and pruned branches are rarely composted and returned to the soil; instead they are collected, burned or disposed of elsewhere.

As a result, humus gradually declines, weakening soil structure, water retention and nutrient-holding capacity. When material cycles are broken, soil loses the foundation needed to sustain long-term fertility.

3.4. "Clean" weeding and bare soil surfaces

Beyond nutrition and biology, the way the soil surface is managed also has a major influence on soil health.

Complete weed removal - mechanically or chemically - is often seen as a sign of good management. Yet when the soil surface is left bare, it becomes more vulnerable to erosion, moisture loss and direct exposure to sun and rain.

Natural vegetation cover, which helps protect and nourish the soil, is removed. The soil therefore loses an important layer of "armor."

A weed-free garden may look tidy, but that very bareness makes the soil more vulnerable.



3.5. Irrigation and unstable moisture management

As weather becomes more variable, irrigation often relies heavily on experience or on reacting to visible crop conditions.

Over-irrigation can leach nutrients and contribute to soil compaction. Insufficient irrigation, by contrast, hardens the soil and interrupts natural processes within it.

In many places, irrigation schedules are still based mainly on perception - watering when the soil looks dry or adding more when crops appear "thirsty" - rather than clearly monitoring soil moisture conditions.

This instability interrupts soil processes, affecting both structure and the soil's capacity to support crops.

3.6. Continuous extraction and insufficient recovery time

In many farming systems, the soil has almost no time to rest. Continuous planting, dense intercropping or multiple harvest cycles keep the land under constant use.

Without periods for recovery, natural regenerative processes cannot keep pace. The soil therefore gradually weakens, even when seasonal yields can still be maintained through additional inputs.

Letting land "rest" is rarely chosen because every period without production means losing part of household income.

3.7. Mechanical disturbance and soil compaction

Frequent traffic, machinery use and repeated tillage disturb and compact soil structure.

When soil is compacted, roots struggle to grow deeply, water infiltrates less effectively, and soil aeration is restricted. These changes happen slowly, but accumulate over time and steadily reduce the soil's functional capacity.

Familiar paths through a garden or intensive soil preparation before each crop - practices often considered necessary - can themselves contribute to increasing compaction over time.

3.8. Monoculture and declining biodiversity

Growing a single crop on the same land for many years reduces the biodiversity of the farming system. The soil becomes accustomed to one pattern of nutrient extraction, while pests and diseases have more opportunity to build up.

This uniformity makes the soil system less flexible and more vulnerable to environmental shocks.

When a crop provides stable income, continuing to grow it year after year is an understandable choice - even if the soil beneath is gradually becoming poorer in ways that are not immediately visible.

**Looking back: direct impacts on soil**

Looking back at what happens every day in the field - fertilizing, irrigating, weeding, applying pesticides, handling crop residues and setting the intensity of production - one common feature stands out: each individual action aims to improve yields or solve an immediate problem.

But when those actions are repeated over long periods and exceed the soil's capacity for self-regulation, they begin to accumulate as pressure.

Soil does not weaken because of one single impact, but because many small impacts overlap, occur continuously and are rarely viewed as a whole.

Nutrient imbalance, declining organic matter, structural disturbance and disruption of natural processes are therefore not separate problems, but different manifestations of the same process: soil is gradually losing its ability to maintain its fundamental functions.

Once these functions decline beyond a certain threshold, soil is no longer truly a living system and instead becomes increasingly dependent on outside intervention - a condition that can be described as ecological "clinical death."

It is important, however, to emphasize that these practices do not stem from ignorance or indifference. In many cases, they are rational choices under the specific conditions farmers face - from yield pressure and weather risks to market volatility.

When performance is judged by what can be seen immediately in each season, while changes in soil unfold quietly over many years, prioritizing short-term solutions is understandable.

To understand why soil is gradually weakening, therefore, it is not enough to look only at what happens in the field. What is visible there is only the most obvious part. Behind it are other forces - markets, the organization of production and the conditions farmers face - that quietly shape how they farm.

These forces are examined in the next chapter.



CHAPTER IV

PRESSURES FROM THE SYSTEM

SOIL IN THE WAY WE PRODUCE

Decisions made in the field do not arise only from individual choice. They are shaped by a wider context

- where farmers must balance market requirements, household livelihood needs and the conditions available to them.

If Chapter III showed how farming practices directly affect soil - from fertilizer and chemical use to surface management - a further question must be asked: why have these practices become so widespread?

Decisions made in the field do not arise only from individual choice. They are shaped by a wider context in which farmers must balance market requirements, household livelihood needs and the conditions available to them.

In other words, soil is affected not only directly by farming practices, but also indirectly by the conditions that shape those practices.

To understand why soil weakens, we therefore need to look more deeply at the forces quietly shaping production behavior. These forces are not always visible, but they accumulate and act over time - creating pressures that the soil must bear.

4.1. Gaps in the knowledge and technical extension system

In many places, especially remote areas, agricultural extension systems lack the capacity to closely support individual farm households. Training sessions are often brief, with little opportunity for continued follow-up or adjustment to the specific conditions of each plot. In some areas, one extension officer is responsible for many communes, making regular support nearly impossible.

Without a stable and trusted source of information, farmers are forced to look elsewhere for advice and learning. This is especially evident in commercial farming areas, where demand for "quick solutions" often exceeds what public extension systems can provide.



