Food and Agriculture Organization of the United Nations

Government of Malawi
Ministry of Agriculture, Irrigation and Water Development

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Poverty-Environment Initiative

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Policy brief

Impact of soil loss in Malawi: microeconomic effects of soil and nutrient loss. Profitability and mitigation measures

GLOBAL SOIL PARTNERSHIP

Background

Sub-Saharan Africa has been historically affected by land degradation phenomena. In many rural countries, the stagnation of the economy can be attributed to low agricultural productivity. According to the World Bank (WDI 2017), in Malawi, the agricultural sector represents around one third of the total value added for 2015. Maize, cassava, potatoes and sugar cane are the major crops in terms of production value. The rural population is predominant, accounting for more than 80% of the total population (WDI 2017). Given the importance of the agricultural sector in the Malawian economy, soil and nutrient loss represent a major limitation to the overall economic development of the country.

Through the adoption of specific agricultural practices, farmers can partially mitigate the impacts of both soil and nutrient loss. However, the adoption of these practices is not an easy task. Some require households to sustain variable costs (fertilizer application), while others come at a fixed cost (anti-erosion practices) or at non-financial costs (crop diversification and legumes intercropping). The FISP already partially compensates households for the high price of fertilizers (Urea and NPK) through the distribution of vouchers. An analysis of the effectiveness of current policies, as well as of new policy design, should not overlook the FISP costs sustained by the Government and the underlying benefits for the different recipient groups. Numerous studies point to a saturated efficiency against large costs of the FISP. However, this study identifies room for further improvements of allocative efficiency with limited implementation costs and substantial benefits for the population.

Methods

This policy brief is based on a recent technical report on the microeconomic and macroeconomic impacts of nutrient and soil loss in Malawi. Econometric estimates were used to evaluate the impacts, differentiated by segments of the national population and geographical areas. In the same manner, the demonstration of mitigation effects by specific agricultural practices offers valuable information for the design of policy recommendations aimed at maximizing farmers' profit when facing the ever-increasing issue of land degradation.
After providing an overview of the impact of soil loss in terms of productivity on different population groups (geographic area, wealth class, gender), we explore potential methods to reduce the effects of soil and nutrient loss. Given the substantial impacts associated with nitrogen (N) loss, only this nutrient is accounted for in the profitability analysis. Two scenarios are considered: a current loss rate of 4kg/ha, and a higher rate of 22 kg/ha. The costs are a function of fertilizer quantity and the FISP average price or the market price. Average maize profits obtained by the farmers are used to account for the current NPK and Urea application rates.

Findings

Figure 1 illustrates the impact of an increase in soil loss in terms of percentage reduction in maize productivity in all the districts. The analysis by district shows that the largest expected impacts affect the southern ones the most.

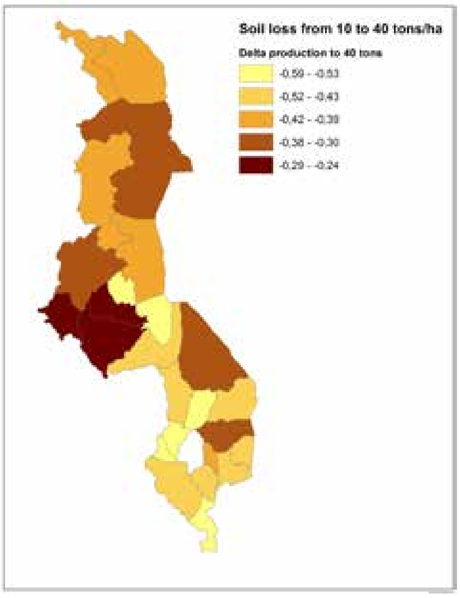

Figure 1: Expected changes in maize productivity (in %) for an increase of the soil loss to 22 tons/ha/year w.r.t. a baseline scenario of 10 tons/ha/year.

Figure 2 reports the impact of a 1% increase in soil loss on different welfare indicators. The analysis is also disaggregated by population groups. We can see that the most fragile households (Decile 1) are those for which the impact is higher for all the indicators. Soil loss does not seems to affect per capita consumption and food security for wealthier households, thanks to their capacity of relying on alternative income sources.

