DISCUSSION STARTER

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Rethinking inorganic fertiliser subsidies

Could 'payments for soil health services' be an option in Malawi?

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Executive summary

In many southern African agroecosystems, inorganic fertilisers are essential as soils are highly weathered, sandy, low in organic matter and inherently nutrient-poor, and in general insufficient nutrients are being applied to maintain soil nutrient levels. However, the inorganic fertiliser subsidy program in Malawi makes limited economic sense and is not delivering on food security goals, partly because soil health in Malawi is in decline.

Inorganic fertilisers do not always make sense, for example when the risk of crop failure due to drought is high or when fertiliser response is very low due to poor soil health.

The solutions to soil health decline are well known. They include various combinations of fallowing, crop diversification, intercropping and crop rotations (especially with legume rotations), soil organic matter additions, liming and applications of the appropriate inorganic fertilisers. But applying good agricultural practices does have challenges.

If soil health solutions involve legumes and diversification, these generally have positive impacts on human nutrition. Soil health solutions also have climate adaptation and mitigation co-benefits. However, soil health improvement is not a silver bullet for farmers and national food security. Equally important will be the many other things that need to happen on and off farms.

Payments for ecosystems services (PES) to smallholder farmers could be a possible mechanism to build soil health. PES is widely used for water, biodiversity and carbon services. In Malawi it could possibly be used to pay for soil health practices and outcomes, including carbon sequestration. Payments for carbon sequestration are likely too small to stimulate behavioural change by themselves, but co-benefits may be large: human nutritional benefits, enhanced fertiliser use efficiencies, higher yields, diversified production as a way of dealing with climate variability, enhanced access to credit etc.

There are a number of possible ways forward to stimulate soil health improvement:

- Repurpose public support by reducing subsidies on inorganic fertilisers to free up resources for other needed public services for farmers and rural communities.
- Improve the use of fertilisers through enhanced extension services. Step up climate-informed advisories, including through digitalization.
- As part of repurposing, reduce the focus on maize to free up resources that incentivise diversification of staple production and increased legume production. Expanding legume production also means having sufficient demand for legume products from the market.
- Link fertiliser subsidies to payments for soil health practices.
- Link the repurposing agenda and payments scheme to carbon finance (i.e. secure and additional stream of finance to fund the payment scheme).
- Provide incentives to the private sector to enhance the accessibility and affordability of lime and organic fertilisers.
- Explore possible low-cost monitoring, reporting and verification (MRV) systems linked to the payments scheme. Cost of lime is a key concern.
- Consider use of digital tools to (i) administer flexible subsidies, (ii) record agricultural practices (as possible inputs to MRV), and (iii) make payments for soil health practices.

Payments for ecosystems services (PES) to smallholder farmers could be a possible mechanism to incentivise soil health practices.

30%

of Malawi's agricultural budget is earmarked for inorganic fertiliser in the fiscal year 2023/24.

Fertiliser input subsidies

Inorganic fertilisers are important but must be part of a package of public support measures. We want to clarify that it is not that inorganic fertilisers should be removed from public support packages. In many southern African agroecosystems, inorganic fertilisers are essential as soils are highly weathered, sandy, low in organic matter and inherently nutrient-poor, and in general insufficient nutrient inputs are being applied to maintain soil nutrient levels.[1] As Giller et al. (2021)[2] note, crop productivity, and thus the food security and/or incomes of farming households, is tightly constrained by nutrient availability because of the nature of the soils, and the limited availability of inorganic fertiliser, manure and compostable organic matter. But inorganic fertilisers do not always make sense, e.g., when the risk of crop failure due to drought or unreliable rainfall is high (a trend that is intensifying under climate change). Inorganic fertilisers also do not make sense when soil health declines, because crop response to the inorganic fertiliser may be too poor to justify their high costs. Inorganic fertilisers should be part – dare we say a small part – of a wider package of public support measures for farmers.

The fertiliser subsidy program in Malawi is making limited economic sense and is not delivering on food security goals. Malawi has a long history of input-based subsidies. The Affordable Inputs Programme (AIP) was introduced in 2020 and follows from the Farm Input Subsidy Programme (2005-2019).[3] Amongst the countries of Southern Africa, Malawi has one of the highest allocations of national budget to agriculture, and of that more than 50% has gone to inorganic fertiliser in the past,[4] probably dropping to 30% in the 2023/24 season. Despite the subsidy program, Malawi continues to struggle with malnutrition and food insecurity, and crop yields remain low. While some smallholder farmers use the fertilisers efficiently and get good yields, others have low yields that do not justify the use of costly inorganic fertilisers. To make the point that fertiliser use efficiency needs to improve, De Weerdt and Duchoslav (2022)[5] argue that because of the low yields, importing maize would be up to five times cheaper than importing fertiliser for maize production. One explanation for the generally poor outcomes of fertiliser use is that the budgetary focus on inorganic fertiliser crowds out the needed support for other agricultural and rural services.