Photo 8: A coffee farmer practicing soil-nurturing cultivation in the Central Highlands. Source: Pham Tuan Anh



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Meanwhile, cooperatives and farmer groups - which could connect farmers with technical knowledge and markets - have often not fulfilled that role as strongly as expected. In many places, their activities still focus mainly on supplying inputs or collecting products rather than accompanying farmers in how they cultivate.

As a result, market information and technical guidance often change as they move down to the local level. Farmers ultimately still rely on what they can observe, exchange with others and apply immediately in practice.

This gap is not simply a lack of information. Without a sufficiently strong reference point, farming decisions can become based on fragmented experience or short-term advice. Over time, practices become inconsistent - from fertilization and pesticide use to soil treatment.

These changes do not have immediate effects, but accumulate season after season. When practices are no longer tied to the actual condition of the soil, natural soil processes become increasingly disturbed and soil vitality declines over time.

4.2. Agricultural input dealers and farming habits

In many places, buying farm inputs is also when farmers ask how to use them. It is common to see someone purchase fertilizer and immediately ask the shopkeeper for application advice - advice that is often linked to a particular product.

Gradually, crop-care practices - from fertilization to pesticide use - are shaped by these exchanges. Options that produce quick visible responses in crops are prioritized, while matters related to the soil - harder to see and slower to reveal results - receive less attention.

In some cases, recommended input rates are higher than necessary, as a way to "play it safe." In the short term, this may reduce perceived yield risk. But when repeated season after season, input use rises while the connection between practice and soil condition becomes increasingly blurred.

When farming decisions rely mainly on crop responses and advice tied to input products, actions such as fertilizing, spraying or treating soil can become disconnected from actual soil conditions. Adjustments that seem reasonable in each season may, when accumulated over time, disrupt natural processes and gradually weaken the soil.



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For many farm households, every season is a calculation of costs and income. When daily livelihoods must be secured, choices that deliver faster results are often prioritized.

4.3. Markets and value chains: signals that do not yet reflect soil condition

At a broader scale, markets and purchasing systems also influence how farmers produce. Yet markets tend to focus more on output and product appearance than on how the product was produced.

In practice, products produced under very different farming approaches - some carefully protecting soil, others extracting it intensively - may still receive similar prices as long as they meet the same output standards.

Environmental requirements, where they exist, often stop at selected certification criteria and are not strongly linked to price. As a result, efforts to conserve and restore soil are not always clearly recognized.

When different practices lead to little difference in selling price, farmers have limited incentive to choose approaches that require more time and effort.

In this way, what is happening in the soil - where vitality is accumulated or lost season by season - is not clearly reflected in how markets value products. A gap gradually forms between what happens in the field and what becomes visible once products reach the market.

4.4. Livelihood pressure and limits on farming choices

For many farm households, every season is a calculation of costs and income. When daily livelihoods must be secured, choices that deliver faster results are often prioritized.

Reducing inputs in order to restore soil may bring long-term benefits, but it can also carry a risk of lower yields in the same season. Not every household has the capacity to accept that risk.

Practices that need time to show results - such as soil restoration - are therefore easily postponed. For households dependent on a single main crop, the room to experiment with alternatives is even narrower.

Under these conditions, many decisions that appear unfavorable for soil are understandable choices.



Photo 9: Pesticide and fertilizer retailer in the Central Highlands. Source: Luong Kim Anh



4.5. Land-use rights and cumulative consequences

In some places, land is transferred or leased for a defined period. When land users do not have a long-term connection to the land, farming practices may shift toward extracting as much as possible during the time available to them.

In such cases, what happens to the soil later is not always considered in present decisions. The consequences can therefore be shifted into the future or onto someone else.

These impacts do not appear immediately, but accumulate gradually. When land use is not accompanied by long-term responsibility, soil can become a resource to be extracted rather than something to be conserved.

4.6. Lack of mechanisms to monitor and recognize soil health

Another problem is that soil condition is not clearly monitored or recognized. There are few practical ways to know whether soil is becoming healthier or weaker, and there is no clear price difference between products grown on healthy soil and those grown on degraded land.

When what happens in the soil is neither visible nor accounted for, it is difficult for soil condition to become part of production decisions. Many choices therefore continue to be based on what can be seen immediately in each season.

In this context, soil changes occur quietly and are often noticed only after they have become pronounced.

4.7. Soil degradation - the result of overlapping pressures

Looking back, changes in soil do not result only from the decisions of individual farmers. They reflect multiple factors acting at once - access to information, how inputs are purchased, market requirements and everyday livelihood pressure.

Under these conditions, many practices that appear unfavorable for soil are understandable choices. It is not that farmers do not know; rather, they are operating within specific constraints.

This also shows that changing techniques only at household level will rarely create lasting change if the underlying conditions remain the same. When practices that benefit soil do not also provide clear short-term benefits, they are unlikely to become widespread choices.

Soil restoration is therefore not only a technical question, but also a matter of creating conditions that allow farmers to choose practices that are good for soil while still securing their livelihoods.

The question, then, cannot stop at farming practice; it must be asked at system level: by what criteria are we evaluating agricultural production?



4.8. A gap in the evaluation system: when "soil" is not yet counted

Recent discussions on sustainable development of export commodities increasingly include environmental and social factors. Yet policy frameworks are still built mainly around familiar objectives such as growth in export value and market expansion, with sustainability factors added as supplementary requirements.

Within this structure, soil - the foundation of long-term productive capacity - has not yet been treated as a core component of the sustainability "formula" in commodity-sector policy mechanisms.

In practice, most policies for export commodities still revolve around familiar indicators such as output, export value and market expansion. Sustainability considerations, where present, tend to focus on directly observable aspects such as product standards, traceability or emissions.

