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Paper 4:
Investing in African Soil

ACIF White Paper 2024

Highlights

Soil degrades more quickly in tropical climates, with Africa losing an estimated 50 million hectares a year to land degradation, accelerated by climate change

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A wide array of methods are being pursued to improve soils, but with different aims. Of those designed to lift food yields, we have selected the seven with the highest impact

All involve behaviour change by farmers, which is a challenging area to for sustainable businesses, but possible where there is a strong focus on audience reach

Five of our seven selected areas also involve technologies and products, making biochar, compost and organic fertilisers, soil diagnostics, synthetic fertilisers and VACS crop ecosystems the top soil investment contenders

Each lifts yields in the range of 20 percent to more than 50 percent, restore soils and prevent land being lost, however, synthetic fertilisers struggle to deliver net financial benefits

Where the input costs and market linkage are in place, these areas can deliver significant progress in securing SDGs 1 and 2, making them a top target for impact investors

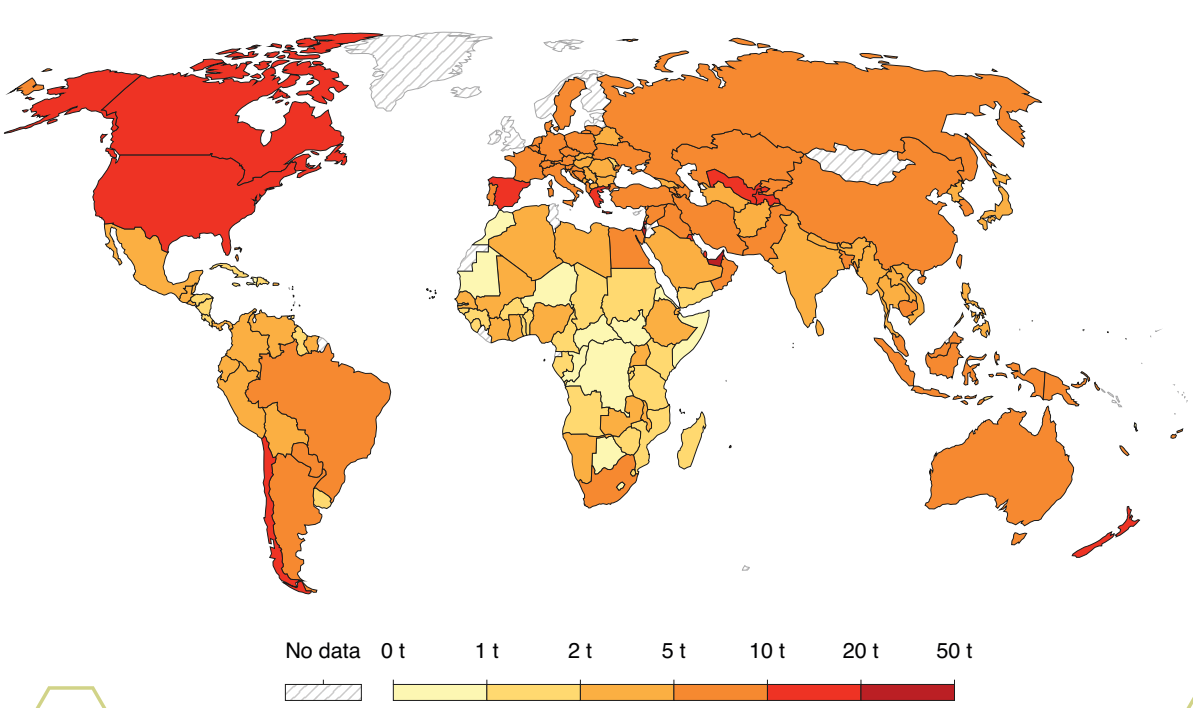
The soil opportunity

Soil is the swing factor in achieving the SDG goals of zero hunger and an end to poverty in Africa. Nutrients in tropical soils degrade more quickly than nutrients in non-tropical soils, in a differential that is widening as a result of climate change. Increased temperatures and more erratic rainfall, arriving as more frequent deluges and longer and more regular droughts, accelerate crusting, leeching, and erosion.

Yet over 70 percent of African families are supported through agriculture, and depleted soils reduce yields to a fraction of their potential. That is seeing the world's peak producers achieve yields of over 20 tonnes per hectare for maize, while Africa delivers an average of 1 to 2 tonnes, as shown in Figure 1.

Better soils typically lift this to more than 5 tonnes per hectare in tropical zones.

Figure 1: Global maize yields, 2023, tonnes per hectare



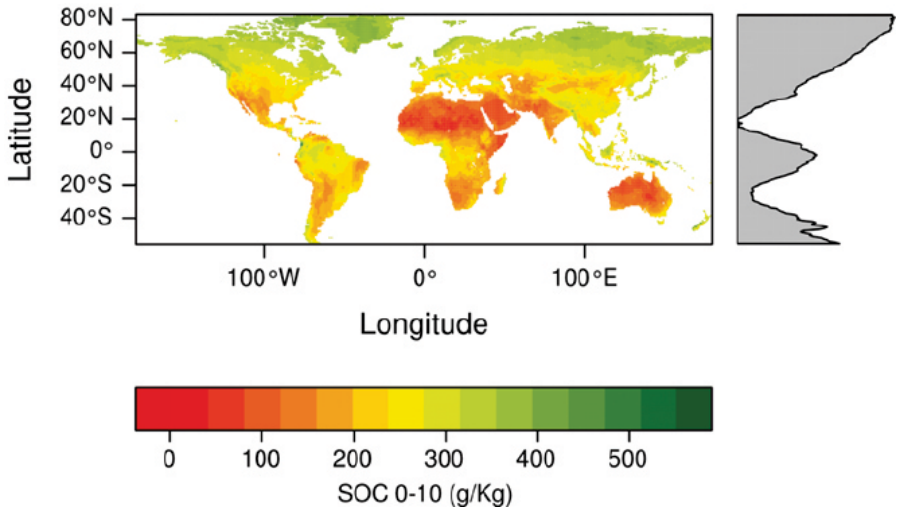
This has focussed attention on ways of changing soil management and adopting methods and technologies that regenerate soils and land. This aim has also been driven by the need to reduce carbon emissions. The carbon held by the soil is greater than the carbon in the atmosphere and in living organisms. It is sequestered in soils both as organic carbon, most often as roots and decaying plant matter, and as carbonates, or mineral carbon deposits.

However, the organic carbon from plants is broken down by microbes, creating carbonate minerals, but also releasing carbon dioxide back out into the air. The volume of these soil carbon emissions is far greater than the CO_2 generated by humankind in its agricultural and industrial activities. This has driven a heated, and so far inconclusive, debate over whether the planet's rising temperatures are increasing the rate of soil organic carbon degradation and its release of Co_2.

But soil carbon is also critical to soil structure and essential to supporting plant growth, which, of itself, captures carbon into growing matter. The carbon prevents soils from forming solid blocks, degrading and eroding, and allows rain and air to be absorbed, plant roots to grow easily, and mobile nutrients, such as nitrates, to reach roots. It also adds minerals, and increases microbial activity in soils. Estimates suggest that increasing soil organic carbon can increase crop yields globally by 10 percent to 37 percent in key staple foods.