Soil health is in decline but solutions are known

Soil health is in decline. The response to inorganic fertiliser in Malawi has declined over time (Fig. 1).[6] This is a sign of soil health decline,[7] though contributory factors likely include the increase in the numbers of extreme weather events and late applications of fertiliser.[8] Malawi and much of Southern Africa is dominated by weathered granite sands (Fig. 2) which tend to be acidic, nutrient-poor and low in soil organic matter, and organic matter is easily lost through tillage. This also implies that solutions for Malawian conditions will be valuable as lessons for other countries in the region. There is vast literature from the region on crop cultivation on these soils. Constant application of inorganic fertiliser – in the absence of soil ameliorative measures – makes the soils even more acidic. And in cases where crops are constantly removed and insufficient fertilisers applied, we get nutrient mining. Tillage – in the absence of soil organic matter additions – leads to soils with minimal organic matter, and this further reduces nutrient-holding capacity. Results from Zimbabwe clearly show the acidification trend, where after independence the government put massive effort into smallholder farming.[9] In the high-potential region this resulted in bumper harvests, but over a decade, this region went from 43% having soils with pH less than 5 (very acidic) to 77%. The seriousness of soil acidity in Malawi is shown in Fig. 3, with vast areas of the country having acidic soils. Very acid soils are marked by aluminium toxicity, phosphorous deficiencies and low fertiliser response.

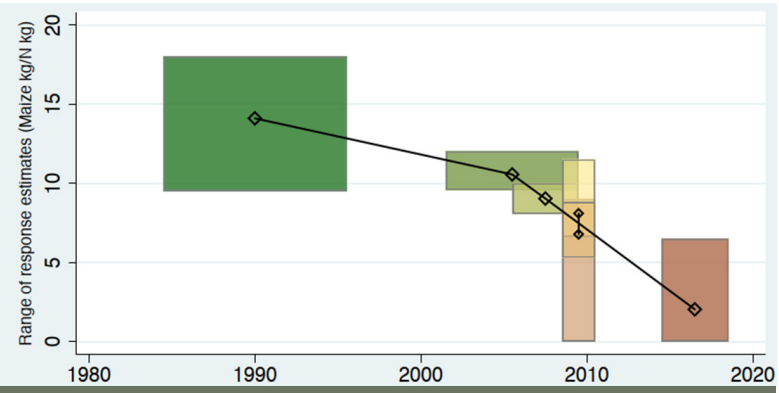

Figure 1. Yield response to nitrogen added on farmer-managed fields over time (1984-2018) in Malawi. This diagram is based on seven different studies, with each box representing the range of yield response estimates on the vertical axis, and the years covered on the horizontal axis. See Nyondo et al. (2021) for further details.[10]