Yet in implementation, soil health - the foundation of long-term production capacity - has still not been clearly incorporated into this assessment system.

As a result, the system may continue recording growth in output and value while the soil underneath steadily weakens - a form of growth that does not fully reflect the ecological costs it creates.

In this sense, the current system is not simply missing one indicator; it is undervaluing the very foundation of production.

This also explains why patterns observed at farm level - increasing inputs, dependence on farm supplies and neglect of soil condition - are not random deviations, but rational responses within a system whose evaluation signals do not fully reflect reality.

The challenge, therefore, is not only to change farming practices, but to restructure product and commodity evaluation systems so that "soil health" becomes a foundational sustainability criterion rather than merely an additional indicator alongside quality, safety or emissions.

When what happens in the soil is measured, recorded and linked to product value - and integrated into indicator systems and policy-management mechanisms - production decisions gain a basis for shifting toward greater sustainability rather than continuing to follow signals that fail to reflect the true state of the soil.



CHAPTER V

NEW SIGNALS FROM THE MARKET OPPORTUNITIES AND LIMITS FOR CHANGING FARMING PRACTICES

Requirements for traceability, information transparency and compliance with environmental standards are no longer isolated demands; they are becoming a broader trend.

If previous chapters showed how soil is being affected and why those impacts occur, another question now arises: can changes from the market alter the way people farm?

As producers become more deeply integrated into value chains, markets no longer care only about the final product; they increasingly pay attention to how it is produced. Requirements for traceability, emissions reduction, responsible resource use and environmental protection are becoming more common. In this way, the market is not merely a place for buying and selling, but increasingly shapes farming practices at household level.

These changes, however, do not occur in a vacuum. They enter a context already shaped by many forces influencing farming, as discussed in Chapter IV. The issue is therefore not only what the market requires, but whether those requirements are clear and strong enough to change established practices.

5.1. When markets begin to care about how products are produced

For a long time, the value of agricultural products was determined mainly by what could be seen in the product itself: yield, size, appearance and selected quality indicators. How the product was produced - especially what happened in the soil - was hardly considered.

In recent years, this has begun to change. Pressure from consumers, environmental regulations and businesses themselves has made production practices more important within value chains. Requirements for traceability, information transparency and compliance with environmental standards are no longer isolated demands; they are becoming a broader trend.

This shift is significant: production factors that were previously less visible - such as soil management, input use and ecosystem protection - now have greater opportunity to be considered when products are evaluated.



Photo 10: Coffee farmer in Dak Lak. Source: Tam An/Tuoi Tre Newspaper



5.2. Standards and certification: an initial step toward evaluating practices

One clear sign of this trend is the spread of sustainable agriculture certification programs. Systems such as 4C, Rainforest Alliance and organic standards assess not only the final product but also production practices - from reducing chemical use and protecting soil and water to maintaining organic matter and environmental and social conditions in farming.

Although they do not always measure "soil health" directly, these standards have at least brought soil back into consideration in production. They can be seen as an initial shift from looking only at the product toward paying greater attention to how the product is made.

The impact of these standards, however, depends on how they are implemented. When requirements remain procedural or are not accompanied by sufficiently clear economic benefits, they are unlikely to drive meaningful change.

A key point is that while many elements of sustainable production - such as emissions, traceability and chemical use - have entered evaluation systems, soil health, the foundation of production, is still not monitored and recognized clearly.

In practice, standards often address soil through specific practices but rarely track soil condition over time. When soil health is not clearly monitored or reflected in product pricing, it is unlikely to carry significant weight in production decisions.

Soil remains present throughout the production process, yet it is rarely visible in economic calculations. Every farming activity affects it, but it is seldom used as a basis for adjusting practices.

5.3. Market limits: when signals are not yet strong enough

Despite positive changes, market signals are still not strong enough to replace long-standing short-term incentives.

The first issue is price. In many cases, the price difference between "sustainable" and conventional products is small. When that premium is unclear or insufficient, farmers have little reason to change familiar practices.

The second issue is cost. Meeting standards requires additional expenditure - for certification, changes in procedures and the risks of transition. For many smallholders, this is a difficult barrier to overcome.

Another limitation is how market requirements are communicated. As they pass through multiple intermediaries, they can become vague or insufficiently specific, leaving farmers unsure where to begin.



Thus, although markets increasingly speak of "sustainability," what is rewarded in price still relates mainly to immediate outcomes. The gap between market requirements and the actual condition of the soil has therefore not yet narrowed clearly.

5.4. Opportunities: when change begins to take clearer shape

Despite these limitations, market changes are also opening several important opportunities.

Some companies have moved beyond purchasing and begun engaging more deeply in production - through technical support, appropriate inputs and the development of more stable sourcing areas.

In these cases, market requirements are not simply "demands" but are translated into concrete support, enabling farmers to change practices without bearing the full risk themselves.

In some places, incentives for good practices are also beginning to appear, although still on a small scale. If maintained and expanded, these approaches could gradually change the calculations that shape agricultural production.

5.5. Transition challenges at household level

Even with these opportunities, changing farming practices at household level remains difficult.

The first challenge is risk. Changes such as reducing chemical inputs or restoring soil often take time to show results. In the early stages, yields may decline while costs remain.

The next challenge is information. Market requirements are not always translated into specific, practical guidance. Farmers may know they are expected to do "better" but still not know where to begin.

Another constraint is resources. Many households lack capital or labor, or have difficulty accessing support services, limiting their ability to experiment and adjust.