However, the degree of gain is driven by the opening degree of shortfall. African soil is amongst the most carbon depleted in the world, with the estimated organic carbon levels in the top 10 centimetres of soil shown, in Figure 2.

Figure 2: Soil organic carbon in top 10 cms, global estimates

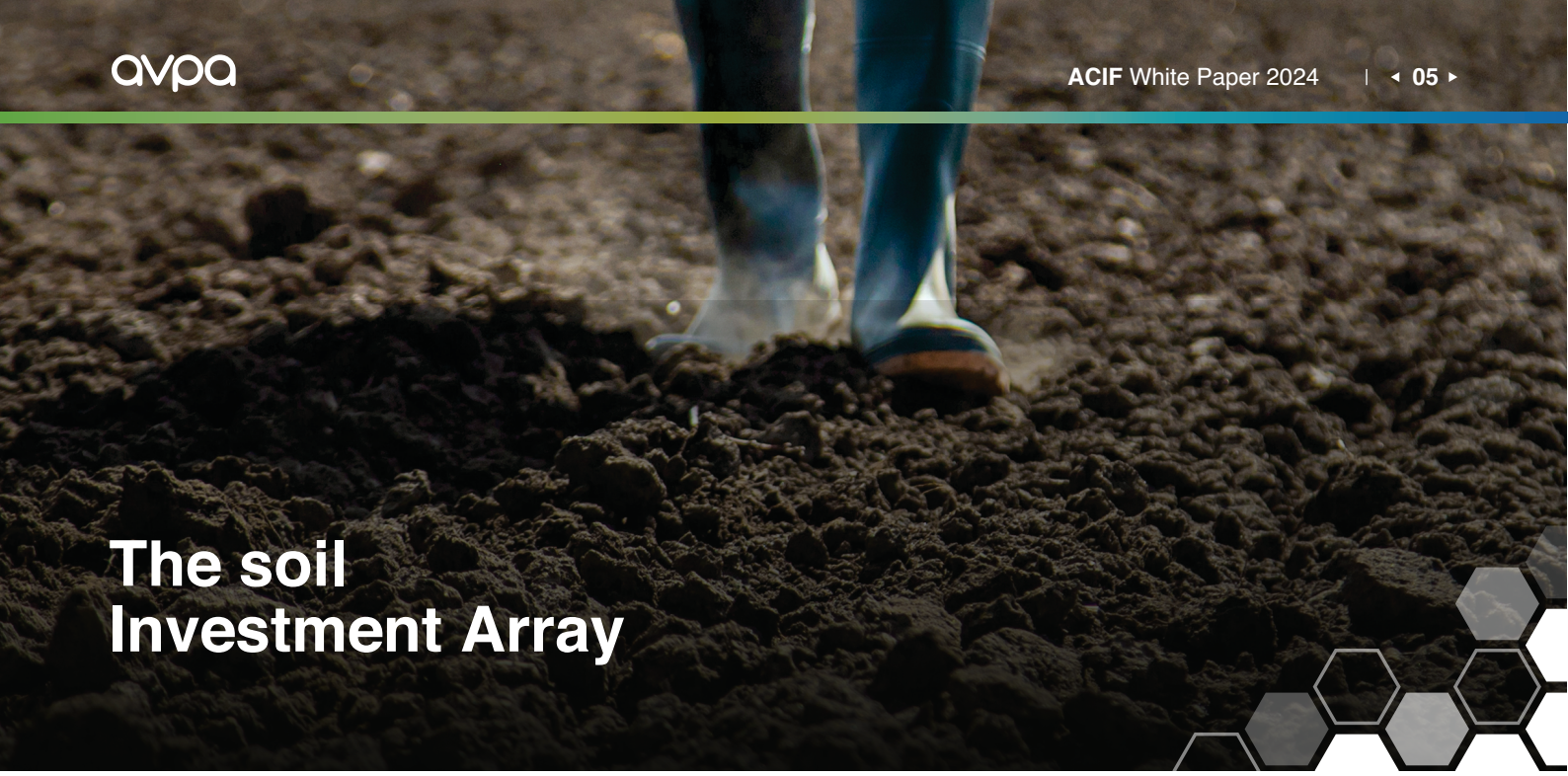


Thus, Africa's low soil carbon levels have been a key factor in its accelerated land degradation and desertification, reducing its agricultural yields and food production, driving food insecurity and poverty, reducing plant cover, and thus local rainfall, and creating drier soils that have made the impact of droughts swifter and more severe.

As a result, by 2020, an estimated 46 percent of Africa's land was degraded, and more than half of the continent's land is expected to be unusable before 2050.

Human activities, notably as deforestation, poor agricultural practices, the conversion of grasslands to croplands, and over-grazing, have been widely cited as drivers in this. However, a series of recent studies point to Africa's soil carbon requiring greater maintenance than is needed elsewhere.

Thus, with the world's fastest growing population, and fastest declining food-generation resources, Africa's needs to achieve soil regeneration and intensified food production have become acute.



The soil Investment Array

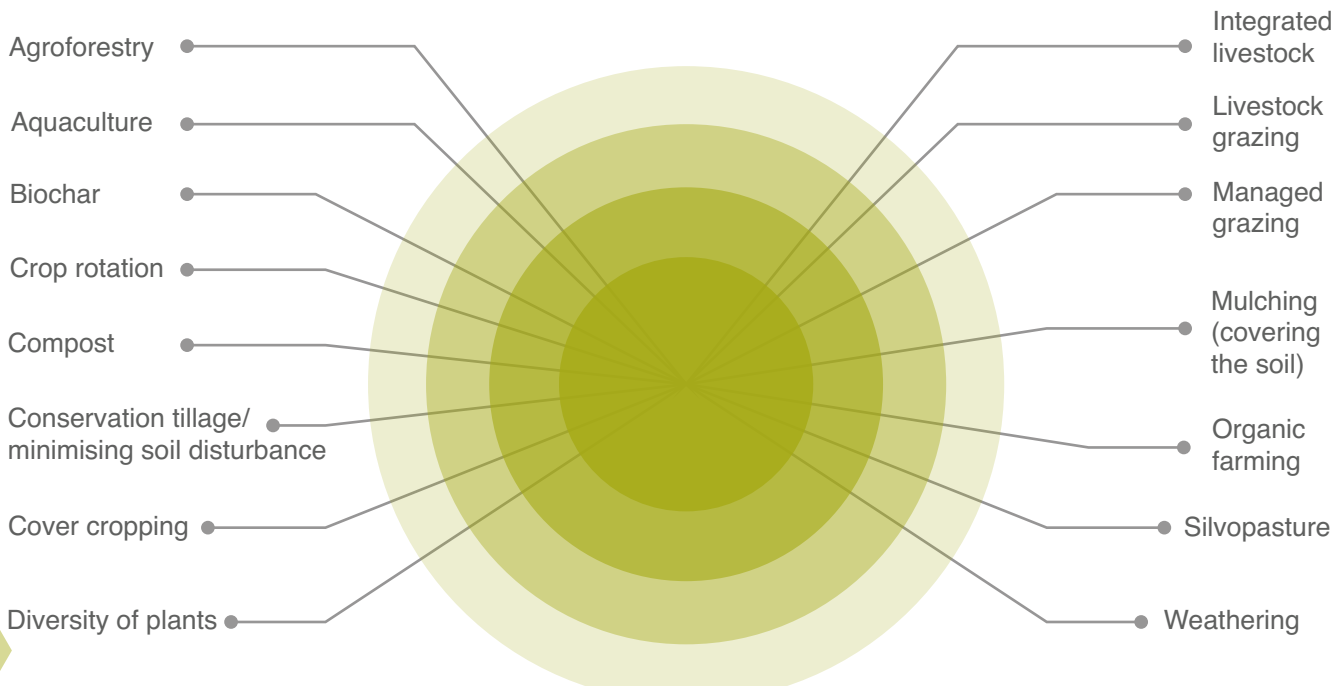
Soil regeneration is a leading area of investment within climate adaptation, but its growth and scope have been limited by four critical factors:

- Its focus has been diffused within sustainable farming driven by mixed aims,
- It suffers from the normal issue in agriculture of complexity and the depth of expert knowledge required,
- It has not benefited from impact prioritisation around adaptation aims, and
- Many of the techniques encompassed rest solely on farmer behaviour change and do not open normal investment pathways.