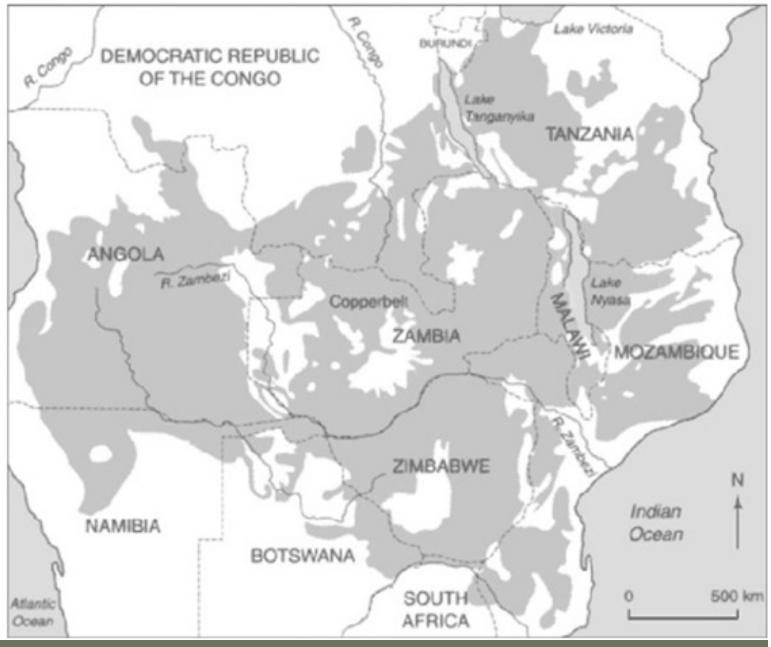

Figure 2. The distribution of miombo woodlands in Southern Africa[11] which corresponds to the distribution of weathered, nutrient poor· generally sandy soils with challenges for crop cultivation.

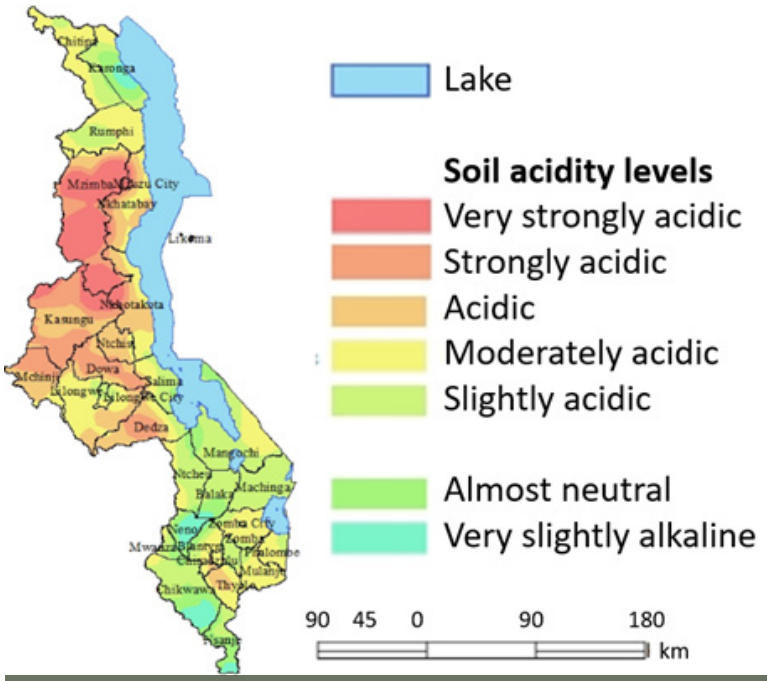

Figure 3. Soil acidity in Malawi (after Munthali et al. 2021).[12]

Solutions to soil health decline and acidification are well known. They include various combinations of fallowing, crop diversification, intercropping and crop rotations (especially legume rotations), soil organic matter additions, liming and applications of the appropriate inorganic fertilisers.[13] Many farmers are aware of what needs to be done but lack the resources to make it happen (Fig. 4).

Figure 4. The soil health problem displayed on a single farm (after Giller, 2022). In the foreground a heavily depleted soil that will give a poor yield. Close to the homestead there is good yield because of better crop management (e.g., likely due to sufficient nutrient and organic inputs, timely farm operations etc.) (Photo: Ken Giller).[14]

Good agricultural practices come with challenges.

"Good agricultural practices" come with challenges. For example:

• Fallowing in Malawi is not a widespread option because of very small farm sizes (averaging 0.69 ha in 2019/20; median: 0.50ha).

• Intercropping and crop rotation could be scaled up, though there are issues of lack of sufficient legume seeds, lack of market outlets for the produce and lack of alternatives to maize in terms of income generation. Benson (2021) argues that because farmers can't rely on thin and unpredictable markets to purchase maize, their primary concern is to satisfy as much of their energy needs from self-production before doing anything else with their land.[15] On 0.5 ha of land, this does not leave much room for crop rotation.

• Legumes can provide a truly renewable source of some nitrogen, but to sustain production in the long term, external sources of other nutrients are required to compensate for the nutrient offtake through harvested crops.[16] Expanding legume production also means having sufficient demand from the market. That an expansion is probably feasible is indicated by the production statistics for Malawi, where between 2010 and 2021, maize production has fluctuated between 2.5 and 4.5 million tonnes, while soybeans and pigeon peas have shown a steady increase (Fig. 5). It is unclear whether farmers can produce more soya at the low price that processors are willing to pay, while at the same time much of Malawi's soya crushing capacity sits unused. Pigeon pea production is largely exported to India and is at risk of the Indian government's occasional imposition of import bans.