Under these conditions, changing practices is not merely a technical question; it is also an economic calculation tied to each household's ability to accept risk.

5.6. When markets can genuinely help change farming practices

If markets are expected to help redirect farming practices, it is not enough simply to impose requirements; those requirements must be clear and meaningful in practice.

First, reliable ways are needed to monitor how soil is changing. What cannot be seen will continue to be overlooked.



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Next, these factors need to be reflected in product pricing. When better practices bring no clear economic benefit, they are difficult to sustain at scale.

Risk for producers also needs to be reduced through technical support, finance or appropriate risk-sharing mechanisms. This is especially important for smallholders.

Finally, market requirements need to be communicated clearly and understandably. Intermediary organizations are crucial because they bridge general requirements and specific field-level practices.

In conclusion

Market changes point to a new direction: from focusing only on products to paying attention to the production process as well. However, this transition is still at an early stage and is not yet sufficient to fully change established farming practices.

What happens in the field - as shown in Chapter III - cannot be separated from external forces - as discussed in Chapter IV. If markets are to become part of the solution, they must not only set different requirements but also change how those requirements are implemented in practice.

More importantly, what happens in the soil needs to become more visible and be taken into account in production assessment. When practices that benefit soil also bring clear economic value, good soil management has a real chance of becoming the common choice.

The question, therefore, is no longer whether soil should matter, but how changes in soil can be reflected more clearly in the way products are valued and choices are made. When that happens, the gap between production and ecology can gradually narrow.



Photo 11: Farmers harvesting coffee in the Central Highlands. Source: Luong Kim Anh



CHAPTER VI

THE PIONEERS

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They see soil restoration not as a cost, but as a condition for survival in the future. More importantly, they do not wait for the system to change; they begin with what they can control on their own land.

If Chapter V showed how market pressures are forcing the production system to change, Chapter VI asks a more practical question: who is turning that transition into reality in fields and gardens - and how are they doing so while signals from the wider system have not yet fully changed?

The answer can be found among pioneering producers - farmers, cooperatives and businesses. They see soil restoration not as a cost, but as a condition for survival in the future. More importantly, they do not wait for the system to change; they begin with what they can control on their own land.

6.1. Beginning with a simple truth: when "saving the crop" no longer works

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The journey of pioneers often begins with a shared experience: hard soil, unstable yields, and diminishing returns from ever greater investment in fertilizers and pesticides. When old practices can no longer "save" the crop, they find the courage to shift toward feeding the soil.

Instead of focusing only on the canopy, they begin thinking about ground cover, roots and life below the surface. They mulch fields with straw and coffee husks, diversify through intercropping, and integrate livestock to return to the soil what has been taken away.

The early stage is difficult, with fluctuating yields and strong social pressure. Yet after several years, persistence brings results: soil structure becomes looser, moisture retention improves and soil organisms return, rebuilding the natural microbial "factories" that underpin fertility.

What matters here is not only the technical change, but the change in perspective: from reacting to visible crop symptoms to observing slower but more fundamental signals from the soil. This shift helps producers move beyond the short-term signals that once dominated their farming decisions.



Photo 12: Coffee garden in the Central Highlands. Source: Luong Kim Anh



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Healthy-soil stability is not only about productivity; it is also an economic "buffer" that reduces exposure to input-price volatility.

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6.2. An experienced farmer in Lam Dong

I still remember the morning I visited Ho Van Hoan's coffee garden in Dak Kim village, Thuan An commune, Lam Dong (formerly Dak Mil district, Dak Nong province). On 3.5 hectares that he has cultivated for more than thirty years, he began "feeding the soil" about a decade ago by composting coffee husks into organic fertilizer and systematically reinvesting in the garden.

The results are striking: his coffee garden consistently carries a deep, sturdy green - the color seen when soil is genuinely healthy. Yields remain stable at 2.7 tonnes of green coffee beans per hectare, while irrigation costs have fallen 20%, fertilizer use 25-30%, and pesticide use has been reduced to a minimum. Hoan explains: "When soil is cared for properly, it responds with stability. I do not have to worry every time fertilizer prices rise or fall."

Lesson: the stability of healthy soil is not only about productivity; it also acts as an economic "buffer," reducing exposure to fluctuations in input prices.

An important point emerges here: once soil becomes the "primary indicator" guiding farming decisions, market signals such as fertilizer prices no longer completely determine producer behavior. In other words, restoring soil helps rebalance the signal system at household level.

Many farmers in Lang Biang commune (formerly Lac Duong district), Lam Dong, have also pioneered agroforestry on sloping land. Intercropping coffee with black cassia and native trees has helped reduce chemical fertilizer use by 30-40%, improve moisture retention and markedly reduce erosion.

These practices show that Indigenous knowledge, when reactivated and combined with field observation, can serve as an alternative source of signals to commercially driven technical recommendations.

6.3. Cooperatives committed to sustainable pepper in Dak Nong

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The added value from sustainability certification not only offsets transition costs, but can also generate substantially higher returns.

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In Village 6, Nhan Co commune, formerly Dak R'láp district, Dak Nong province, Dang Tan Huynh - Chair of the Board of Dong Thuan Organic Pepper Cooperative - and its members have persisted with organic production since 2016. They accepted that in the early years their pepper gardens would not have the lush appearance associated with "chemical therapy," in exchange for long-term sustainability.

Today, the cooperative has 30 members and more than 80 hectares certified to U.S. organic standards. Each year it exports about 80 tonnes to demanding markets at prices 20-40% above the conventional market.