On this basis, ACIF has sought to identify the soil regeneration methods that have the highest impact on yields and income - and thus African resilience to climate change - and examine the investment opportunities that these raise.

Based on PitchBook data, Boston Consulting Group identified sustainable farming, which is primarily focussed on soil regeneration, as the second largest area of adaptation investment globally, behind precision farming. However, this scope is splayed across multiple activities, including those shown in Figure 3, below.

Figure 3: Scope of soil regeneration activities



Not all of these methods are driven by the aim of raising yields and food output. Some are more focused on reducing synthetic pest control, increasing carbon creation, or reducing water use.

This can raise challenging issues in balancing across these different outcomes.

Agricultural outcomes can also conflict. For instance, agroforestry has been found to reduce temperatures in the surrounding area and limit some pest infestations, but it has also been found to reduce yields by depleting root-level water availability and sunlight through canopy cover.

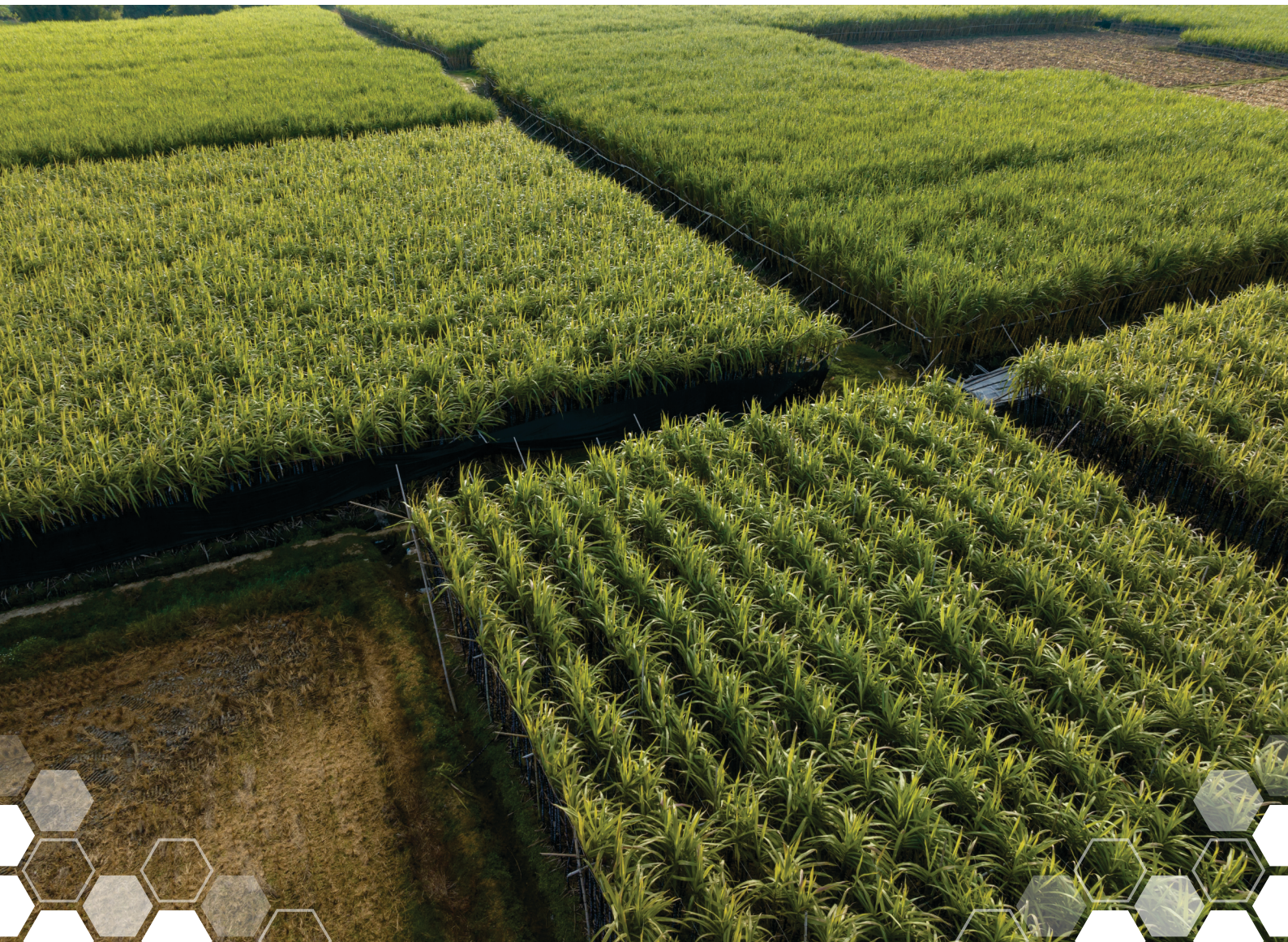
On this basis, we have set out to identify the most productive interventions based on three criteria:

01 They have the highest impact on yields, and thus food security and incomes, in tropical and African climatic zones

02 They have the highest impact in generating additional plant cover, most especially on degraded lands, thus creating new eco-systems that increase rainfall and increase soil water retention, enhancing drought resilience

03 They have a net positive impact on the carbon cycle, reducing carbon creation, and on water use, reducing water needs in food production.

We then explore the most productive soil regeneration activities for their split between behaviour change, technology opportunities, and business opportunities.



Low-impact interventions

A series of interventions listed in Figure 4, above, do not fulfil our three criteria. Of these, the first exclusions are on the basis of their mixed impact on yields.

As mentioned above, agroforestry can have a negative impact on soils. It has many merits in carbon sequestration from the atmosphere into the forestry, can generate food through tree crops, reduce ambient temperatures, and, in specific circumstances, enhance yields. However, in a review of 145 studies on tropical and subtropical agroforestry and crop combinations, 19 had a positive impact on yields, 29 were neutral, and 113 had a negative impact.

Organic farming, similarly, presents mixed impacts, with occasional sharp yield gains, but predominantly zero to negative yield impacts. A set of five studies across Kenya and Ghana reported that in four of them "most yields and gross margins under organic management remained at similar levels as the conventional values", although one achieved sharp yield improvements. Global reviews (meta-analyses) have shown organic agriculture reduces yields by 18 percent to 40 percent, with the negative yield impact greatest in warmer climates.