• Crop residues are insufficient to maintain soil organic matter for the entirety of farms. Crop residues are also in demand for livestock feed, and burning of residues is also prevalent, largely for pest and disease control. There are win-win situations that can be exploited. If yields can be raised, then there are more crop residues, and if one can apply crop rotations some of the pest and disease problems will be reduced.[17]

• Manure is in short supply, and generally insufficient to cover the entirety of a farmer's field. Manure by itself also does not have sufficient nutrients to maintain high yields. Use of combinations of manure and inorganic fertiliser is well-known by farmers and scientists as a means to raise yields. Many of those getting good yields in Malawi are probably already applying this practice. Pen feeding – and thus accumulating manure – and making compost with the manure through adding other wastes – will help in fertilising fields. Mbeya fertilizer – a composted mixture of chemical fertilizer, ash/bran and animal dung is one such option.

• Liming is a solution to soil acidification when other soil amelioration techniques are not possible (e.g., when there is limited crop rotation, or insufficient organic inputs). However, it adds to the costs farmers face. Many researchers have shown the benefit of liming to improve fertiliser response rates. Research in Malawi suggests that liming plus appropriate inorganic fertiliser makes economic sense in terms of the outputs achieved.[18]

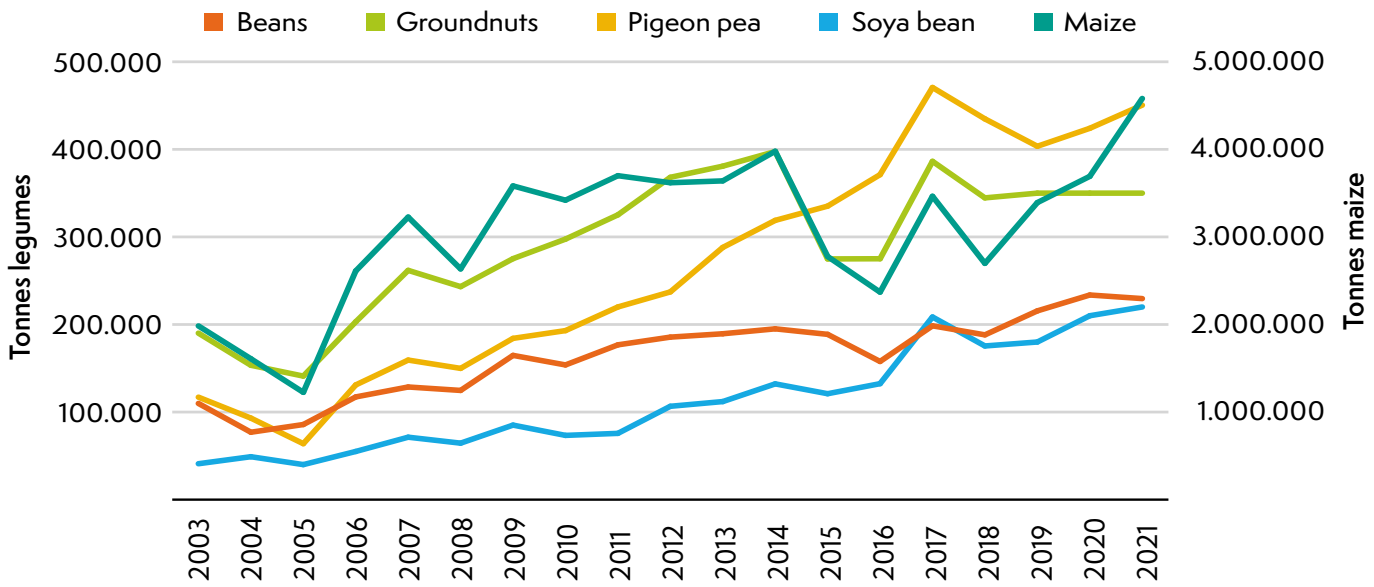

Figure 5. Production statistics for maize and legumes in Malawi (FAOSTAT)

Soil health solutions have nutrition and climate co-benefits

Soil health solutions can enhance human nutrition. If soil health solutions involve legumes and diversification, these generally have positive impacts for human nutrition. Integrating input subsidies and appropriate soil management in Malawi has led to positive outcomes for crop incomes and micro-nutrient consumption.[19] Access to legume subsidies has helped diversity diets.[20]