Lesson: the added value from sustainability certification not only offsets transition costs, but can also generate substantially higher returns.



What matters here is not only organic technique, but the role of collective organization. The cooperative has become a mechanism for "amplifying new signals" from the market, translating sustainability requirements into concrete economic benefits that can be shared among members.

Another example is Hoang Nguyen Agricultural Cooperative in Thuan Ha commune, formerly Dak Song district. Faced with widespread pepper mortality caused by chemical overuse, the cooperative stepped in to guide farmers through conversion.

This shows that intermediary organizations - when they function effectively - can serve as bridges, translating fragmented signals from markets and knowledge systems into concrete action at household level.

6.4. A pioneering enterprise in high-tech agriculture

High technology delivers its full value only when paired with a new way of thinking about soil and the production ecosystem.

The story of Tran Huy Duong, Director of Langbiang Farm in Da Lat, is also inspiring. He persistently learned technologies from the Netherlands, Israel and Japan and built a modern production system.

A key difference is that he adopted IoT technology early to remotely control the production environment.

Here, technology is not merely a tool for raising yields; it makes farming decisions measurable. When water, nutrients and environmental conditions are precisely controlled, mismatches between inputs and system condition are reduced.

Lesson: high technology delivers its full value only when accompanied by a new way of thinking about soil and the production ecosystem.



Photo 13: Coffee processing facility in the Central Highlands. Source: Luong Kim Anh



6.5. From isolated practices to transition models - and the costs involved

At first glance, the stories above may look like isolated efforts. But viewed together, a common pattern begins to emerge.

Transitions rarely begin with ecological ideals. They begin when a "tolerance threshold" is crossed: costs rise, effectiveness declines and risks increase. When old practices stop producing the same results, producers are forced to try alternatives - cautiously at first, and then gradually as a new way of farming takes shape.

Although these practices differ in form, they converge around common principles: reducing dependence on external inputs, rebuilding organic matter, maintaining cover and diversifying farming systems. In other words, they represent a shift from "feeding the crop" to "feeding the soil."

It is important, however, to recognize that this process is far from easy.

In the early stages, yields may fluctuate and costs may rise because of additional labor or changes in practice, while benefits are not yet clear. In many cases, several years are needed before soil improvements become stable. Social pressure, long-established farming habits and the need to secure immediate income mean that many producers are unable to stay the course.

Even successful models depend heavily on local conditions: soil type, climate, household resources and access to information and technical support. No single approach can therefore be applied immediately everywhere.

These difficulties reveal an important point: practices that benefit soil do not automatically become common choices, even when their long-term benefits are clear.

From this perspective, the significance of the pioneers lies not only in their results, but in demonstrating a feasible pathway in which soil restoration and production efficiency are not opposites, but can coexist.

The question is therefore no longer whether change is possible, but how these practices can move beyond the efforts of individual pioneers and become supported and expanded throughout the system.



6.6. What the pioneers have in common

These pioneers share one thing: their change begins with a change in mindset. At the same time, they often have more favorable conditions - access to capital, information or support networks.

This reveals an important reality: soil-friendly practices have not become common choices not because they are ineffective, but because not everyone has the conditions needed to pursue them.

The challenge, therefore, is not merely to replicate models, but to make these choices feasible for the majority.

Conclusion: when the problem is not the practice itself, but how the system shapes choices

Observations from these cases show that changes in farming do not occur as isolated technical choices; they are linked to how the entire system operates.

When economically "rational" decisions lead to soil degradation, the problem is no longer a lack of technique, but the way signals are shaping production behavior.

The key question is therefore not "what additional solution is needed?" but: what must change in the system so that sound practices can be sustained and spread?

This is the starting point for Chapter VII.



Photo 14: Coffee tree in the Central Highlands. Source: Lương Kim Anh



CHAPTER VII

SOIL RESTORATION AS A SYSTEMIC CHALLENGE

RESTRUCTURING THE PRODUCTION SYSTEM

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Instead of only "feeding the crop," farming is reorganized to "feed the soil" - by returning organic matter, maintaining cover, diversifying and reducing disturbance.

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If Chapter VI showed that change has already begun in practice, Chapter VII asks how those changes can move beyond a small number of cases and become a broader trend. Doing so requires looking beyond individual models.

The answer is not simply to replicate a few successful models, but to redesign the conditions that shape how people farm. In this approach, soil restoration is not merely a technical goal, but a long-term strategy requiring participation from multiple actors.

From this perspective, the chapter is organized in three layers: first, a strategic framework built around four pillars; second, implementation mechanisms through the roles of different actors; and finally, practical suggestions drawn from experience.

Transition framework: from extraction to regeneration

Soil degradation is not the result of one technical error. It emerges from multiple factors acting together within a particular system of organization. When that system causes economically "rational" decisions to produce harmful effects on soil, the problem no longer lies in individual techniques, but in how the system itself operates.

Soil restoration therefore cannot stop at localized adjustments. A structural shift is needed: from an extractive model to a regenerative one.

In an extractive model, yields are sustained mainly through external inputs. Soil is gradually no longer seen as a living system, but simply as a place to grow crops - a medium where natural biological functions are replaced by fertilizers, pesticides and irrigation. As internal cycles are disrupted, the system becomes increasingly input-dependent while the soil's capacity for self-recovery declines.

By contrast, emerging practices in some areas begin with the soil. Instead of only "feeding the crop," farming is reorganized to "feed the soil" - by returning organic matter, maintaining cover, diversifying and reducing disturbance. As fundamental soil functions recover, yields become less completely dependent on external inputs and increasingly supported by the soil system's own capacity.