We further excluded low-impact interventions. These typically achieve yield gains of zero to 10 percent.

Silvopasture, planting trees in grazing areas, has strong carbon sequestration benefits, and has been found to deliver cooling, but there is little evidence of enhanced yields or enhanced tropical yields. In temperate zones, silvopasture has been found to increase the volume of some types of forage grown under trees, but studies of livestock have found no change in their weights or growth.

Mulching is a popular option within sustainable agriculture, covering land with organic, or even inorganic, matter to prevent moisture loss and limit weed competition. However, the yield impact is relatively minor. Mulching delivers more for low-fertility tropical soils than medium or high, but only delivers significant gains when combined with fertiliser, where these gains could equally be ascribed to the fertiliser alone.

Plant diversity/ **polyculture** offers some yield gains versus monoculture, with reduced pest intensity cited as a main driver. However, in an agricultural environment where smallholders produce 90 percent of the continent's food typically in polyculture production, with wide crop diversity and mixed cropping, the leverage to gain yields by promoting polyculture is inherently limited within African food systems. The same limitations apply to **integrated livestock.**

Conservation tillage has been heavily promoted in Africa, but there is no consistent evidence of yield gains, with conventional tillage delivering a range of, sometimes critical, yield benefits. Combining minimal soil disturbance with retained crop residues does reduce CO_2 emissions, as well as maintaining soil organic carbon making it an investment for carbon mitigation rather than a priority adaptation investment. It also increases nitrous oxide emissions, Overall, it is not a primary adaptation tool.

Other soil regeneration methods, such as **managed grazing,** can take the pressure off soils and lead to a degree of regeneration, but their aim in preventing the damage caused by overgrazing is to contain agricultural production at the maximum levels the soil can ably support. They do not, per se, improve the soils in a way that increases the human food output, but represent a way to limit it in order to prevent further declines ahead.

Finally, enhanced **weathering** has been pursued primarily to sequester carbon, accelerating the natural weathering of rock by adding crushed basalt to soils. This reduces carbon emissions and increases soil organic carbon. It offers a speedy improvement to soil pH, but appears to provide a lesser yield boost in Africa than in temperate climates. At higher applications it can, conversely, reduce yields, putting it outside our list of top soil investments for restoring food systems through soil interventions.

Figure 4: Demonstrated short-term crop yield increases with various weathering materials

Crop	Reference	Material	Result
Soy	Haque *et al.,* 2020b	Wallastonite	Improve yield up to 5 wt% amendment, with reduced yield at higher application/continued application
Alfalfa	Haque *et al.,* 2020b	Wallastonite	Improve yield up to 10 wt%, with reduced yield at higher application/continued application
Bean	Haque *et al.,* 2019b	Wallastonite	Improve biomass at 12.5 wt% amendment (did not reach maturity, bean yield not reported
Corn	Haque *et al.,* 2019b	Wallastonite	Improve biomass at 12.5 wt% amendment (did not reach maturity, grain yield not reported
Sorghum	Kelland *et al.,* 2020	Basalt	Increased yield at 40 ton/acre application
Sorghum	Das *et al.,* 2020	Slag	Increased yield at 2 ton/hectare application

Priority Soil Investments

We have identified seven areas of soil-related businesses with a high food system and income impact, as shown in Figure 6, below.

Figure 5: The soil regeneration methods with the highest yield impacts

	Method	Yield gains
1	Biochar	25% to 100%+
2	Compost	Up to 92%
3	Crop rotation	Up to 38%
4	Soil diagnostics	29%
5	Cover crops	Average 2.6%, but over 21% if legumes used and no fertiliser added
6	Synthetic fertiliser	20% to 100%+ but costs can exceed income gains without subsidisation
7	VACS crops	Able to grow on degraded land in severe climate change, restoring soils as they grow

In commercialising businesses in these areas, entrepreneurs and investors serve an African agricultural market that is a bottom-of-the-pyramid market, where market uptake rests on a strong value proposition to farmers.

Figure 6: The African farmer market: Nigeria, Kenya, Malawi

Nigeria:

Smallholder farmers

88.4%
of all family farms

$401 per month
Income from crops:

Average
0.53
hectares

Poverty rate
73%

Larger farms

11.6%
of all family farms

$331 per month
Income from crops:

Average
3.14
hectares

Poverty rate
80%

Kenya:

Smallholder farmers

80.9%
of all family farms

$101 per month
Income from crops:

Average
0.53
hectares

Poverty rate
49%

Larger farms

19.1%
of all family farms

$157 per month
Income from crops:

Average
2.25
hectares

Poverty rate
46%

Malawi:

Smallholder farmers

74.6%
of all family farms

$81 per month
Income from crops:

Average
0.5
hectares

Poverty rate
59%

Larger farms

25.4%
of all family farms

$119 per month
Income from crops:

Average
1.4
hectares

Poverty rate
47%

All soil interventions rest on farmer behaviour change, but some require only behaviour change, such as crop rotation and cover crops. In these areas, the scope for private sector engagement is confined to advisory and information services, meaning businesses must earn from the advisories themselves, or through other services derived from their farmer interface.

In Ghana, Agrocenta set out to fund free extension advice through commissions on selling financial services. However, this pitted it against competitors selling financial services as their primary business without associated agricultural advisory costs. It also depended on high-value information generating a large audience reach.

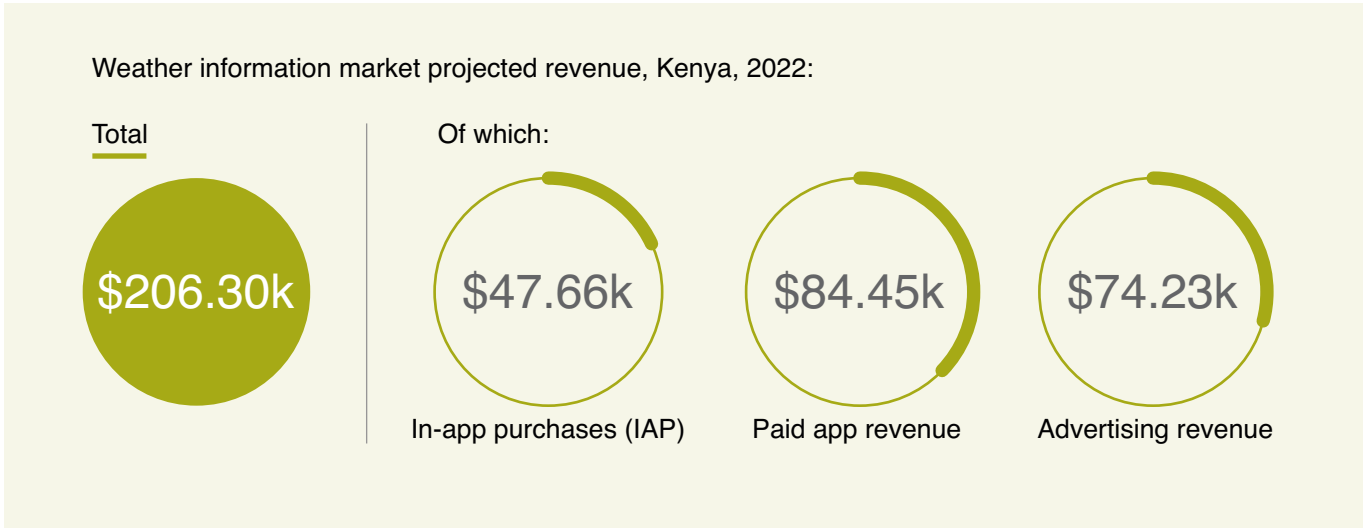
In fact, Agrocenta has since shifted its focus towards informing and implementing bespoke community projects funded by corporates or aid, in a now common shift of focus in the behaviour-change segment.