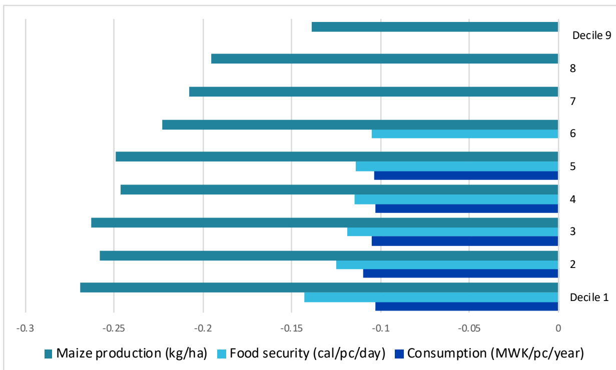

Figure 2: Percentage impact on welfare indicators for a 1% increase in soil loss, for different segments (deciles) of the population

Moreover, the findings from the report also clearly indicate that female headed households experience, on average, double the negative impact on productivity and per capita real consumption that male headed households experience.

Among the nutrients, the major impacts of depletion are linked to Nitrogen loss. Fertilizer application is one of the practices that could help to replenish nutrients and, indeed, increasing chemical fertilizer use is a major objective of FISP. Nevertheless, the increase in land degradation phenomena calls for additional policy efforts related to setting application rates. At the current nutrient (N) loss rate, the profit maximizing application rate of NPK for an average farmer corresponds to 168 kg/ha with FISP pricing and 111 kg/ha for the full market price. When N loss rate increases to 22 kg/ha, the profit maximizing quantities are 149 kg/ha and 101 kg/ha, respectively. For Urea, the profit maximizing quantities for the FISP and full market price are of 173 and 116 kg/ha, respectively, with the current N loss and 125 kg/ha and 79 kg/ha for an increasing N loss scenario.

Using the current fertilizer application rates forthe increased N loss increase, the average annual profitability would decrease by about 11% (from 65,000 MWK to 58,000 MWK), whereas by using the recommended fertilizer rates, it would increase by about 13.1%, even considering any increases in N loss. Figure 3 shows the Benefit-Cost (B/C) ratio of the current and recommended Chitowe application rates under the two loss scenarios (the Urea shows the same figures).

Nevertheless, when disaggregating the analysis by FISP recipients and wealth class, the results indicate that:

1. farmers that are not under the FISP always have lower current application rates of fertilizers, which demonstrates the low affordability of commercial fertilizers;
2. poor non-recipient farmers have a chemical fertilizer application rate of almost zero;
3. under the current FISP setting, the profit maximizing rate of fertilizer application, when N loss shifts from 4 to 22 kg/ha, would increase to around 100 Kg/ha with respect to the current rate;
4. in absolute terms (increase of annual net income), poorer farmers benefit the most when switching to the profit maximizing rate;
5. importantly, among the middle and upper classes, FISP recipients seem less responsive to fertilizer use than non-recipients, implying that the FISP inclusion criteria could be reviewed by selecting more efficient farmers than current ones.

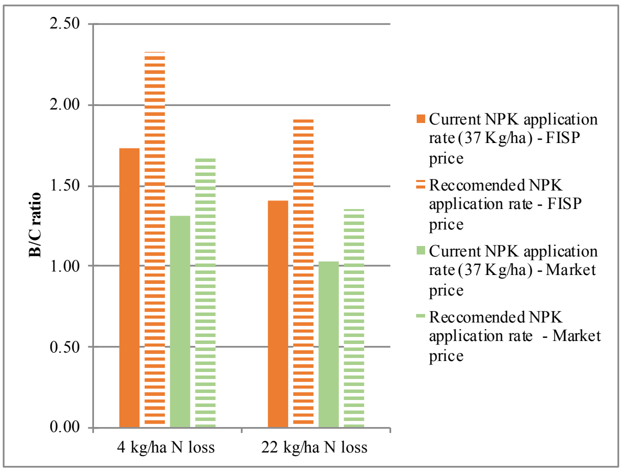

Figure 3: C/B ratio for increasing N loss and comparing current and recommended NPK (chitowe) application rates.