At this level, soil restoration is no longer a single intervention, but a principle for reorganizing the entire production system.

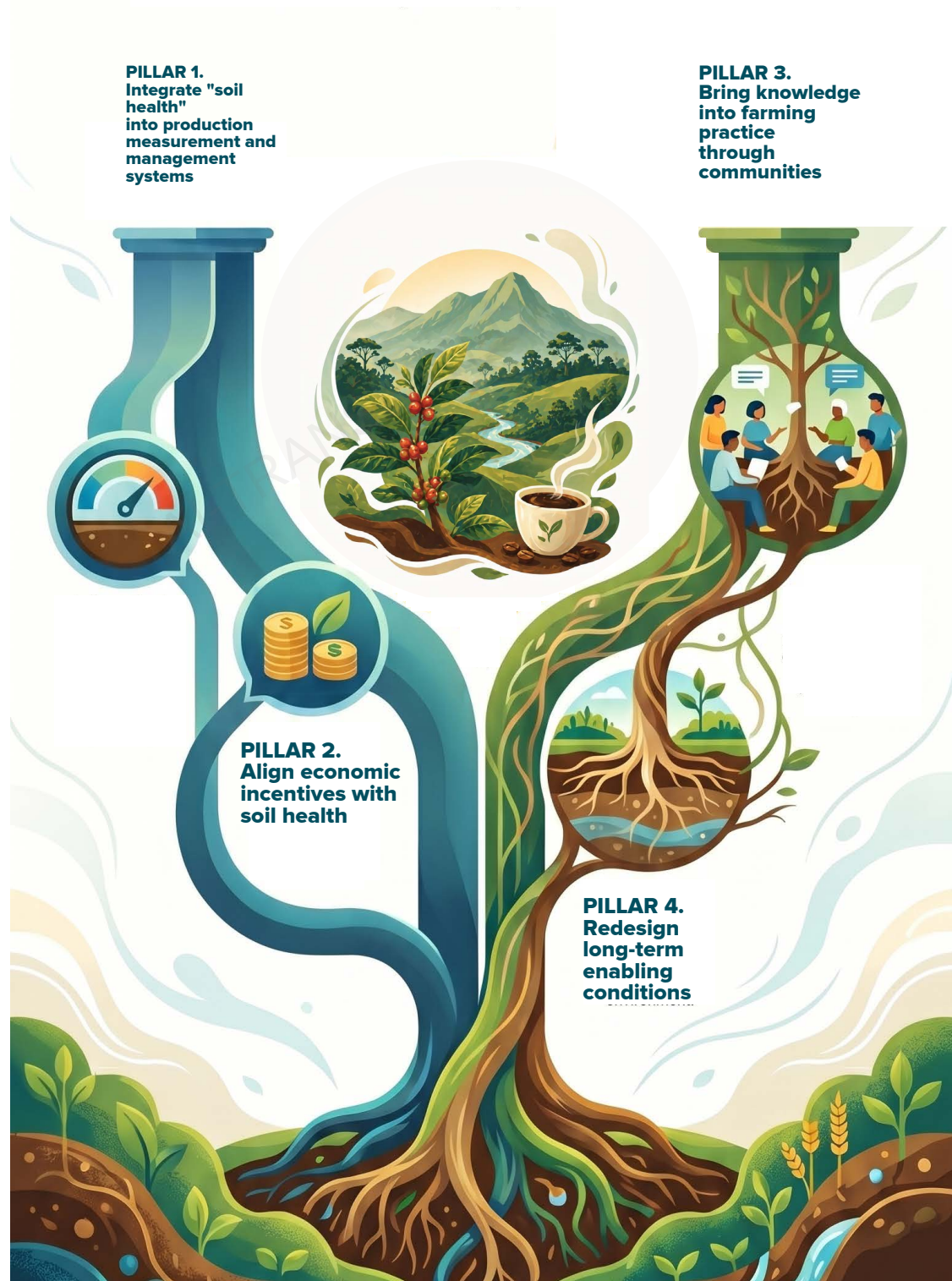


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In other words, this is not only a technical change, but a change in how the system generates productivity: from dependence on external inputs toward reliance on the soil's own capacity for recovery.

1. Four pillars of the transition strategy

In this context, the solutions do not attempt to cover everything that "could be done." Instead, they focus on intervention points with the potential to create wider change while remaining feasible under the practical conditions of the Central Highlands.



**Pillar 1. Integrate "soil health" into production measurement and management systems**

One of the underlying causes of soil degradation is that the factors determining long-term soil quality are not included in production assessment systems. If they are not measured, they cannot become a basis for management and decision-making.

The starting point, therefore, is not to change techniques but to change how soil is viewed and monitored. Soil health should be incorporated as an official indicator alongside yield and output. This need not require complex systems; it can begin with a minimum set of indicators - such as organic matter, pH, ground cover and infiltration capacity - monitored periodically at household or farmer-group level.

As information accumulates over multiple seasons, changes that were previously difficult to detect become clearer. At organizational level, cooperatives, extension systems and businesses can coordinate monitoring and create a "soil profile" for each plot. Maintained over time, these data can support not only management but also credit, insurance and market standards.

Pillar 2. Align economic incentives with soil health

Farming decisions are not based on knowledge alone; they are shaped primarily by economic incentives. When markets and finance do not fully reflect soil condition, production choices tend to favor short-term benefits.