Another model has been subscription-based advisory services, such as iCow, which charges for advice to dairy farmers in Kenya, earning additional income from advertising, promoting sponsored products and services to these farmers, and providing data analytics and insights to agriculture stakeholders. Models such as this often also add input marketplaces and sales platforms to generate additional commission income, with an example being Esoko in Ghana

However, all of these elements depend on large audience uptake, and the agricultural advisory sector has struggled to achieve that. Moreover, these multifaceted businesses require a wide range of advanced specialisms and activities, generating heavy resourcing needs. They also run head-to-head with grant-sponsored organisations, such as Solidaridad and Digital Green.

The breakthrough for such businesses is a large audience, at which point sustainability becomes far simpler. An example of this is weather information, where large audience reach has been used to generate app and ad revenues, as shown in Figure 7 below. Various apps, such as Agripredict in Zambia are chasing this simpler model, but audience size remains their core challenge.

Figure 7: Kenya information service revenues - the example of weather



Greater scope for investment lies in behaviour change segments associated with technology sales, which has driven attention towards soil diagnostics. Soil tests enable farmers to grow the most productive crops and use the best fertiliser for their soil. This has a substantial impact in that even fertiliser use can reduce yields, as discussed below. Soil composition is not ubiquitous and there is no one-size-fits-all treatment to raise yields, with the same intervention delivering different yield impacts on different soils.

This has seen organisations such as Solidaridad launch its Kvuno Soil Labs, offering $5 soil tests from low-cost mobile soil testing kits, with recommendations on which crops will grow best on a smallholder's land and the best fertiliser mix for them. The grounding of these advisories in individual analysis at an affordable cost makes for a promising value proposition. However, two years after its launch, farmers remain widely unaware of this testing option and the evidence of its uptake has yet to be shared.

Other initiatives in soil testing include those by NGOs, such as the SoilCares Foundation, which has been offering free soil testing and advice to farmers since 2017, and reports 100,000 tests delivered in the last 8 years.

The pace and uptake from these philanthropic initiatives does not bode well for their commercial viability. All bottom-of-the-pyramid businesses need high volumes, on small margins. They must also, now, establish a market position alongside these philanthropic services.

However, this segment may still present investment opportunities in the development and dissemination of low-cost technologies. Some of these, such as Maryland University's SoilDoc have been developed within academia and require commercialisation and amplification to move into mainstream use. Others, such as AgroCare's soil scanner, are now market dominant, and while they carry a big price ticket for farmers at $3,600, have opened the way to low-cost service provision from organisations such as Solidaridad and Soilcares.

However, the most powerful agents in improving soil fertility, yields and incomes, are a cluster of soil additives, with two of these falling into the circular economy, by redeploying waste to rebuild soils.

In terms of its universal gain and absence of downside (there is no evidence it reduces yields if over-added), biochar is the superstar of soil regeneration. Rated, but infrequently monetised, as a pathway to carbon credits, it has the highest impact on soil carbon content of any soil intervention. Its impact on yields depends on soil types, but has been found to be greatest in tropical agriculture, with upper-range yield gains frequently reported at over 100 percent globally, and at over 150 percent in Africa.

This has generated mounting interest, with US biochar producers, distributors, value-added producers, and equipment manufacturers earning more than $600m in 2023 and forecast to achieve a five-fold increase in income by 2025. However, the obstacle is demand, with work underway in both the US and Europe to develop end-use markets, of which agriculture is only one, and, potentially, the least lucrative.

In Africa, the efficacy of biochar - used originally by the Incas to add soil fertility that lasted for centuries - offers scope for multiple businesses to make biochar from agricultural waste by slow-burning it in smokeless fires and mixing it with compost. In 2023, climate tech company Bio-Logical raised a $1m seed round to build what it billed as the largest biochar production facility in Africa, turning around 30,000 tonnes of agricultural waste a year into biochar, sequestering 25,000 tonnes of CO_2 and providing biochar to smallholders.

Farmers can also make their own biochar, but few are yet doing so.

Likewise, farmers can make their own organic fertiliser or compost, but this area is growing as an investment sector, with estimated sales in Africa of $249m in 2024 and an annual growth rate of over 7 per cent, dominated by production and use in South Africa. Leading producers in Africa, include Rizobacter, Novozymes, Symborg, International Panaacea Limited, and MBFI, but the market remains dominated by many dozens of much smaller start-ups.

Figure 8: Market concentration in organic fertiliser production in Africa

Consolidated- Market dominated by 1-5 major players

Africa Organic Fertilizers Market

Fragmented- Highly competitive market without dominant players

Studies have also found cumulative yield gains on combining biochar with synthetic fertiliser reporting yield increases of up to five-fold on their combined use.