Soil heath solutions will have climate adaptation and mitigation co-benefits. It is increasingly important to build climate resilience and greenhouse gas mitigation into farming systems and value chains. Diversification through intercropping and crop rotation for enhancing soil health is also appropriate for climate change adaptation. The current subsidy programme heavily favours maize. It is important to diversify staple crop production in Malawi – cassava, sweet potato, rice etc. Improved soil organic matter can help farmers get through dry periods in the growing season. Improved soil health will lead to better fertiliser use efficiency and better yields. If this is coupled with good market prices and reasonable costs of inputs, farmer income can increase, which is also important for adaptation, as poverty and climate vulnerability are closely linked. Improved soil health has the potential to sequester carbon in some places and thereby contribute to climate change mitigation.

But soil health solutions are only a part of the solution to a thriving, resilient rural economy

Soil health improvement is not a silver bullet. While the focus in this *Discussion Starter* is on soil health, this is not a silver bullet for farms, livelihoods and national food security. Equally important will be the many other things that need to happen on and off farms, amongst which are attention to weed management, pest and disease control, timely operations (that are often not possible because of labour shortages and late delivery of inputs), mechanisation, good advisory systems, good markets for outputs, good market infrastructure etc.

Soil health solutions can be an important part, but only a part, of climate change adaptation solutions. For climate adaptation, it is necessary to have additional elements to build climate resilience.

Soil health improvement is not a silver bullet

the many other things that need to happen on and off farms will be equally important.

• Most importantly, good **climate-informed advisories** are needed, so farmers know when it is likely to be best to plant, fertilise and harvest; which varieties are likely to perform best; and when it would be unwise to apply expensive inputs (e.g., in a year that is predicted to be very bad for crop yields due to drought).

• Another element is **sustainable irrigation**. Irrigated land in Africa is woefully inadequate and research shows that sustainable irrigation could be greatly scaled up.[21] Climate risk analyses and hydrological surveys need to proceed with the scaling up of irrigation, to ensure that irrigation is truly sustainable.

• **Climate-resilient practices and technologies** will also be crucial, e.g., drought-adapted varieties.

There are limits to poverty alleviation through stimulating smallholder production. Rainfed agriculture in combination with small farm sizes is unable to bring households out of poverty.[22, 23] There are considerable limits to how much more income can be made from Malawi's fragmented smallholder farms. Benson and De Weerdt's (2023) analysis demonstrates that most poor farming households will never be able to escape poverty through their farming alone, even with substantially higher crop productivity.[24] An expanded and more productive off-farm sector will be equally important.[25] Social protection is crucial for the poorest section of the rural population that lacks sufficient agricultural assets.[26]

Payment for ecosystems services (PES) is a possible mechanism to build soil health

Payments for ecosystems services (PES) to smallholder farmers could be a possible mechanism to build soil health. PES is widely used for water, biodiversity and carbon services. The global initiative CompensACTION seeks to promote PES innovation at large scales to facilitate positive environmental outcomes.[27] In Malawi, PES could be used for soil health services. Such payments could help to incentivise sustainable agriculture practices, which would facilitate climate change adaptation and mitigation (the latter through carbon sequestration), increase and diversify farmer incomes, and possibly improve credit ratings and easier access to finance for farmers.

Payments for carbon sequestration are likely too small to stimulate change by themselves but co-benefits may be large. Farms in Malawi are small and the additional carbon sequestered through soils or agroforestry would likely bring in very small payments to farmers, but the co-benefits of such schemes may still be attractive.[28] These could include, depending on how the scheme is set up: human nutritional benefits, enhanced fertiliser use efficiencies, higher yields, diversified production as a way of dealing with climate variability, enhanced access to credit etc.

Creative low-cost monitoring, reporting and verification (MRV) systems will be essential for PES. A key feature of PES is the MRV system. In the case of a soil health scheme this would mean tracking soil health changes, which could be very costly and outweigh the benefits. For example, soil carbon could be a good simple proxy for soil health, but to detect changes would require massive, expensive, sampling schemes. Tracking practices rather than ultimate outcomes may be a possible way forward. There are a number of companies now offering MRV systems for soil carbon, but these would need to be tailored to southern African conditions and they are largely untested and relatively complex.[a]