Soil restoration therefore needs to be accompanied by changes in incentives. One important direction is to connect market requirements with farming conditions from the outset - through contracts, production criteria and value-chain linkages. When these requirements are clear and stable, they can create signals strong enough to redirect production practices.

If soil health is absent from pricing systems, every restoration effort - however technically sound - will remain at a disadvantage.

From this perspective, redesigning price, credit and market mechanisms becomes an inseparable part of soil restoration. Mechanisms are also needed to recognize the value of practices that improve and maintain soil quality - through prices, contracts or transition support. Financial tools should likewise match the time needed for soil recovery, including medium- and long-term credit, green finance and risk-sharing mechanisms.

A further point deserves clearer recognition: many current policy mechanisms and commodity-development strategies still focus mainly on output and export value. Sustainability is receiving more attention, but discussions still concentrate largely on factors that are easy to observe or trace.

Meanwhile, soil - the foundation of long-term production capacity - has yet to appear clearly in how product quality and sustainability are assessed.



This creates an important requirement: soil condition - in other words, "soil health" - should gradually become part of the definition of product quality and of related policy mechanisms.

When soil is recognized as part of product value, market and policy signals can more fully reflect the costs and benefits of different farming choices.

Pillar 3. Bring knowledge into farming practice through communities

The problem is not a lack of knowledge, but that knowledge has not yet entered practice in a stable and sustained way.

In many cases, producers "know" what should be done but cannot easily "follow through" because of risk and uncertainty during transition. The approach therefore needs to shift from "technical instruction" to "accompaniment throughout the process."

Community-based learning models - farmer groups, demonstration plots and lead farmers - allow knowledge to be tested, adjusted and verified under real conditions. When farmers see results on land similar to their own, knowledge becomes more credible and more likely to be sustained.

Pillar 4. Redesign long-term enabling conditions

Changes at household level can be sustained only when the underlying conditions allow them to be.

Land-use rights and access to capital are especially important. Improvements in soil take time, but when tenure is insecure or finance operates only on short cycles, decisions naturally favor immediate benefits.

Strong coordination mechanisms are also needed to connect the different parts of the system - from data and extension to markets and policy - into a coherent chain of operation.



Photo 15. Intercropped coffee garden in the Central Highlands. Source: Luong Kim Anh



Where to begin? A practical starting pathway for producers

Soil restoration is a long-term process. The most important question is not "what is the correct thing to do?" but "where can I begin in a way that can be sustained?"

In practice, very few people can change an entire farming system in a short period. The starting point therefore lies not in large solutions, but in small steps that can be taken immediately and whose results can be observed.

A practical approach is to begin with three steps.

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Look again at your own soil

Producers do not need complex tools to identify soil condition. Signs such as whether soil dries quickly or holds moisture, compacts easily or remains loose, and has many earthworms or few soil organisms are enough to indicate trends. When these observations are recorded over successive seasons, they become a simple but valuable "soil diary."

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Choose one or two of the most suitable changes to begin with

This may mean keeping ground cover instead of leaving soil bare; composting and returning residues such as coffee husks and pruned branches; or reducing fertilizer where excessive amounts have been used. The changes do not need to be large, but they should be clear enough for producers to...

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Maintain and adjust

Soil restoration does not produce immediate results. Early changes may be difficult to see and can even feel less effective for a time. But when they are maintained and adjusted based on actual observation, cumulative improvements gradually emerge.

The important point is that producers do not need to do everything at once. They only need to start at an appropriate point and allow change to unfold step by step.

With this approach, soil restoration is no longer a distant goal, but a process that can begin on the land farmers already know.



2. From strategy to action: the roles of different actors

If the pillars above answer the question "what needs to change?", this section answers "who will do it, and how?"



Farmers can begin with small but well-directed changes. Practices such as maintaining ground cover, returning organic matter, adjusting fertilizer use and managing water are not new, but they are practical starting points. The key is not to do many things at once, but to begin correctly and maintain the practice consistently.



Government agencies create the enabling conditions for sound practices to persist. This includes integrating soil health into official measurement systems, ensuring stability of land-use rights and establishing coordination mechanisms among different parts of the system.



Businesses are where market signals are formed. Through purchasing criteria, contracts and pricing mechanisms, companies can encourage soil-friendly practices - such as maintaining cover and returning organic matter - while sharing part of the transition cost.



Intermediary organizations such as cooperatives and extension services act as "converters": bringing knowledge into practice, organizing implementation and accompanying producers throughout the transition.



Scientists have a role in making knowledge understandable, applicable and appropriate to specific conditions.



Financial resources need to be designed so that the "time horizon of capital" does not conflict with the "time horizon of soil." Only then do long-term choices become feasible.



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3. Conclusion: when the system changes, behavior changes

Soil restoration is not about adding one more technique to production; it is about reconsidering how the entire system operates.

What is happening to soil does not result from a single mistake, but from many choices that are reasonable at the time. Change therefore does not begin with one solution, but with adjusting the conditions that shape those choices.

When production practices, market operation and knowledge transfer no longer work against soil, changes at household level will no longer remain isolated experiments; they can be sustained and spread.

At this level, soil restoration is no longer a separate objective, but a principle for reorganizing agricultural production toward greater sustainability.

When soil is properly understood as a living system, every farming decision changes - not only to harvest this season, but also to preserve the soil's capacity to live and produce in the seasons ahead.