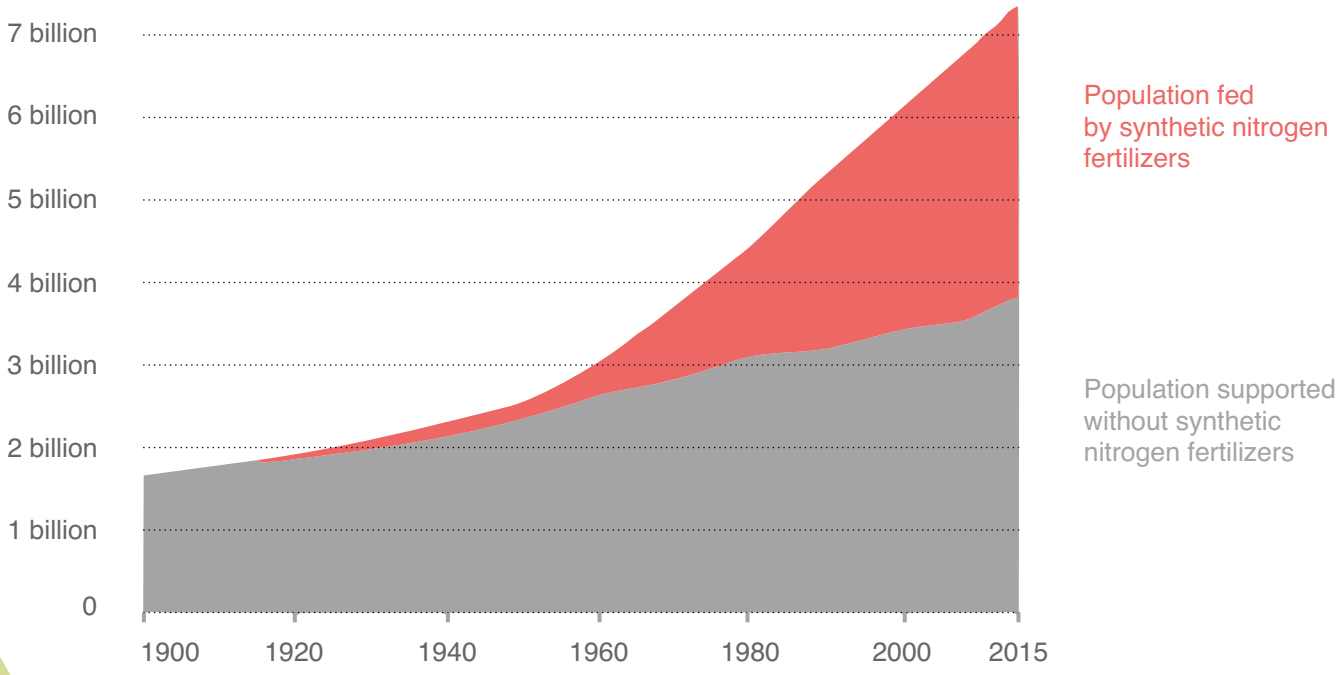
Fertiliser

Fertiliser is an anomaly in soil care. It can quickly boost yields, but leads to acidification of soils and the leaching of nutrients that then damages fertility, making it akin to the cocaine of soil: giving a quick hit, but destroying the body.

Acidification can be so severe on fertiliser use that it has generated forecasts in some parts of the world of a 24 per cent reduction in yields as a result. As well as acidifying the soil, it leads to leaching of critical nutrients, such as calcium and magnesium. The solubility of nitrogen and the degree to which it can run-off during rain into waterways, where it causes environmental damage, has also led to widespread opposition to its continued use. However, if correctly used, it increases the yields of all crops by 20 percent or more, and of vegetables, and sometimes grain crops, by over 100 percent.

Such a large difference in food output, delivered by the world's most widely used soil support, represents a compelling case for the use of synthetic fertilisers, with the African Development Bank president warning in 2024 that the fertiliser shortages being caused by the Russia-Ukraine war could reduce African food production by as much as 20 percent.

Figure 9: World population supported by synthetic nitrogen fertilizers

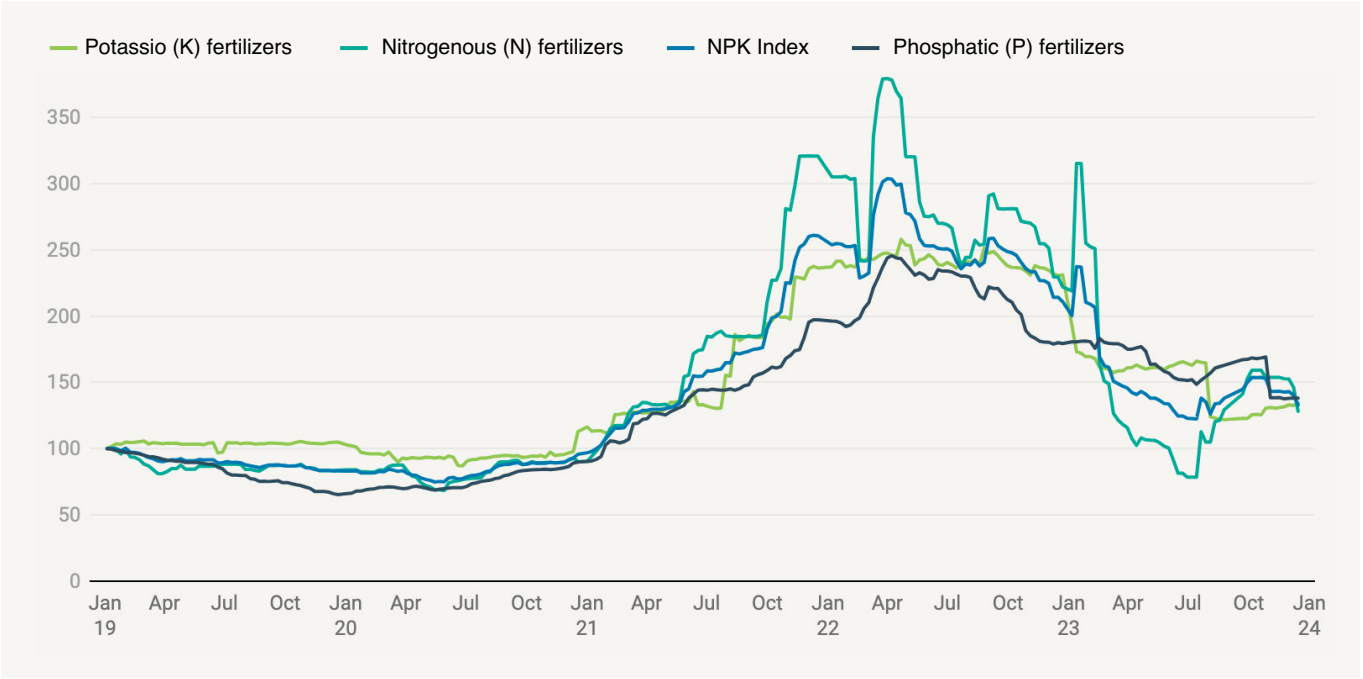


Sourse:Erisman et al., (2008); Smil (2002); Stewart (2005)

This degree of vulnerability is despite Africa's relatively low levels of fertiliser use, at around 25kg per hectare of cropland, compared to a world average of 118 kg per hectare. Greater fertiliser use could deliver large gains, with one study finding that increasing fertiliser use from 9kg to 82kg per hectare in Tanzania would reduce the country's percentage of food-insecure farming households from 28 percent to 13 percent. However, the same study also found optimum fertiliser levels in Uganda to be far lower, at 24kg per hectare.

However, as researchers map the potential for gains, fertiliser prices tripled from 2020 to the end of 2022, and while international prices have since receded, but African prices have not, with analysts citing a lack of competition as a main reason.

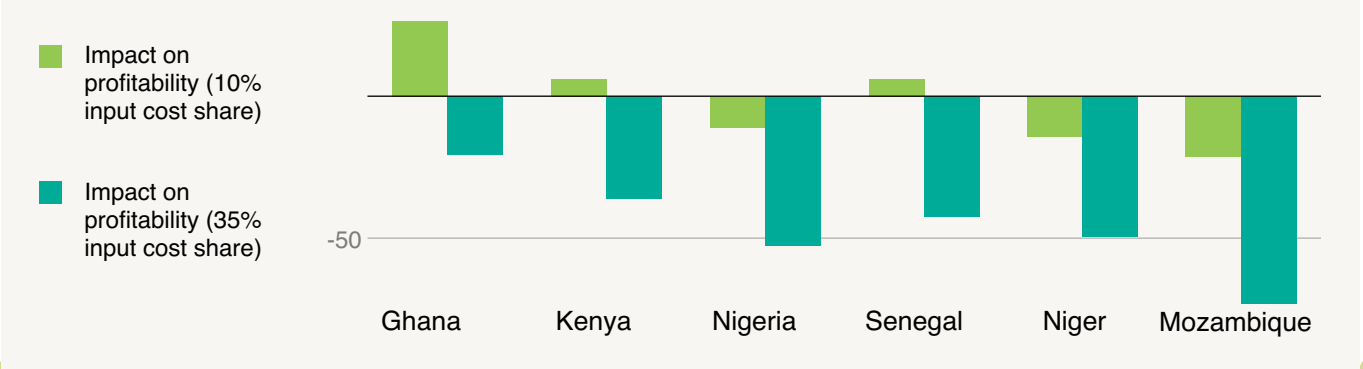
Figure 10: Trends in International fertilizer prices by nutrient



Source: Author elaboration based on Bloomberg data and Food Security Portal's Fertilizer Dashboard.