As shown in Table 1, bringing all current FISP recipients to the recommended rates, when N loss increases and the price of fertilizers is subsidized, results in a non-profitable policy measure, with a "social" (farmers + government) B/C ratio lower than one (B/C=0.43). This is due to a high provisioning cost sustained by the government and to the fact that many FISP recipients are less efficient than non-recipients. Despite the high cost to the Government, the policy has a beneficial effect on farmer productivity.

A) Delta fertilizer application rate (to switch from current to recommended)	210%
B) Average delta net crop income of FISP participant (MWK)	14,000
C) Current (2016) FISP recipients (HH)	900,000
D) Current Government FISP cost (only fertilizers) (MWK)	27,000,000,000
E) Delta benefits of FISP participant (to switch from current to recommended rate) (B*C)	12,600,000,000
Delta government FISP cost ((A*D)-D)	29,700,000,000
B/C ratio of subsidizing the recommended fertilizer rate when the N loss increases (E/F)	0.42

Table 1: Social (farmers + government) B/C ratio to shift the current FISP recipients from the current fertilizer application rate to the profit-maximizing rate.

As explained above, FISP non-recipients are more efficient in terms of fertilizer use in the middle wealth class. Thus, the Government could shift a share of vouchers from current recipients that are more likely to purchase commercial fertilizers (owners, with a higher education and a large number of household members) to those non-recipients that are less likely to purchase commercial fertilizers. With this adjustment the social B/C ratio would shift from 0.42 to 0.89, closer to 1.

An alternative viable and cost-effective proposal could be to enlarge the fraction of farmers that are more likely to buy fertilizers from the private sector at the market price, thus reducing the government's subsidy cost. The main socio-economic characteristics that increase the likelihood of purchasing from the private market are identified as being higher education levels, land ownership and a higher wealth status. At the same time, the adoption of specific practices, such as legume intercropping, are a good substitution for the mitigation of N loss by considerably increasing chemical fertilizer use. Poorer farmers are more prone to adopting these substitute practices because they are most likely already using high crop diversification management practices in order to reduce the potential climatic and market risks.

Farmers that adopt legume intercropping obtain a higher net crop income, probably due to the capacity of legumes to fix N, thus reducing the use of fertilizers and associated costs. Consequently, the net crop income of both FISP recipients and non-recipients, increases by about 40% on average when this practice is adopted. In this case, the recommended fertilizer rate for actual FISP participants would be similar to the current rate, and the costs for the Government, summarized in Table 2, is lower than when assuming only a change in the fertilizer subsidies (Table 1). The resulting profitability of this proposal seems to be very high (B/C=4.34) even considering a moderate N loss scenario.

A) Delta fertilizer application rate (to switch from current to recommended)	0%
B) Average delta net crop income of FISP participant without legume intercropping (MWK)	22,000
C) Potential recipients of legume seeds (HHs)	830,000
D) Additional cost to the Government of legume seeds	4,200,000,000
E) Delta total benefits of FISP participant (to switch from current to recommended rate and legume intercropping) (B*C)	18,260,000,000
B/C ratio of subsidizing the recommended fertilizer rate and legume intercropping when N loss increases (E/D)	4.34

Table 2: Social (farmers + government) B/C ratio to shift the current FISP recipients from the current fertilizer rate to the profit maximizing rate when legume intercropping is subsidized.

Final remarks and recommendations

The largest impacts of soil loss are faced by small-holder farmers, (-0.269% reduction in maize production compared to -0.139% for larger farmers for a 1% increase of current soil loss level). Such a pattern is similar when considering food security and total consumption outcomes. Therefore, further policy intervention should aim to mitigate such productivity gaps in order to also improve key livelihood assets such as caloric intake and total consumption in households that are strictly dependent on agriculture, while wealthier households can rely on additional sources of income.