Possible ways forward to enhance soil health

1 Repurpose public support by reducing subsidies on inorganic fertilisers to free up resources

• .... for other needed public services for farmers. Sustainable and resilient farming and lifting farming households out of poverty is predicated on a wide range of public and private support services: transport and energy rural infrastructure; digital connectivity; marketing infrastructure; good markets for farm products; access to credit and insurance; expanded irrigation; access to mechanisation; appropriate seeds; weed, pest and disease control measures; and climate-informed advisories.[29] Improved advisory systems need to prioritise: (a) Timely and accessible weather advisories for the agricultural sector; (b) Need for intercropping and crop rotation, especially of legumes; (c) Importance of good weed control to boost yields; and (d) Improved extension of fertilisers. The latter could involve, amongst other things, promoting the use of area-specific fertiliser recommendations, avoiding the use of acidifying fertilisers such as urea, use of up to three split fertiliser applications, liming, growing crops and varieties adapted to local soil and climatic factors, manure application, rainwater harvesting, physical soil conservation measures and conservation agriculture.

[a] Examples of possible tracking systems include: "Biocode — Carbon footprint calculator that makes sense" and "Enabling sustainable farming through world-leading MRV"

Payments for ecosystems services (PES) to smallholder farmers could be a possible mechanism to build soil health.

• ... for social protection recipients.[30] The current allocation of fertiliser subsidies is not economically efficient, with many farmers unable to reap the benefits of increased yields that fertilisers should bring. Fertiliser allocations to unproductive farmers is an inefficient and costly social protection mechanism. More productive farmers need to be targeted for fertiliser subsidies. Least productive farmers are also likely to be the poorest of the poor and will need to be supported through other social protection measures. Over the longer term, some of these may transition to higher productivity through investments in soil health, agricultural extension and research. [31, 32] Others may transition to being employed in rural or urban areas.

• ... as part of repurposing, reduce the focus on maize to free up resources that can foster diversification of staple production and foster expanded legume production. Legumes are one part of the solution to soil health as well as being important for nutrition, but to expand their production needs access to seeds, the soil inputs they need (commercially available, high-quality inoculum and appropriate fertiliser blends), good extension advice on the soil inputs needed and good markets. Incentives for legume production and alternative staples could involve enhancing access and affordability of inputs needed and incentivizing the private sector to build good output markets for legume production and for staples other than maize. Nutrition education on the consumption of nutrient-rich diversified foods could be improved through working with the Ministry of Health. This can be linked to the Scaling Up Nutrition initiative that is active in Malawi.

2 Link fertiliser subsidies to payments for soil health practices

To make the most out of costly inorganic fertilisers, it is essential to improve soil health. PES is a possible mechanism to improve soil health but does have challenges. PES payments are made on the delivery of a service. In the case of soil health, this would occur after the crop has been grown and the service delivery verified, but farmers need upfront payments as inputs are needed before the season commences. In addition, soil health is a "slow variable" with measurable change only occurring after several seasons. We suggest upfront payments for soil health practices, but with longer-term monitoring of soil health outcomes, to ensure that the practice payments are delivering the outcomes desired.

3 Link the repurposing agenda and payments scheme to carbon finance

This could stimulate an extra stream of income for the farmers, though the amounts will not be large. The primary short-term benefits of the scheme for farmers will come through improved fertiliser use efficiencies, better crop growth and increased incomes.

4 Provide incentives to the private sector to enhance the accessibility and affordability of lime and organic fertilisers

5 Consider the use of digital tools to (i) administer flexible subsidies, (ii) record agricultural practices and (iii) make payments for soil health practices

Transaction costs of the soil health payment mechanism need to be low, and it is likely that digital tools will be essential. These could also be linked to the way which subsidies are administered.[33] Flexible subsidies would allow farmers to choose what they need to address their "pain points". Farmers are almost always in a better position than outside experts to know what they need. Practices that deliver payments could be recorded on a digital tool. It will be important to build a farm database to track soil health practices for the MRV system. And farm databases could also be used to assess credit risks and facilitate the flow of finance. The payments made to farmers for soil health practices could be digitally transferred. However, we do recognise that previous digital systems have been negatively experienced by farmers.[34]

6 Explore possible MRV systems, including remote sensing as a low-cost mechanism to track changes in soil health

A number of research groups and companies are experimenting with remote sensing as a way to track soil carbon, which could serve as an indicator of soil health.[35,36] However, changes are only likely to be detected over a longer period of time and perhaps only at a regional scale rather than a farm scale. This could possibly be used to demonstrate that the scheme is on track, rather than as a mechanism to verify payments at a farm level.

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