This has reduced the ratio of income gains to fertiliser costs, reducing crop profitability in Africa, and disincentivising the use of fertiliser for home-grown food crops - with farmers in Mozambique, for instance, suffering a more than 75% reduction in maize farming profitability as a result of the fertiliser price movements, as shown in Figure 11, below.

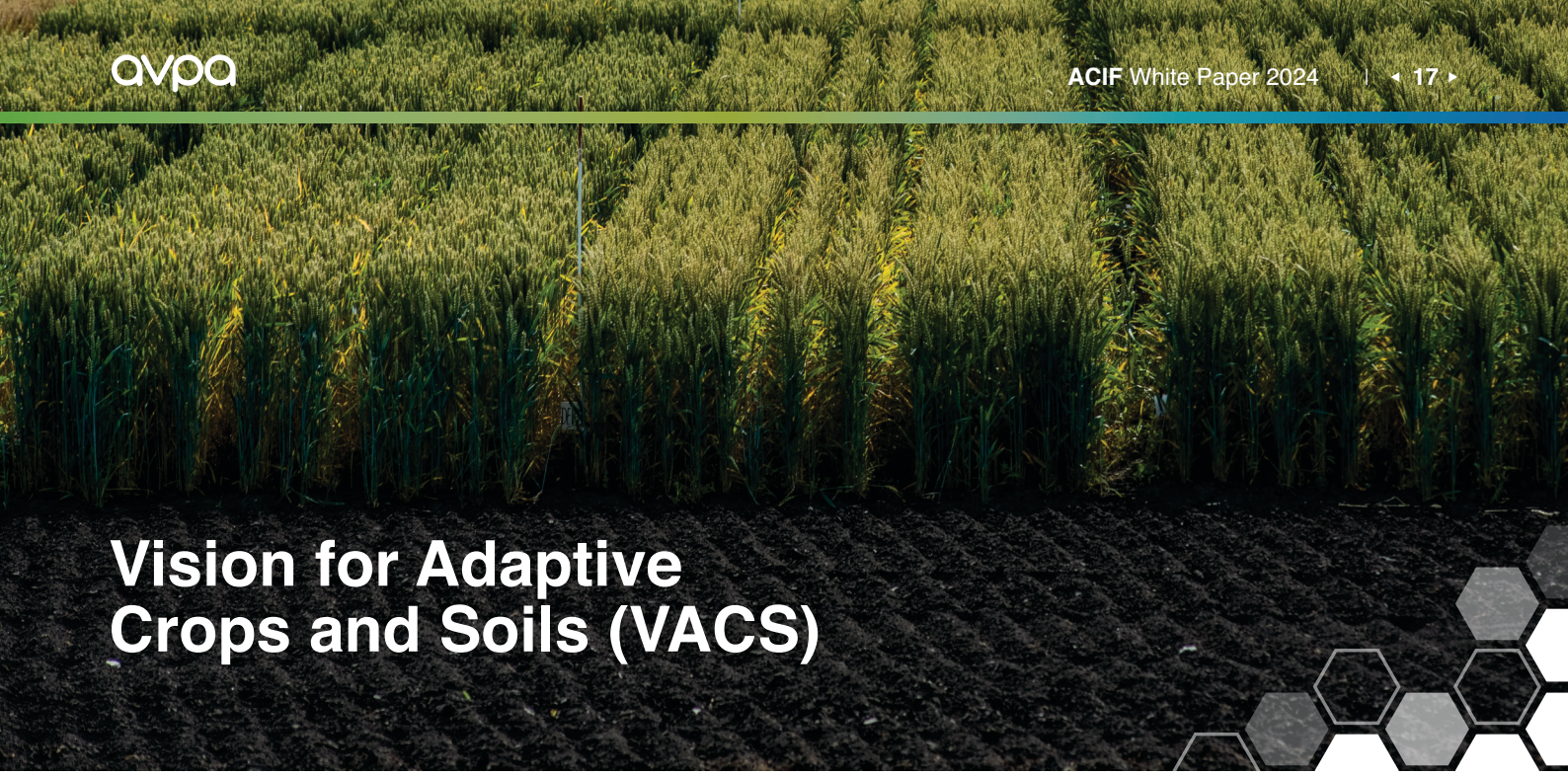
Figure 11: Simulated impact of the 2022 fertilizer price shock on profitability of maize farming in selected African countries



The African Union is seeking to reduce the continent's high fertiliser prices and import dependency by increasing local fertiliser production. Its 2006 Abuja Declaration set a target level for African fertiliser use of 50kg per hectare. In 2020, the union launched its Soil Initiative for Africa (SIA), announcing in 2024 its aim of tripling the local production in Africa of organic and inorganic fertilisers, and seeking $15bn of private sector investment.

Most of the mineral fertiliser made in Africa has been made in northern Africa, but 2022 saw the launch of the Dangote Fertilizer Plant in Nigeria, as the largest in Africa, producing 3m tonnes of fertiliser a year following a $2.5 bn investment. The IFC has also provided a €100m green loan to the OCP Group in Morocco to build four solar power plants to power its fertiliser production, while the African Development Bank's African Fertilizer Financing Mechanism (AFFM) has provided funding and commercial credit guarantees, including for the distribution of fertiliser to smallholders in Tanzania and Nigeria.

With the African fertiliser market estimated to achieve revenue of $14.6bn in 2024, it offers multiple routes to private sector investment in expanded local production, innovation and distribution. However, its current pricing levels are seeing most African nations forced to subsidise fertiliser prices in order to open access to farmers at prices that deliver net gains, with synthetic fertiliser now representing a poorer return-on-investment than circular additives such as biochar and compost.



Vision for Adaptive Crops and Soils (VACS)

In January 2023, the AU, FAO, USDoS and USAID launched the Vision for Adaptive Crops and Soils (VACS), taking a new tack in soil regeneration by promoting crops that could best withstand all aspects of climate change, while also delivering strong food yields, growing in poor soils, and improving them, thus reversing land degradation. This powerful initiative saw the UN General Assembly declare 2023 the International Year of Millet.

Overall, VACS span 60 traditional, indigenous crops, of which millet is a central pillar. Most of these, observes the FAO: “have received little to no investment in plant breeding to improve their resilience, yield, or nutritional value, and lack promotional efforts to enhance their marketability and ultimately, consumption.”

Yet, millet is typical of these crops in its ability to thrive in degraded soils, lift soil organic carbon, and use nitrogen more efficiently than other crops. It also mobilises phosphorous, increasing its availability to plantlife, and reduces soil erosion with its deep root system.

The scale of these benefits is, as yet, barely understood, with calls mounting for deeper research into the soil benefits of these crops, but their ability to thrive in poor soil conditions, as well as their high and relatively abundant nutrition, iswell documented. This is seeing VACS crop promotion gaining rapid traction across international organisations, FDIs and philanthropists, with the maize and wheat centre, CIMMYT, the most recent to commit to their promotion - as climate modelling showing ongoing falls in both maize and wheat yields in Africa as a result of climate change, as shown in Figure 12, below.