The gender gap should also constitute a policy priority, since soil loss affects female-headed households with much larger impacts. A 1% reduction in soil loss translates into about a-0.23% in maize productivity for male-headed households and -0.39% for the female ones. The impacts on total real per capita consumption show the same order of magnitude. This pattern is also confirmed by hypothesizing an average loss increase to 22 tons/hectare, which would yield a 32-61% loss in maize productivity. When imposing a more severe scenario with an average loss of 40 tons/hectare, the expected productivity loss ranges from 39% to 77% with regard to the current baseline scenario of 10 tons/hectare.

Similarly to the top soil loss, the nutrient loss also assumes differentiated impacts across different groups. In the case of nitrogen (for which the most significant effects are found), the impacts on the most fragile rural farmers are more than double the impact on wealthier farmers. Moreover, warm agroecological zones are likely to be more affected by an increase in land degradation.

When considering the effects of practices aimed at mitigating the impacts of soil and nutrient loss, the highest economic mitigation impact results from the adoption of anti-erosion practices such as the planting of Vetiver grass, followed by terraces, tree belts and bunds. When nutrient loss is accounted for, crop diversification represents a key strategy to be sustained at the political level, as it is associated with a significant reduction in potassium and nitrogen loss, even considering that this practice is more frequently adopted by female-headed households.

When considering further policy interventions for mitigating the impact of nutrient loss, it is worth considering the current FISP cost, which seems to not be strongly sustained by a relevant return in terms of social net benefits. This is despite the fact that farmers – especially the poorest ones – would gain a net income important for their livelihood when the issue of nutrient loss becomes more severe.

Strategies to increase access to commercial fertilizers, excluding those households that are more likely to purchase fertilizers from the private sector, would reduce subsidy costs for the Government. The latter should account for farmer characteristics when allocating FISP vouchers, in order to give priority to the most marginalized farmers that suffer the most from soil loss impacts. On the contrary, wealthier farmers should receive lower subsidies, although an increase in the distribution of subsidies to the middle class would be more favorable. These allocation criteria would allow the Government to maintain the current expenditure for fertilizers and avoid the huge increase projected in the case of a single practice setting. This would also result in a higher profitability, B/C=0.89, which is higher than B/C=0.42 associated with the single-policy case. The socio-economic characteristics that maximize the probability of buying from the private market, are a higher age and education of the household head, high distance from main urban areas, plot ownership and political activity of household members. These points should be taken into consideration by policy makers when choosing target groups for their subsidy program.

An alternative and more profitable solution may be to encourage other agricultural practices able to substitute the mitigation effect provided by fertilizer use in the face of nutrients loss. The reduced costs of fertilizers is expected to increase the net crop income of about 40% on average for all the groups (poor, middle and well-endowed households with higher benefits estimated in cool humid and sub-humid agroecological zones). Encouraging the integration of modern practices with effective sustainable practices, with legume intercropping as an elective practice, would have a negligible cost for the Government (mainly due to the increase in distribution of subsidized legume seeds and, ideally, providing extension services to incentivize the adoption of this practice) while generating a very high return (B/C =4,15). This is a win-win scenario, given that the impact of nutrient loss is asymmetrical and females are the most affected groups. Furthermore, female household heads are more likely to adopt legume intercropping. Therefore, by targeting this group for subsidies, intercropping could produce a twofold effect of reducing the gender productivity gap as well as mitigating nutrient loss.

The **Poverty-Environment Initiative (PEI)** Malawi of the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP) supports country-led efforts to mainstream poverty-environment linkages into national development planning and budgeting. PEI provides financial and technical assistance to government partners to set up institutional and capacity-strengthening programs and carry out activities to address the particular poverty-environment context. PEI is funded by the governments of Norway, Spain, Sweden, the United Kingdom, and the European Union and with core funding of UNDP and UNEP.

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The **Global Soil Partnership (GSP)** was established in December 2012 as a strong interactive partnership to promote sustainable soil management. It is a mechanism that fosters enhanced collaboration and synergy of efforts between all stakeholders, from land users through to policy makers. Its mandate is to improve governance of the planet's limited soil resources in order to promote the sustainable management of soils and guarantee healthy and productive soils for a food secure world, as well as support other essential ecosystem services. Awareness raising, advocacy, policy development and capacity development on soils, as well as relevant implementation in the field are among the main GSP activities.

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