Photo 16: Farmers harvesting coffee in the Central Highlands. Source: Luong Kim Anh

IN PLACE OF A CONCLUSION

The soils of the Central Highlands did not become depleted overnight - and they cannot be revived by a single decision. Some things can only be understood after living with them for long enough. For me, Central Highlands soil is one of those things. The journey from vibrant multi-layered forests, through abundant golden harvests, to today's increasingly visible signs of degradation is the result of processes accumulated over decades. It is not only a story of nature, but also a reflection of how people have organized production, operated markets and made development choices.

Among areas facing ever greater extraction pressure, other practices still exist - where farmers begin with very small steps: returning residues to the soil, maintaining vegetation cover and gradually reducing dependence on chemicals. At first these choices may be individual experiments, but they point toward a different pathway: soil can recover when it is treated as a living ecosystem rather than merely as a production platform.

More importantly, change does not occur in a vacuum. When connections exist - among farmers, and between farmers, cooperatives, businesses and sources of knowledge - good practices can be strengthened and scaled. Without those enabling conditions, each attempt at change can become a major risk that farmers must bear alone.

In the sacred language of many generations, soil has always been regarded as "Mother Earth" - not merely as a metaphor, but as recognition that all life begins from and depends upon it. Restoring soil is therefore not only a technical or economic choice, but a fundamental investment in the future - one in which people are not separate from, but part of, the ecosystem on which they depend. When soil is healthy, the foundations of sustainable development can be rebuilt, and the highlands can continue sustaining people through their own internal vitality.



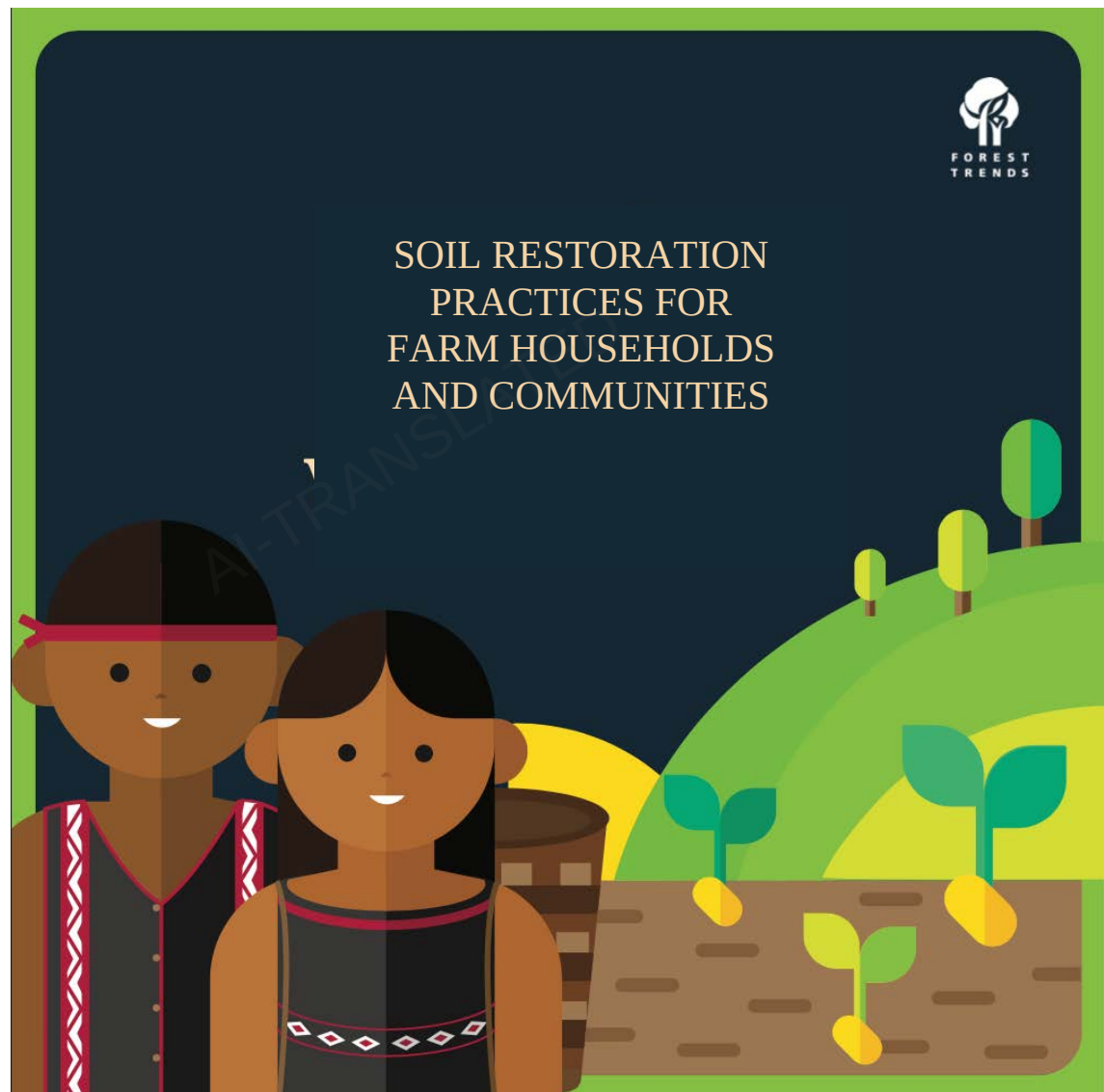


APPENDIX

HANDBOOK: "SOIL RESTORATION PRACTICES FOR FARM HOUSEHOLDS AND COMMUNITIES"

This appendix draws on observations from actual production to suggest several simple practices that farmers can use to begin restoring and caring for their soil.

For details, please see the [LINK](#)





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