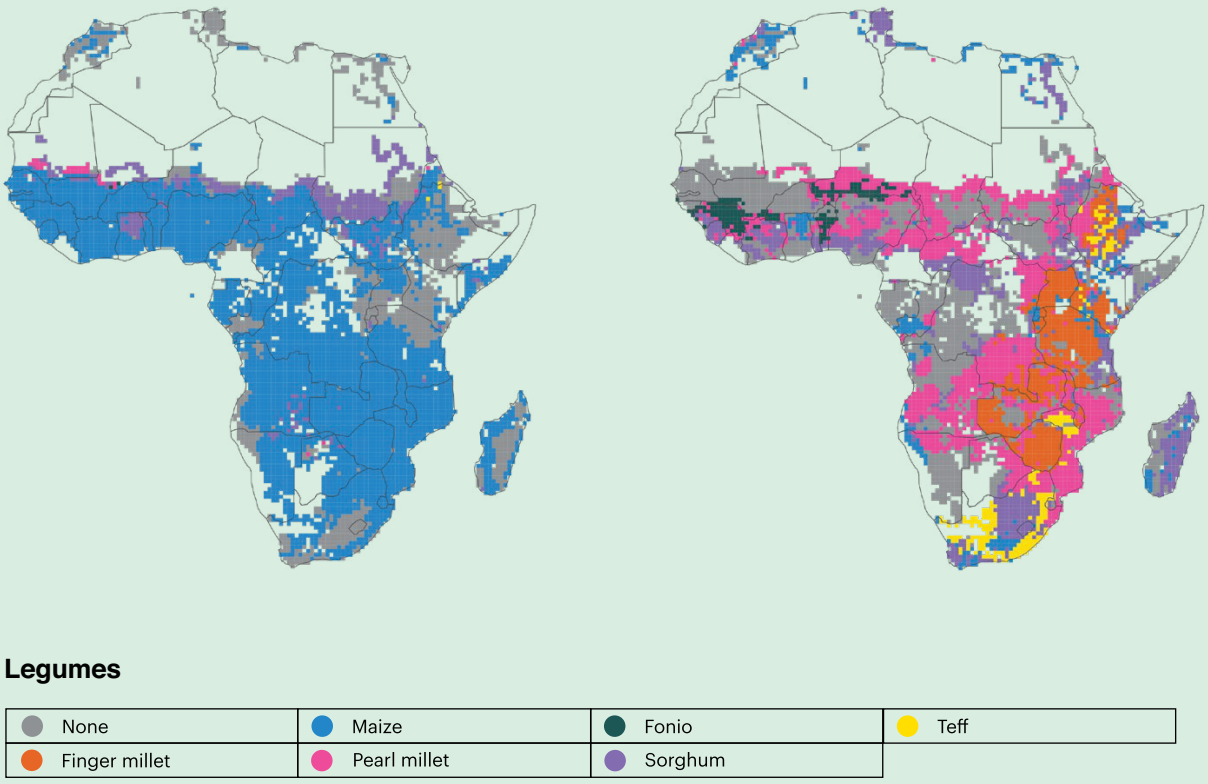
But while rising emphasis is being placed on promoting these crops, they face a profound challenge around end-use. A 2024 workshop in Senegal on the bottlenecks to the uptake of millet in Africa, concluded that: “With the right mix of policy support, technological innovation, and market development, millets have the potential to become the cornerstone of Africa's resilient and sustainable agricultural future.”

In this, demand has already demonstrated its strength as a technology driver. In July 2024, the Kenya Agriculture and Livestock Research Organisation (KALRO) announced the launch of a new, large-grained sorghum seed, resistant to bird attacks, which it had developed in liaison with Kenya Breweries, as a large-scale buyer of sorghum for beer making.

Any wider shift to VACS crops, likewise, rests on the development of the entire value chain to secure rapid progress, with the market currently in an interregnum where many farmers who are shifting to millet growth reporting they are unable to sell their harvests.

A handful of early movers have incorporated millet into their products, including Olam, Kellogg’s in African market breakfast cereals, and Sosat in South Africa. But few of the continent’s bread manufacturers have yet ventured into millet-based breads, holding on strongly to processing, now principally imported, wheat.

Figure 10: Trends in International fertilizer prices by nutrient



A shift lies ahead, however, with research institutes such as Ghana's Food Research Institute developing sour dough for breads and extrusion snacks, and consumer testing showing that switches to up to 70 percent millet flour make little difference to consumer assessments of breads in Africa. Millet flours are also gluten free and have additional health benefits.

As a result, Africa is seeing a first generation of startups creating millet-based value chains and foods. Amaati in Ghana is growing rapidly and profitably working directly with farmers in VACS crops and flagging up a $417k EBT target for 2025. Another processor, Nyirefami in Tanzania was funded as long ago as 2011 to source millet and other crops from 500 Tanzanian farmers that it is processing and marketing.

Others, such as Aduna are producing fonio from millet to use in Cous Cous in the Gambia and Senegal, while Makarere University has worked on a finger millet snack.

However, the development of millet, even into millet flour, remains a substantially dormant sector and a major roadblock to the transition to soil-enhancing VACS crops. Moreover, without such investments, growth to date suggests they will deliver little to slow Africa's land degradation.

Africa's millet market grew from 18m tonnes in 2010 to just 20m tonnes in 2020, while sorghum rose from 25m to 30m tonnes over the same decade, according to the FAO.

Our soil investment insights for Africa

Based on our analysis, we draw the following insights into adaptive soil investments in Africa:

01 Behaviour change:

All soil impact businesses rest on farmer behaviour change. Those targeting behaviour change as their main output need to gain critical mass in audience reach, requiring mainstream media skills and intensive marketing. Soil impact technology and product businesses also need to address awareness raising and behaviour change as a prerequisite for sustainability.

02 Additives:

the most powerful impacts on soil in terms of food gains come from additives, of which biochar is the most transformative, followed by composts and organic manures. The production costs and viability of these circular economy outputs is strong.

03 Synthetic fertiliser:

large funds are available to build new fertiliser production capacity in Africa. But the returns in extra yields can deliver less income than fertiliser costs, seeing fertiliser widely subsidised by African governments and undermining the net income gains for African nations. Low cost technologies and production will mark a significant breakthrough in this market.

04 VACS crops:

Planting materials are sub-optimal and offer scope for investment to increase their positive impacts on soils and yields. However, the big investment need to support Africa's transition to soil enhancing superfoods is the development of a full value chain for these crops, including processing and end uses.

The White Paper Series

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The African Venture Philanthropy Alliance (AVPA) Climate Finance Unit seeks to enable the mobilization and deployment of impact capital for climate action across Africa. This publication is part of the Africa Climate Investing Series on Adaptation Finance which seeks to accelerate the development of a vigorous and sustainable private sector in adaptation in Africa through the development of key knowledge assets.

The series addresses climate impacts, private-sector financing needs, current and emerging financial flows and instruments, including novel emerging markets, sectoral case studies, and innovative policy frameworks. AVPA would specifically like to thank the African Development Bank (AfDB) through the Fund for African Private Sector Assistance (FAPA) and the Lemelson Foundation for providing the financial support that has made this series a reality.

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